The Demand for Condoms: Evidence from a Randomized HIV Prevention Experiment in Zambia

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To my parents.

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List of Abbreviations

AIDS	Acquired immunodeficiency syndrome
ART	Antiretroviral therapy
ATE	Average treatment effect
BDM	Becker-DeGroot-Marshak
CBH	Central Board of Health
CSO	Central Statistical Office Zambia
DHS	Demographic and Health Survey
FHT	Family Health Trust
GDP	Gross domestic product
GPS	Global Positioning System
GRZ	Government of the Republic of Zambia
HFC	Health Facility Census
HIV	Human immunodeficiency virus
IHME	Institute for Health Metrics and Evaluation
IIA	Independence from irrelevant alternatives
iid	independent and identically distributed
ITN	Insecticide-treated bed net
JICA	Japan International Cooperation Agency
LCMS	Living Conditions Monitoring Survey
MMNL	Mixed multinomial logit
MNL	Multinomial logit
MOH	Ministry of Health Zambia
MSM	Men who have sex with men
NGO	Non-Governmental Organization
OLS	Ordinary least squares
PEP	Post-exposure prophylaxis
PMTCT	Prevention of mother-to-child transmission
PrEP	Pre-exposure prophylaxis
RCT	Randomized controlled trial
RUM	Random utility maximization

SFH	Society for Family Health
SSA	Sub-Saharan Africa
STI	Sexually transmitted infection
SUTVA	Stable unit treatment value assumption
TIOLI	Take-it-or-leave-it
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
ZMK	Zambian Kwacha (Zambian currency until 2012)
ZMW	Zambian Kwacha (Zambian currency introduced December 2012)
ZSBS	Zambian Sexual Behaviour Survey

1 Introduction

Health is not only indispensable for an individual's well-being and quality of life but also a crucial determinant of economic development. Healthy individuals spend less for health care and consume fewer resources of family members in terms of time devoted to care. The economic benefits of good health, however, continue far beyond averted health care costs, in particular through the following channels: healthy children achieve better learning outcomes than peers struggling with frequent absences in school or cognitive impairments as a result of disease, healthier adults are more productive and less often unemployed, and an increased life expectancy constitutes an incentive to save and invest. Education, productivity, and investment are crucial determinants of an individual's income. A large body of research has found substantial positive effects of health on economic development at both, the microeconomic and macroeconomic level, substantiating impressive economic returns to investing in health (Mwabu 2008; Jamison et al. 2013).

In order to enhance or preserve their health, individuals consume health care. Health care comprises all goods and services with the primary purpose of improving health or preventing its deterioration, that is, curative and preventive health care. Since the 1960s, research on individual demand for health care has advanced remarkably, contributing to the formation of health economics as a subdiscipline of economics and its growing importance in academia and public policy (Culyer and Newhouse 2000). Among health economists, a broad consensus has emerged that demand for health care differs significantly from standard consumer choice due to the impact of health care consumption on the consumer's health (Schultz 2004; Mwabu 2008). At least since Michael Grossman's (1972) influential work on health capital, the health economics literature recognizes the dual benefits of health to an individual in terms of physical and psychological well-being on the one hand and as a source of economic development on the other hand. Demand for health care is thus considered as derived from demand for health; or in other words, unlike standard consumer goods, health care is commonly not a direct source of utility for the consumer but rather demanded as an input to produce health, which in turn provides utility as an end in itself and as a means of generating income.

The importance of health to the physical well-being and economic success of individuals and societies motivates governments around the world to intervene in health care markets. Common interventions include the direct provision or subsidization of health care with the aim of encouraging demand by reducing the cost for the consumer. The motivations for public interventions in health care markets are two-fold: to increase equity and to increase economic efficiency (Mwabu 2008; Dupas 2014b). Although the definition of equity is not consistent in the health literature (Culyer and Wagstaff 1993; Wagstaff and Doorslaer 2000), the pursuit of increased equity can broadly be described as an ethical concern regarding the distribution of health in the population; a concern which manifests itself in the human right to receive a minimum amount of health care regardless of an individual's financial means. The aim for increased economic efficiency, on the other hand, is rooted in the theory of welfare economics. As elaborated in the seminal article of later Nobel Prize winner Kenneth Arrow (1963), considered a founder of health economics, health care markets differ strongly from the standard model with competitive markets. In particular, Arrow emphasized that the competitive preconditions for an efficient allocation of resources are commonly not met in health care markets and that this can be related to the presence of uncertainty, which is much more pronounced in health care markets than in other markets. Uncertainty exists, for instance, regarding an individual's risk of illness or the effectiveness of health care. Furthermore, he emphasized that the level of uncertainty is highly asymmetric in health care markets: patients commonly have significantly less relevant information than medical professionals. At the same time, insurance products to protect oneself against the risk of medical expenses and income losses are often not available. Government interventions in health care markets are consequently the attempt to overcome market imperfections and the welfare losses resulting from the failure to reach the optimal state in the sense of Pareto.

Both, the concern for equity in health as well as imperfections in the health care market are particularly pronounced in developing countries, motivating widespread interventions not only by national governments but to a large extent by international donors. As a consequence of widespread poverty and insufficient supply of health care, a large part of the population does not receive a minimum amount of health care from an ethical point of view. In addition, market imperfections are common: the lack of information on disease risks and health care is even stronger in developing countries and insurance and credit markets are commonly non-existent (Mwabu 2008; Dupas 2011). Prevention of diseases is of particular importance in low-income countries and the focus of many health interventions for the following reason. Low-income countries face very different health challenges than high-income countries. While non-communicable diseases such as heart conditions and strokes are on the rise also in low-income countries—currently accounting for 37% of deaths compared to 88% in high-income countries—they suffer from a high prevalence of diseases that are contagious, including diarrheal diseases, HIV/AIDS, malaria, and tuberculosis (WHO 2017c).[1] Communicable diseases receive particular attention by development interventions because their prevention is associated with positive externalities. More precisely, in addition to the individuals who protect themselves from acquiring a communicable disease, for instance through vaccination, others benefit from a lower disease transmission. Public interventions therefore aim at increasing consumption of preventive health care towards the social optimum (Arrow 1963; Mwabu 2008).

A distinctive feature of the communicable diseases prevalent in developing countries is that most of them are preventable by adopting very simple preventive behaviors. In the event of illness, however, they are often life-threatening as a result of inadequate health care in resource-limited settings (Dupas 2011). For illustration, a large share of diarrheal diseases can be prevented by drinking only water which has been boiled or treated with special purifying products beforehand, and by washing hands on a regular basis. The risk of malaria can be significantly reduced by sleeping under an insecticide-treated bed net to avoid mosquito bites. Considering that health and economic benefits of preventing these diseases are large, and assuming that the absence of adequate treatment possibilities and health insurance products in developing countries induces individuals to adopt less risky behaviors, one would expect that weighing costs and benefits results in a strong demand for simple preventive health products, including bed nets, soap, or water treatment products.[2] On the contrary, however, private investment in disease prevention is extremely low in developing countries, contributing to the fact that diarrheal diseases, HIV/AIDS, and malaria all rank among the seven leading causes of death in low-income countries (Dupas 2011; WHO 2017c).

[1] Communicable diseases, maternal causes, conditions arising during pregnancy and childbirth, and nutritional deficiencies accounted for 52% of all deaths in low-income countries and for 56% of all deaths in the African region in 2015 (WHO 2017c).

[2] This assumption is in line with the argument made by Arrow (1963) that missing insurance markets reduce the desire of individuals to consume risky goods, implying that risky goods are complementary to risk protection.

This dissertation focuses on one specific preventive health product with great significance for developing countries. More precisely, I analyze empirically the demand for condoms by means of a randomized HIV prevention experiment in Zambia. Condoms have been shown to be highly effective at preventing sexual transmission of HIV when used consistently during sexual intercourse (Weller and Davis-Beaty 2002).[3] HIV/AIDS has arguably been the most threatening disease in developing countries during the last three decades, and has characterized in particular the disease burden in Sub-Saharan Africa. Despite a recent decline in transmission at global level and remarkable developments with respect to HIV/AIDS treatment, the extent of the epidemic remains devastating. In 2015, 37 million people were HIV-positive worldwide. Over 2 million people became newly infected with the virus, mostly through heterosexual contact, and over 1 million people died of its consequences. Sub-Saharan Africa accounts for two thirds of both, the number of people living with HIV as well as the global number of annual new infections, and for even 70% of HIV-related deaths (UNAIDS 2016a). Due to the progressive deterioration of the human immune system and thus the individual's health as well as the fact that the working-age population is primarily affected, HIV/AIDS has severe economic implications for individuals and their families. Empirical research has shown HIV infection to adversely affect labor market participation and productivity (Fox et al. 2004; Larson et al. 2008; Thirumurthy, Zivin, and Goldstein 2008; Levinsohn et al. 2013) as well as human capital investment (Zivin, Thirumurthy, and Goldstein 2009; Fortson 2011).

Although resources have been slightly declining in the last few years, HIV/AIDS has received unprecedented amounts of public spending since its discovery. Total resources for the response to HIV/AIDS in low and middle-income countries amounted to 19 billion US dollars in 2015 (UNAIDS 2016b). As the extent of the epidemic and the dominance of sexual transmission became clear in the early 1990s, many countries in Sub-Saharan Africa witnessed a massive expansion of condom distribution programs to encourage the use of the only effective prevention method available at that time. With the major scientific advances made in the field of HIV/AIDS treatment since the early 2000s and the discovery of the preventive effect of antiretroviral drugs, attention has somewhat shifted away from condoms towards biomedical methods of HIV prevention. Yet, recently, the international community

[3] Throughout this dissertation, I refer to male condoms, that is, customary condoms utilized by men, as distinguished from female condoms, which are inserted by the woman before sexual intercourse and are also promoted in some African countries.

has reemphasized the crucial role of condoms for HIV prevention and the global response to the epidemic, increasingly recognizing their advantages, such as high cost-effectiveness, additional protection against other diseases and unwanted pregnancies, and the fact that they remain complementary to all other HIV prevention methods, which only provide partial protection (UNFPA, WHO, and UNAIDS 2015).

While the international community largely agrees on the need to intervene in health care markets and to encourage health-related behaviors including preventive behaviors in developing countries, the type and extent of interventions are subject to ongoing debate among researchers and practitioners.[4] With respect to condom distribution, much of the debate has centered around the questions at what price condoms shall be provided to the consumer, where they should be offered, and what messages should be provided to which target group. Most countries in Sub-Saharan Africa implement a two-pronged approach to make condoms available to the public: on the one hand, condoms are provided free of charge at public health clinics while on the other hand, so-called social marketing programs provide specific condom brands at subsidized prices in local shops and carry out education campaigns to raise knowledge about HIV/AIDS and preventive measures, often to specific high-risk groups (Sweat et al. 2012; O'Reilly et al. 2014). While free distribution intends to ensure access to condoms even for the most destitute, social marketing programs aim at creating conditions closer to the market. More precisely, social marketing programs develop a condom brand and promote its distribution through private logistics systems to make it available at subsidized prices in outlets which are more convenient to the population than health clinics, both, in terms of access as well as privacy. They thus aim at encouraging condom use by reducing the costs of condom acquisition for the consumer, including the monetary price, travel costs, as well as psychological costs (Armand 2003; Chapman et al. 2012; Sweat et al. 2012). Charging a positive price is a key principle of social marketing for the following reasons. Free condom distribution has strongly been associated with a waste of resources, presuming that condoms are distributed to individuals who do not need or use them. Furthermore, in many Sub-Saharan African countries, concerns exist among the population that condoms distributed free of charge are of poor quality. Positive prices of social marketing condoms are intended to stimulate demand, encourage use, and reduce

[4]See, for instance, the comment by Mead Over and discussions in the blog of the Center for Global Development: "User Fees, Optimal Pricing and Upward Sloping Demand Curves in Health" (`https://www.cgdev.org/blog/user-fees-optimal-pricing-upward-sloping-demand-curves-health`).

wastage by attaching a value to the condom, by signaling product quality, and by targeting individuals with the highest health benefits (Lewis 1986; Meekers 1997; Armand 2003; Brent 2010; Chapman et al. 2012; Sweat et al. 2012; O'Reilly et al. 2014).

Despite many years of widespread HIV prevention interventions making condoms available in developing countries and educating the population, condom use remains a considerable challenge in many countries suffering from a high HIV prevalence, giving rise to questions regarding the effectiveness of HIV interventions. The last years have been characterized by a recurring debate on development effectiveness calling for more rigorous methodologies in order to show "what works and what does not" in development assistance and therewith justify the use of public funds. In applied microeconomics, this has resulted in an increased implementation of randomized controlled trials with the goal of identifying causal effects of interventions which allow sound statements about their effectiveness (Banerjee and Duflo 2009). In the course of this development, a growing body of experimental field studies examines preventive health behaviors and barriers to prevention in developing countries. Experimental studies have primarily analyzed demand for insecticide-treated bed nets and water purification products, but a few also focus on soap, vitamins, and shoes. In sum, these studies confirm that market imperfections are common reasons why private investment in disease prevention is low in developing countries. For instance, it has been shown that individuals are more likely to adopt preventive behaviors after being educated on the returns to prevention, suggesting that a lack of information on risk of illness and effectiveness of prevention kept them from making rational decisions (Madajewicz et al. 2007; Jalan and Somanathan 2008). Furthermore, a series of studies has shown that individuals respond very sensitive to the price of preventive health products (Ashraf, Berry, and Shapiro 2010; Cohen and Dupas 2010; Meredith et al. 2013; Blum, Null, and Hoffmann 2014; Comfort and Krezanoski 2017). Although they represent simple products in terms of their technology and application, many preventive health products require a large initial investment as, for instance, shoes or insecticide-treated bed nets. As a consequence, missing credit markets or lack of safe saving conditions have been identified as reasons for the large price sensitivity of demand (Dupas 2011; Tarozzi et al. 2014).

Considering the long history of condom subsidization programs in developing countries, it is not surprising that a vast number of studies and surveys evaluating condom social marketing programs has been carried out. While there is some evidence that condom programs can increase condom use, it has been criticized that this statement is primarily based on studies lacking sufficient rigor (Foss et al. 2007; Sweat et al. 2012). In fact, most studies devoted to analyzing determinants of condom demand suffer from methodological weaknesses, in particular the failure to isolate the effects of different factors such as price, physical access, substitute goods such as other contraceptives, or simultaneously implemented initiatives, especially education campaigns. Furthermore, existing studies mostly rely on stated preference surveys, reported past purchase behavior, or aggregated sales data, which are associated with different forms of biases. Systematic reviews on social marketing programs and demand for contraceptives have repeatedly called for more rigorous research on determinants of condom demand, in particular for randomized experiments (Janowitz and Bratt 1996; Sweat et al. 2012; O'Reilly et al. 2014; Korachais, Macouillard, and Meessen 2016). Yet, while the experimental evidence base has grown for other preventive health products as illustrated above, to the best of my knowledge, no randomized field experiment providing data on actual condom purchase decisions has been carried out so far that can establish causal effects of different factors on condom demand.

Several aspects inherent to condom demand suggest that evidence on determinants of demand for other preventive health products is not directly transferable to condoms. More precisely, distinctive features of condoms suggest that factors such as consumer price and access, in particular in the sense of distance to sales points, affect demand for condoms differently than other products. First, compared to most preventive health products which have recently been studied, including insecticide-treated bed nets, condoms are comparatively inexpensive. It has been assumed that as a result, the costs of condoms as a barrier to their use have not been of large interest (O'Reilly et al. 2014). However, while condoms do not require a large initial investment, they have to be acquired frequently to provide effective protection. As a result, even low prices and short distances may weigh more heavily in the purchase decision given that they are incurred very frequently. Second, given the concerns of inferior product quality of free condoms in many developing countries, the role of price in signaling product quality may be more pronounced for condoms than for other health products. Consequently, individuals may have a preference for a certain brand, suggesting that costs of acquisition may play a smaller role. Third, the great majority of diseases throughout the world, but especially in developing countries, is associated with poverty. Consequently, most preventive health products exhibit the largest health benefits among the poorest populations. HIV/AIDS, however, is an exception: in Sub-Saharan Africa, HIV prevalence is higher among wealthier population groups (Mishra et al. 2007), with likely implications for the role of costs in determining demand. Fourth, while the demand for other health products mainly depends on economic costs, in case of condoms, psychological costs due to stigma and discrimination are likely to play an additional role. In many countries suffering from a high HIV prevalence, condoms are strongly associated with disease as well as sex work (Meekers and Rossem 2005; Brent 2010). To avoid being seen during a condom purchase and being suspected of having HIV or risky sexual partnerships, individuals may consider very carefully where to purchase, suggesting that economic costs of acquisition decrease in importance while privacy becomes a decisive factor in individual purchase behavior. Especially in the wake of stagnating funds for the HIV/AIDS response in recent years (UNAIDS 2016b), understanding behaviors with respect to condom demand becomes even more important to design effective condom programs and maximize health benefits.

Motivated by the lack of rigorous evidence and the special features of condoms, this dissertation empirically analyzes demand for condoms in rural Zambia, thereby focusing on the importance of different types of costs in determining condom purchase behavior. The thesis consists of two main studies: the first study examines the price sensitivity of demand for condoms by comparing condom sales at different price levels. The second study concentrates on the role of travel costs and psychological costs in determining individual condom purchases. The empirical analyzes are based on a unique data set which combines condom sales data from a field experiment conducted in rural Zambia, in which prices were randomly assigned to condom sales agents, and geospatial data of the study area. Although based on the same data, the two studies address condom demand from different perspectives and apply different empirical methods. The first study adopts the sales perspective and estimates a reduced-form model of differences in condom sales at the level of the condom agents. In addition, it takes advantage of the exogenous variation in price among agents that results from the randomization to control for potential spillovers in sales between condom agents. The study therewith expands the body of randomized field experiments investigating price sensitivity of demand for preventive health products.[5] Furthermore, it adds to the growing body of randomized controlled trials recognizing and controlling for spillover effects,

[5]Examples of previous experimental studies on preventive products include Ashraf, Berry, and Shapiro (2010), Cohen and Dupas (2010), Meredith et al. (2013), Blum, Null, and Hoffmann (2014), Dupas (2014c), Tarozzi et al. (2014), and Comfort and Krezanoski (2017).

which has surged with the increasing importance of social networks and peer effects in the economics literature.[6] The second study focuses on the individual level and estimates a discrete choice model to investigate the impact of travel costs and psychological costs on condom sales location choice. The economic analysis of discrete choice, based on the seminal works of Daniel McFadden (1973), has been used to analyze spatial competition on retail markets including markets for automobiles and movie theaters (de Palma et al. 1994; Berry, Levinsohn, and Pakes 1995; Davis 2006). It has further found applications in health economics, for instance, to investigate demand for health care and individual health provider choice (Gertler, Locay, and Sanderson 1987; Borah 2006; Sarma 2009; Varkevisser, Geest, and Schut 2012). The second study therewith expands the literature on modeling demand for geographically differentiated products in a discrete choice model to the case of a preventive health product.

The context of the dissertation is characterized by extreme poverty and widespread HIV/AIDS. Zambia is among the poorest countries in the world. After strong economic growth beginning in the early 2000s, the landlocked country in the south of Sub-Saharan Africa reached lower-middle-income status in 2011. However, the combination of declining copper prices, the country's main export good, and poor harvests has worsened Zambia's economic outlook in recent years (World Bank 2015; World Bank 2017). Economic growth of the last decades has mainly benefited urban areas with the consequence that poverty is especially high and persistent in rural areas. Countrywide, 60% of Zambia's population lives below the national poverty line (CSO 2012). Besides other serious health challenges, Zambia is heavily affected by HIV/AIDS. Currently, an estimated 12.9% of the population is HIV-positive, placing Zambia on rank 7 worldwide (UNAIDS 2017). The great majority of new HIV infections in Zambia occurs through sexual contact. The factors found responsible for the HIV/AIDS epidemic in Zambia are the practice of having multiple and often concurrent sexual partnerships in combination with low and inconsistent condom use. The underlying drivers of these risky sexual behavior patterns are complex. They are associated with cultural and religious norms as well as gender roles and are reinforced through factors such as poverty, access barriers, and economic dependency, stigma and discrimination, low education and risk awareness, excessive alcohol consumption, and high levels of labor migration (Mulenga et

[6] See, for instance, Miguel and Kremer (2004), Ichino and Schündeln (2012), Baird et al. (2014), Bobba and Gignoux (2014), and Dupas (2014c).

al. 2009; GRZ 2015). Condom promotion is an important component of Zambia's response to HIV/AIDS. Similar to other Sub-Saharan African countries, Zambia implements both, condom social marketing programs as well as distribution of condoms free of charge at public health clinics. The Zambian social marketing program was shown to have reduced barriers to condom acquisition in urban areas, in particular by making condoms available in non-traditional outlets in poor neighborhoods (Agha and Kusanthan 2003). Access to condoms, however, remains a great challenge in less populated areas, which is consistent with the persistently low use of condoms in these areas (Seidenfeld 2014; CSO, MOH, and ICF 2015).

The empirical analyses of both studies are based on data from the randomized field experiment conducted in 2013.[7] The study area, located in Zambia's Eastern Province, covers a population of about 70,000 people and lacks even basic infrastructural development. The point of departure for the randomized experiment was the missing condom market in rural areas: previous to the experiment, condoms were only available free of charge at the five public health clinics in the area. We worked with the preexisting system of community health volunteers who are responsible for providing basic health services to rural communities. More precisely, we conducted a four-month field experiment in which 119 community health volunteers living in different villages of the area served as condom sales agents, creating new condom sales points at village level. The key feature of the study design was the random assignment of condom prices: each sales agent was randomly assigned one of three prices for a pack of three condoms and offered condoms at this one fixed price during the four months of the experiment. The three prices—25, 50, and 100 ngwee—corresponded to 0.05, 0.10, and 0.20 US dollars at the time of the experiment. The highest price of 100 ngwee was equivalent to the social marketing price found in the closest town to the study area. It was therefore selected as the reference price which allows to analyze demand in rural areas given a potential roll-out of the condom subsidization program existing in urban areas. For comparison, at the time of the study, the social marketing price of 100 ngwee found in

[7] The field experiment in rural Zambia was funded by KfW Independent Financial Cooperation Evaluation Unit. It was conducted jointly by myself and David Seidenfeld, American Institutes for Research, Washington, DC. We jointly developed the research design including the survey instrument, conducted interviewer trainings in Zambia and discussed the study implementation and resulting data. Implementation of the experiment was monitored by the Zambian-based Non-Governmental Organization Family Health Trust and data entry was done by Palm Associates in Zambia. Accordingly, I use 'we' when referring to the implementation of the experiment. All other work including data cleaning and processing, spatial mapping of the study area, elaboration and performance of the analyses, results interpretation, literature search and analysis, and writing was done by myself.

urban areas accounted for one tenth of the market price for commercial condom brands, indicating that even the highest price in the experiment is highly subsidized. Data was collected from every condom customer by means of a brief survey. Furthermore, the study area was manually mapped to receive geospatial data. More precisely, since no large-scale maps exist for Zambia's remotest areas and no geographic data in terms of GPS coordinates was collected on the ground in the course of the field experiment, I determined the GPS coordinates of the condom agents and the villages in the study area *ex post* on the basis of hand-drawn maps collected from the health clinics and satellite imagery. In this way, I obtained measurements of the distances between the population and the condom agents that allowed to incorporate a spatial dimension in the empirical analyses.

By analyzing the effects of price on condom demand, the first study feeds into the public debate on preventive health product pricing and expands the body of experimental evidence by a preventive health good of utmost importance in many developing countries. It has been argued that consumer prices of preventive health products affect health benefits in terms of avoided diseases through several channels. More precisely, the magnitude of health benefits achieved in a population by means of different pricing strategies for preventive products ultimately depends on first, how price affects take-up of the preventive health product, that is, the price sensitivity of demand; second, how price affects the composition of buyers according to their risk of illness and thus expected health benefits; third, how price affects actual utilization of the product; and fourth, how the utilization of the preventive product affects others, that is, the extent of health externalities (Cohen and Dupas 2010).

The study investigates the first two channels with respect to condoms. More precisely, I estimate the price sensitivity of demand for condoms and analyze how price affects the share of condom sales to population groups characterized by a high risk of HIV. It has been argued that higher prices effectively allocate preventive health products to individuals who need it the most, assuming that individuals with the highest expected health benefits also have the highest willingness-to-pay. As discussed above, charging a consumer price is a key principle of condom social marketing programs and intended to reduce wastage and encourage use by attaching a value to the condom, by signaling product quality, and by targeting it to the individuals with the highest health benefits. However, although condoms are at the center of the health pricing debate and despite repeated calls for experimental studies, robust empirical evidence on consumer responses to condom prices is scarce.

The empirical strategy of the study is based on the comparison of condom sales outcomes at sales agent level during the field experiment in Zambia at the three alternative consumer prices. More precisely, to analyze price sensitivity of condom demand, I estimate the effect of price on total condom sales at agent level. To analyze selection effects based on risk of illness, I estimate the effect of price on the share of condom purchases made by individuals belonging to certain HIV risk groups. I find that condom sales at the agents increase significantly and substantially as the price decreases, indicating that the population responds very sensitive to condom prices, even at very low prices. The increase in the number of customers at lower prices, the extensive margin of demand, is substantially larger than the increase in the number of condoms bought per customer, the intensive margin of demand, suggesting that lowering prices is more effective at attracting new customers than at encouraging existing customers to purchase more condoms. This is in spite the fact that the average quantity of condoms purchased per customer falls short of the number needed for full protection during the period of the experiment, suggesting that condom use is not consistent. With respect to the effect of price on the composition of buyers according to their HIV risk, I find ambiguous effects that are likely to result from the economic situation of the risk groups. On the one hand, the share of condoms purchased by population groups with an above-average HIV prevalence increases at lower prices for those groups which, according to relevant literature, are at the same time financially constrained as, for instance, widows (CSO, MOH, and ICF 2015). This suggests that higher prices screen out certain groups who pose an extremely high threat to others in terms of transmitting HIV. On the other hand, I find that the share of condom sales to HIV risk groups decreases at lower prices for groups that are not associated with being disproportionately financially constrained, such as individuals with multiple sexual partners. These results substantiate the findings from recent field experiments on preventive health products in that first, demand is very sensitive to price in developing countries and second, higher prices lead to worse targeting of preventive products for which health benefits are largest among the poorest populations by screening out the neediest.

The second study investigates how condom demand is affected by costs which may be less obvious than the price of a product, that is, travel costs and psychological costs. Standard models of consumer choice commonly focus on the importance of price in individual decision-making. With respect to health care demand, it is widely recognized that besides the consumer price of health-related goods and fees for medical care, monetary costs of traveling and opportunity costs of time spent for accessing goods and services are crucial factors affecting demand (Mwabu 2008). In addition to these economic costs, a growing body of literature in psychology and behavioral economics emphasizes the importance of psychological costs in individual decision-making, which originate from stigma and discrimination, in particular with respect to health-related behavior. Both, travel costs and psychological costs of accessing health care are of particularly high relevance in rural areas of developing countries. Empirical research has shown that in sparsely populated areas of developing countries, utilization of health care is hampered by long distances, insufficient and costly transport and poor road conditions (Tanser, Gijsbertsen, and Herbst 2006; Thornton 2008; Schoeps et al. 2011; Kumar, Dansereau, and Murray 2014; McLaren, Ardington, and Leibbrandt 2014). At the same time, psychological costs of accessing health care are high in most developing countries due to the high burden of life-threatening infectious diseases. Empirical research provides support that HIV-related stigma hampers utilization of HIV services, such as testing or treatment of diseases related to HIV in Sub-Saharan Africa (Wolff et al. 2005; Murray et al. 2013).

Building on this research, I investigate the importance of travel costs and psychological costs with respect to condom acquisition in rural Zambia. The study area is very sparsely populated, roads are of poor quality, and means of transport very limited. In addition, psychological costs of acquiring condoms are large: condoms are negatively associated with being HIV-positive, having multiple partners, as well as with female sex work. Consequently, individuals are likely to consider very carefully where to purchase condoms. I argue that as a result of psychological costs associated with condom acquisition, individuals do not only weigh economic costs, such as travel costs and price, in their decision-making but also have preferences for certain attributes of the sales locations which promise higher privacy and confidentiality. In fact, psychological costs may give rise to situations in which individuals accept or even value higher economic costs in exchange for lower psychological costs. For instance, while it is unlikely that an individual would opt for a distant location to acquire other preventive health products, such as soap or a bed net, an individual who intends to purchase condoms may prefer to buy further away from home to avoid being seen by relatives and acquaintances.

I analyze the importance of economic and psychological costs in determining individual choice of a condom sales location in rural Zambia by means of a discrete choice model derived under the assumption of individual utility-maximizing behavior. The model specifies the choice of a condom sales location to result from individual preferences for certain attributes of the sales locations, including price, distance from the individual's home village to the sales location, as well as demographic characteristics of the sales agent. Considering that an individual chooses between alternative sales locations to realize the condom purchase and that preferences differ between individuals, I estimate a flexible mixed multinomial logit model of condom sales location choice that allows for variation in preferences for the attributes of the condom sales locations across individuals, resulting from both, observed and unobserved factors.

The results show that economic costs, including price and travel costs, are decisive determinants of condom sales location choice. In particular, the study reveals that individuals are very sensitive to distance as the probability of choosing a certain condom agent decreases significantly with increasing distance between the individual's home village and the respective condom sales location. I find some evidence that the negative effect of distance on location choice is weaker for individuals who report they had multiple sexual partners in the last year, which is consistent with the hypothesis that individuals who have stronger reasons to hide sexual relationships are less reluctant to travel. In addition, the results provide strong support for heterogeneous preferences of individuals for certain characteristics of condom sales agents, confirming the assumption that costs other than of economic nature influence condom sales location choice. Most pronounced is the strong preference of women to purchase condoms from female condom agents. This is in line with the literature indicating that the acquisition of condoms in Sub-Saharan Africa is shaped by traditional gender roles and affected by prejudices towards women demanding condoms (Meekers and Rossem 2005; Brent 2010; Duffy and Regan 2010). Arguably, women expect to find higher confidentiality and less preconceptions from other women when purchasing condoms and consequently accept higher effort in terms of travel. Moreover, I find that younger customers prefer to purchase condoms from younger sales agents, indicating that they expect to find higher understanding from peers than from older condom agents.

In sum, the two studies provide rigorous evidence on the crucial importance of costs in determining demand for condoms. Despite large benefits of preventing an incurable disease and insufficient HIV treatment options, even small economic costs, including price and travel costs, as well as psychological costs lead to a substantial decline in condom demand among the population in rural Zambia. The strengths of the empirical analyses mostly originate from the rich data which has the following advantages. With respect to the first study, the experimental data allows to identify causal effects of price on demand by creating exogenous variation in condom price offered at the sales agents. Furthermore, the exogenous variation in combination with the distance measures allows to control for spillovers in sales between agents. The second study benefits in particular from the fact that precise data is available on different sales alternatives from an individual's point of view, allowing to model individual choice by means of a discrete choice model.

The results have several important policy implications which can be summarized as follows. First, the substantial price elasticity of demand for condoms suggests that condoms must be highly subsidized in developing countries in order to have a noticeable impact on take-up by the population and consequently increase health benefits, especially given the large positive health externalities of HIV prevention. This is in line with the recommendations made based on previous experimental field studies on other preventive health products. Sound evidence on the relationship between price and demand is crucial to inform the numerous condom social marketing programs in their strategic decisions on pricing. Many social marketing programs aim at creating conditions closer to commercial markets and—not least due to fading donor support— intend to promote financial sustainability by increasing prices. The results of this dissertation clearly undermine the argument of achieving financial sustainability by showing that charging higher prices must not even result in higher revenues, given the strong response in demand. Second, condoms should be provided close to where the population lives. As a result of HIV stigma and discrimination, one could assume that individuals prefer to purchase condoms further from home to avoid being seen and, as a consequence, are not particularly sensitive to distance. This is not the case, however. Despite evidence that individuals assumed to have higher psychological costs, namely individuals with multiple sexual partners, are less reluctant to travel, overall, individuals clearly prefer geographic proximity, emphasizing the need to reduce travel costs for condom acquisition. Third, as a result of psychological costs of condom acquisition, special attention has to be given to the characteristics of condom sellers as well as to the composition of the target groups of condom programs. For rural Zambia, the integration of female condom sellers has great potential with respect to HIV prevention since female agents are especially effective at targeting widows, a group with an extremely high HIV prevalence and hence risk of transmission. Yet, in particular with respect to psychological costs, the local context such as existing gender roles and the extent of stigma and discrimination must be accounted for to adapt condom programs accordingly.

Beyond the specific area of condom demand, the dissertation provides the following impulses for the provision of health products in general. By showing that the price sensitivity of demand for condoms is even higher than for other preventive products, the results emphasize the need to consider price as a barrier to acquisition even for items that do not require a large initial investment but are, on the contrary, quite inexpensive. This is especially relevant for products which have to be acquired frequently in order to be effective since the costs multiply and, as a whole, may constitute a financial burden to the individual. Distinguishing between the extensive and the intensive margins of demand for frequently needed products further provides valuable insights into the consistency of health behaviors. Furthermore, by showing that the share of sales to some high-risk groups is higher at higher prices, the results suggest that for products where health benefits are not concentrated among the poorest, charging higher prices may be a reasonable instrument to increase efficiency of public resource allocation. This could be relevant for non-communicable diseases, which are not especially pronounced among the poorest.

Ultimately, from the perspective of ensuring equity in access to condoms, the field experiment constitutes a practical example of how access to condoms can be improved for the commonly underserved populations in rural areas of developing countries by making use of the existing system of community health volunteers. In light of tight health budgets, many developing countries increasingly rely on community health volunteers to provide basic health services at village level and make progress towards universal health coverage (Cotlear et al. 2015). The condom experiment led to a considerable increase in the amount of condoms acquired in the study area, suggesting that providing incentives to community volunteers for selling condoms has potential to considerably improve access to and take-up of condoms in rural areas, and therewith to contribute to the prevention of HIV/AIDS.

The remainder of the dissertation is structured as follows. Chapter 2 provides detailed background information on HIV/AIDS. Section 2.1 focuses on general information, including the biological characteristics of HIV, developments of the HIV/AIDS epidemic at global level and its economic implications, as well as the role of condoms in the international response to the epidemic. Section 2.2 focuses on the context in Zambia and discusses the trends in Zambia's HIV/AIDS epidemic, the key drivers of the epidemic, as well as the country's response, with a special focus on the existing approaches to condom distribution. Chapter 3 presents design and implementation of the randomized price experiment and the data collected. In addition, the chapter describes the approach taken to geo-reference the study area and obtain geospatial data. Furthermore, it provides detailed descriptive statistics, including a randomization check. Chapter 4 presents the sales perspective study on the price sensitivity of demand for condoms and includes a comprehensive literature review on the effects of price on demand for preventive health products. Chapter 5 presents the individual level study analyzing the importance of travel costs and psychological costs in determining sales location choice. Chapter 6 summarizes the main findings of the dissertation and the resulting policy implications as well as the strengths and limitations of the empirical analyses. It closes with thoughts on future research.

2 Background on HIV/AIDS

This chapter provides background information on HIV/AIDS in general and specifically in Zambia. Section 2.1 begins with general information on the biology and the epidemiology of HIV/AIDS. More precisely, Section 2.1.1 describes biological characteristics of HIV including its impact on the human body, disease progression, transmission routes, as well as treatment and prevention possibilities. Section 2.1.2 briefly presents developments of the HIV/AIDS epidemic at global level and its economic implications. Section 2.1.3 discusses the role of condoms in the international response to HIV/AIDS. Subsequently, Section 2.2 focuses on the HIV/AIDS epidemic in Zambia. Section 2.2.1 provides a concise overview of the country context, followed by a short summary of the key figures and trends of the HIV/AIDS epidemic in Section 2.2.2. Section 2.2.3 presents the key drivers of Zambia's epidemic including low levels of condom use in the population. Ultimately, Section 2.2.4 describes the Zambian Government's response to the epidemic with a special focus on existing condom distribution interventions.

2.1 General Information and Global Relevance

2.1.1 The Biology of HIV

The human immunodeficiency virus (HIV) infects a certain type of white blood cells, known as T-helper cells or CD4 cells, that are an essential part of the human immune system. By impairing the cells' function of fighting diseases, infection with HIV leads to a gradual deterioration of the immune system, making the individual susceptible to so-called opportunistic infections and certain types of cancers. The acquired immunodeficiency syndrome (AIDS) describes the advanced state of HIV infection when the individual develops opportunistic infections—the most common being tuberculosis—or HIV-related cancers, which are usually the cause of death. After an incubation time of a few weeks, most HIV-positive individuals experience an episode of sickness with symptoms similar to those of influenza. Once recovered, they usually enter a latency phase, that is, a symptom-free phase of several years, which explains why HIV infection often remains undetected for a considerable amount of time. Without treatment, most infected individuals develop signs of HIV-related diseases within 5 to 10 years after infection (AVERT 2016; WHO 2016b; WHO 2017a). Survival analysis suggests that an untreated HIV infection leads to death within 8 to 15 years after infection and about 2 years after being diagnosed with AIDS (Todd et al. 2007; Wandel et al. 2008; Resch et al. 2011). Disease progression depends on multiple factors, including the type of the virus, the individual's age, physical health and nutritional status, as well as psychological condition.[8] In addition, treatment of opportunistic infections affects the course of the disease which implies that the survival period can be substantially shorter, especially in resource-limited developing countries with inadequate health care systems (Fawzi et al. 2004; Langford, Ananworanich, and Cooper 2007).

HIV is transmitted through certain body fluids, more precisely, through those body fluids which can have a virus concentration sufficiently high to enable transmission. This includes blood, semen, vaginal secretions, mucous membranes of the penis, vagina, and rectum, as well as breast milk. HIV can enter the human body through mucous membranes (including oral mucosa), large bleeding wounds, and breastfeeding. The main transmission routes are sexual contact, exposure to blood (through blood transfusion or needle-sharing, for instance), and 'vertically' from mother to child during pregnancy, birth, or breastfeeding (AVERT 2016; WHO 2016b). While heterosexual intercourse is responsible for the vast majority of newly acquired HIV infections worldwide (UNAIDS 2012), the biological per-act transmission risk, referred to as infectivity, is low during heterosexual contact and lower than for other transmission routes. A recent systematic review estimates the highest per-act transmission risk for blood transfusion (9,250 infections per 10,000 exposures), followed by mother-to-child transmission (2,260 per 10,000), receptive anal intercourse (138 per 10,000), needle-sharing among injection drug users (63 per 10,000), percutaneous (through the skin) needle stick (23 per 10,000), insertive anal intercourse (11 per 10,000), receptive penile-vaginal intercourse (8 per 10,000), and insertive penile-vaginal intercourse (4 per 10,000) (Patel et al. 2014). Transmission risk during sexual intercourse depends on the infectiousness of the HIV-positive individual and the susceptibility of the uninfected partner (Boily et al. 2009). Infectivity increases with the viral concentration, the so-called viral load, of the HIV-positive individual, which is high early after infection in the acute stage as well as in the

[8]Two types of HIV, both causing AIDS, are known: HIV-1 and HIV-2. HIV-1 has spread globally and accounts for the majority of HIV infections, in particular also in the highly affected Southern African countries. HIV-2 is geographically concentrated in Western Africa. Both types are similar with respect to viral structure, modes of transmission, and clinical consequences in terms of opportunistic infections. Yet, transmission rate is lower and disease progression is slower for HIV-2 compared to HIV-1, explaining, at least in part, its lower prevalence (UNAIDS 2011; Nyamweya et al. 2013; AVERT 2016).

late stage of the disease (Hollingsworth, Anderson, and Fraser 2008). Furthermore, the risk of sexual transmission is elevated in the presence of other sexually transmitted infections (STIs) (Boily et al. 2009; Patel et al. 2014; WHO 2017a).

Since the mid-1990s, significant progress has been made with respect to the treatment of HIV/AIDS. Antiretroviral drugs suppress the replication of the virus within the human body and reduce the viral load to undetectable levels, virtually halting disease progression. With early initiation and continued adherence, lifelong therapy with a combination of three or more antiretroviral drugs, known as (highly active) antiretroviral therapy (ART), individuals living with HIV can remain productive for many years (WHO 2017a). Evidence from both, high-income and low-income countries, shows that HIV-positive individuals who start ART early and adhere to treatment can have a near-normal life expectancy. Studies from Uganda (Mills et al. 2011), South Africa (Johnson et al. 2013), and Rwanda (Nsanzimana et al. 2015), for instance, estimate that average life expectancy of HIV-positive individuals who start ART at the age of 20 and at an early stage of the disease exceeds 25 years. In areas highly affected by HIV, ART can thus even lead to an increase in life expectancy at population level (Bor et al. 2013).

However, to this day there is neither a cure nor a vaccine for HIV/AIDS, emphasizing the importance of preventing infection in the first place. Regarding the prevention of sexual transmission, the common form of protection is the use of condoms during sexual intercourse. Condom use is highly effective in preventing HIV; evidence shows that male condoms reduce heterosexual transmission of HIV and other STIs by 80% or more (Weller and Davis-Beaty 2002).[9] Since the mid-1990s, biomedical HIV prevention with antiretroviral drugs has continuously gained importance. Arguably, the greatest success has been made with respect to the prevention of HIV transmission from a HIV-positive mother to her child, known as prevention of mother-to-child transmission (PMTCT). Without any intervention, mother-to-child transmission rates lie between 15% and 45%. By administering antiretroviral drugs to both, the mother and the baby, transmission rates can be reduced to below 5% (WHO 2017b). In addition to PMTCT, the last decade has witnessed advances in biomedical methods for the prevention of sexual transmission of HIV. Research has es-

[9] Condom effectiveness is usually analyzed based on epidemiological studies that compare incidence rates, that is, new infections between groups of 'always' condom users and 'never' condom users. These studies cannot verify that condoms were used correctly during every sexual act. The protective effect of perfect use, referred to as condom efficacy or theoretical effectiveness, is even higher than 80% (Weller and Davis-Beaty 2002).

tablished that apart from improving health and life expectancy of people living with HIV, antiretroviral drugs have a preventive effect: by lowering the viral load in blood, semen, as well as vaginal and rectal fluids of HIV-positive individuals, early initiation of ART can reduce the risk of HIV transmission to an uninfected sexual partner by over 90%, a phenomenon known as 'treatment as prevention' (Cohen et al. 2011). This effect is likely to have a large impact on population level risk: evidence from South Africa, for instance, suggests that high ART coverage in a community substantially reduces the risk of an uninfected individual to acquire HIV (Tanser et al. 2013). Moreover, an uninfected individual at risk of HIV can reduce the probability of contracting the virus by taking antiretroviral drugs as pre-exposure prophylaxis (PrEP). A meta-analysis of randomized controlled trials (RCTs) estimates that PrEP can reduce the risk of contracting HIV by over 50% (Jiang et al. 2014). Among participants with laboratory-detected presence of the drug, interpreted as a proxy for treatment adherence, risk reduction can increase to about 90% among men who have sex with men (MSM) (Grant et al. 2010) as well as among heterosexual partners (Baeten et al. 2012) and up to 70% among injection drug users (Choopanya et al. 2013). Ultimately, animal studies and case-control studies of health care workers indicate that antiretroviral drugs taken immediately after exposure to HIV (through sexual intercourse or contact with infected blood), known as post-exposure prophylaxis (PEP), are also effective in reducing the risk of HIV infection (Cardo et al. 1997; Sultan, Benn, and Waters 2014). Evidence is not sound, though, and RCTs are unlikely to be conducted since they would imply deliberately withholding PEP from individuals who were exposed to HIV. In addition to the preventive effects of ART, RCTs conducted in South Africa (Auvert et al. 2005), Uganda (Bailey et al. 2007), and Kenya (Gray et al. 2007) provide evidence that male circumcision reduces the risk of contracting HIV for men during heterosexual intercourse by up to 60%.

It is important to note that the studies cited above were conducted in different settings, including both, high-income and low-income countries, and therewith under very different conditions. In addition to the fact that all prevention methods only provide partial protection from HIV infection, it must be taken into account that their effectiveness crucially depends on adherence, either to ART or in the sense of consistent condom use, as well as on the health status of the individual. Both, adherence and health, are commonly inadequate in low-income countries as a result of poor and inconsistent access to health care, drugs, and condoms as well as widespread poverty, malnutrition, and other diseases. This suggests that the actual preventive impacts are substantially lower in most real-world settings than under controlled conditions.

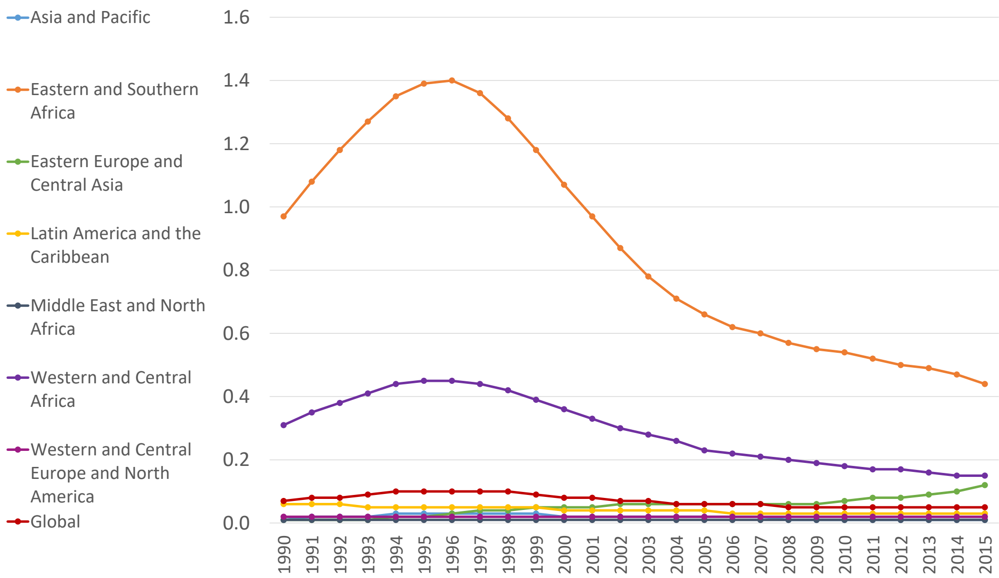
2.1.2 The Global HIV/AIDS Epidemic and its Implications

Despite some earlier cases, AIDS only came to public attention in the 1980s when incidences accumulated in communities of MSM and injection drug users in the United States. In 1983, HIV as the cause of AIDS was clinically discovered (Gallo and Montagnier 2003). In the following years, global incidences of HIV infections increased rapidly. Yet, with the exception of Sub-Saharan Africa (SSA) and parts of the Caribbean, the disease remained largely under control and infections are mostly concentrated in certain risk groups such as MSM, injection drug users, sex workers, migrants, and prisoners. In many countries of SSA, however, HIV spread throughout the population and evolved into a so-called generalized epidemic, which describes the situation when the disease has spread sufficiently among the general population to be self-sustaining through heterosexual networks (UNAIDS 2011; AVERT 2017).

Trends in epidemics are analyzed by means of prevalence and incidence. HIV prevalence is the proportion of individuals in a population, for example, in a country or an age group, which is HIV-positive at a given point in time, irrespective of the time of actual infection. HIV incidence quantifies the number of new HIV infections in a population during a certain time period, usually during a year, and is commonly also expressed as rate (UNAIDS 2011). HIV incidence is the preferred measure to analyze recent developments because it reflects the current rate of transmission while HIV prevalence is the result of past infections. Yet, incidence is more difficult to measure and estimates are thus associated with greater uncertainty than prevalence estimates. To illustrate the difference between the two measures, HIV prevalence can increase even if the epidemic is on the decline—meaning the number of new infections, the incidence, decreases—when improved availability of ART results in longer survival times of HIV-positive individuals.

Figure 2.1 and Figure 2.2 depict the development of HIV incidence rate and HIV prevalence by geographic region since 1990. Both figures clearly indicate that the HIV/AIDS epidemic has been halted or even reversed at global level. As shown in Figure 2.1, the global HIV incidence rate peaked in the second half of the 1990s at about 0.1% and has been declining continuously since then. The global trend is driven by the developments in SSA, that is, the two regions Eastern and Southern Africa as well as Western and Central Africa, where the HIV incidence rate has witnessed a steep decline from the peaks in 1995 and 1996 at 1.4% and 0.4%, respectively. Concerns exist with respect to Eastern Europe and Central Asia, the only region showing an increasing trend in the HIV incidence rate.

FIGURE 2.1: HIV Incidence Among Adults (15-49) by Region, 1990-2015 (in Percent)

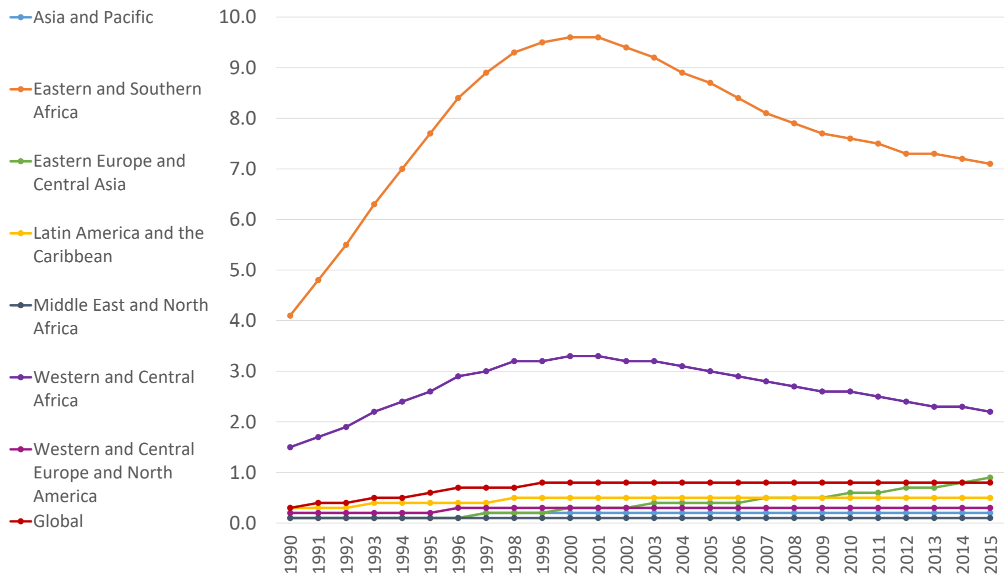


Author's depiction according to UNAIDS (2017)

While the global HIV incidence rate is decreasing, Figure 2.2 reveals that global HIV prevalence has stabilized at about 0.8%. The fact that it has not witnessed a decline similar to the HIV incidence rate is due to an increasing average life expectancy of HIV-positive individuals resulting from improved access to ART, which translates into fewer HIV-related deaths. In the most affected regions in SSA, however, HIV prevalence is also on the decline.

Despite the promising trends in terms of a reduced transmission of HIV at global level, the extent of the epidemic is devastating. In 2015, 37 million people were living with HIV worldwide and 2.1 million people became newly infected. SSA accounts for two thirds of both, the number of people living with HIV as well as the global number of annual new infections. HIV was responsible for 1.1 million deaths in 2015, of which over 70% occurred in SSA (UNAIDS 2016a). As shown in Figure 2.3, the south of SSA is most severely affected. The ten most affected countries, all located in SSA, with the corresponding HIV prevalence in the population aged 15 to 49 are Swaziland (28.8%), Lesotho (22.7%), Botswana (22.2%), South Africa (19.2%), Zimbabwe (14.7%), Namibia (13.3%), Zambia (12.9%), Mozambique (10.5%), Malawi (9.1%), and Uganda (7.1%) (UNAIDS 2017).

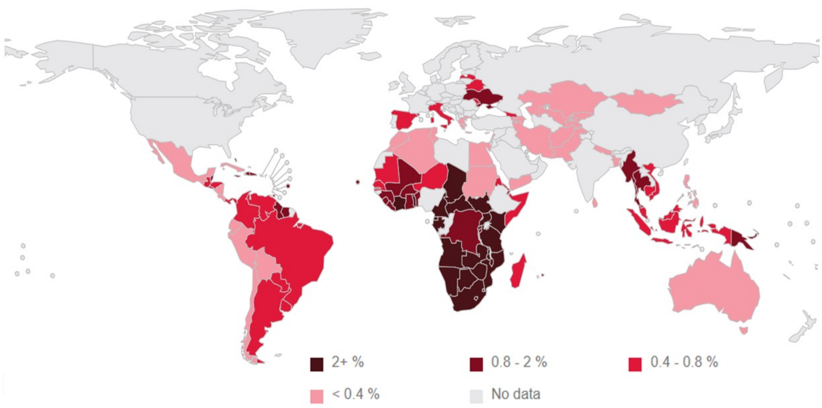
FIGURE 2.2: HIV Prevalence Among Adults (15-49) by Region, 1990-2015 (in Percent)



Author's depiction according to UNAIDS (2017)

The response to HIV/AIDS in low and middle-income countries has received unprecedented financial resources from both, domestic sources as well as international donors. Total annual resources available for HIV/AIDS doubled between 2006 and 2015 to about USD 19 billion (UNAIDS 2016b). In addition to the substantial costs of HIV prevention and treatment programs, HIV/AIDS is associated with considerable economic losses due to its devastating effects on human morbidity and mortality. Extensive research has been carried out with respect to the economic implications of HIV/AIDS. A large body of literature analyzes the macroeconomic causal effects of the epidemic which are expected to result from a reduction in the working-age population—which is the group most heavily affected by the epidemic—combined with reduced savings and investments (including in education) owing to lower life expectancy and thus planning horizons. Evidence on the relation between HIV/AIDS and economic growth, however, is not clear with many researchers finding small and some even large negative effects, but some also rather limited or even no effects (see, for instance, the summaries in Mwabu (2008), Fortson (2011), or Thornton (2012)). Results from micro level studies more clearly indicate a causal relationship between the disease and socioeconomic outcomes: HIV infection has been found, for instance, to adversely affect individual labor productivity (Fox et al. 2004), likelihood of employment (Levinsohn et al. 2013), and human capital investment (Fortson 2011). A number of studies confirms these effects indirectly by quantifying improvements of socioeconomic outcomes of individuals living with HIV after the initiation of ART, including higher worker productivity (Larson et al. 2008), increased labor force participation and weekly hours worked (Thirumurthy, Zivin, and Goldstein 2008), decreased worker absenteeism (Habyarimana, Mbakile, and Pop-Eleches 2010), and higher school attendance of children in households of treated adults (Zivin, Thirumurthy, and Goldstein 2009).

FIGURE 2.3: HIV Prevalence Among Adults (15-49) by Country, 2015 (in Percent)



UNAIDS (2017)

2.1.3 The Role of Condoms in HIV Prevention

As the extent of the HIV/AIDS epidemic and the dominance of sexual transmission became clear in the early 1990s, the subject of condom use, as the only effective measure to prevent infection during sexual intercourse available at that time, received more and more attention. Developing countries witnessed a massive expansion of subsidized condom distribution programs, commonly combined with HIV education campaigns promoting condom use (Sweat et al. 2012). Although condom use in developing countries has increased over the past decades, the level of condom use remains a considerable challenge in many countries that suffer from a high HIV prevalence. In particular, while condom use has reached a relatively high level during sexual intercourse among casual partners in many highly affected countries, it is persistently low between regular partners (de Walque and Kline 2011; Reynolds, Luseno, and Speizer 2013).[10] Given the neglect of condom use in regular partnerships, most achievements through condoms in terms of averted HIV infections are found to have been made in high-risk groups such as MSM or in the context of sex work (Potts et al. 2008). Overall, it is argued that condoms have played a decisive role in HIV prevention so far: according to UNAIDS (2016b), condom use has prevented approximately 45 million new infections since the onset of the HIV/AIDS epidemic.

Despite the major scientific advances in other forms of HIV prevention described above, including treatment as prevention, PrEP, PEP, and male circumcision, the international community considers condoms a crucial component of the global response to HIV/AIDS. The reasons are the following. First, condoms are not only highly effective in preventing HIV but also cost-effective: the cost per HIV infection averted through condom use is estimated to be considerably lower than the lifetime costs of providing ART (UNAIDS 2016b). Second, access to ART remains extremely challenging in many regions burdened with HIV due to financial, geographical, or psychological barriers of the population (Mills et al. 2006). Adherence to treatment is a prerequisite for ART to be effective in preventing onward transmission but can often not be ensured. A meta-analysis based on 84 observational studies from both, developed and developing countries, estimates that the average rate of reporting over 90% adherence to HIV treatment is 62% (Ortego et al. 2011). A study from rural Zambia reports that six weeks after treatment initiation, only 60% of the patients were fully adherent to ART (Sasaki et al. 2012). Third, even if adherence can be ensured, biomedical prevention methods only provide partial protection from HIV infection as discussed above. In particular, male circumcision, for instance, only lowers the risk of contracting HIV for men while the risk for women is not reduced. Thus, condom use remains complementary for other HIV prevention methods. Fourth, concerns exist about behavioral risk compensation as a response to ART. To clarify, the effectiveness of ART in treating and preventing HIV and the associated reduction in cost of infection as well as risk of infection for an individual

[10] Compare also the levels of self-reported condom use at last sexual intercourse for different types of sexual partners for the ten countries with the highest HIV prevalence worldwide presented in Table A2.1 in the Appendix.

may increase the riskiness of sexual activity of both, infected and uninfected individuals (de Walque, Kazianga, and Over 2012). This is especially problematic in combination with insufficient treatment adherence, that is, if HIV-positive individuals falsely believe they are not infectious due to ART but, in fact, are as a result of interrupted treatment. Condom promotion is therefore highly recommended to counteract potential adverse behavioral responses.[11] Ultimately, besides HIV prevention, condom use has additional benefits in terms of preventing other STIs as well as unwanted pregnancies, which is not the case for ART. In sum, despite new effective biomedical prevention methods, condoms are not only the most cost-effective method to prevent HIV but also remain essential as a complementary method, rendering them a crucial element of the international response to the HIV/AIDS epidemic.

2.2 Zambia and the HIV/AIDS Epidemic

2.2.1 The Zambian Context

The Republic of Zambia is a landlocked country in the south of SSA with a population of 16.2 million in 2015. Population density is low compared to other African countries at 22 people per km^2. Annual population growth exceeds 3% and is among the highest in the world. Zambia experienced strong economic growth beginning in the early 2000s and reached lower-middle-income status according to the World Bank classification in 2011. Between 2004 and 2010, annual gross domestic product (GDP) grew continuously at over 7%, mainly driven by strong copper exports. Recently, Zambia's economic outlook has worsened, however. Declining copper prices due to reduced demand mainly from China affect the country's economy substantially. Poor harvests owing to droughts caused by El Niño as well as frequent power outages pose additional challenges. In 2015, GDP growth dropped to about 3% (World Bank 2015; World Bank 2017).

Economic growth of the last decade has almost exclusively benefited urban areas. The potential of the agricultural sector, which employs about 70% of the population, is far from being fully realized, and the bad harvests have harmed the poorest families in particular

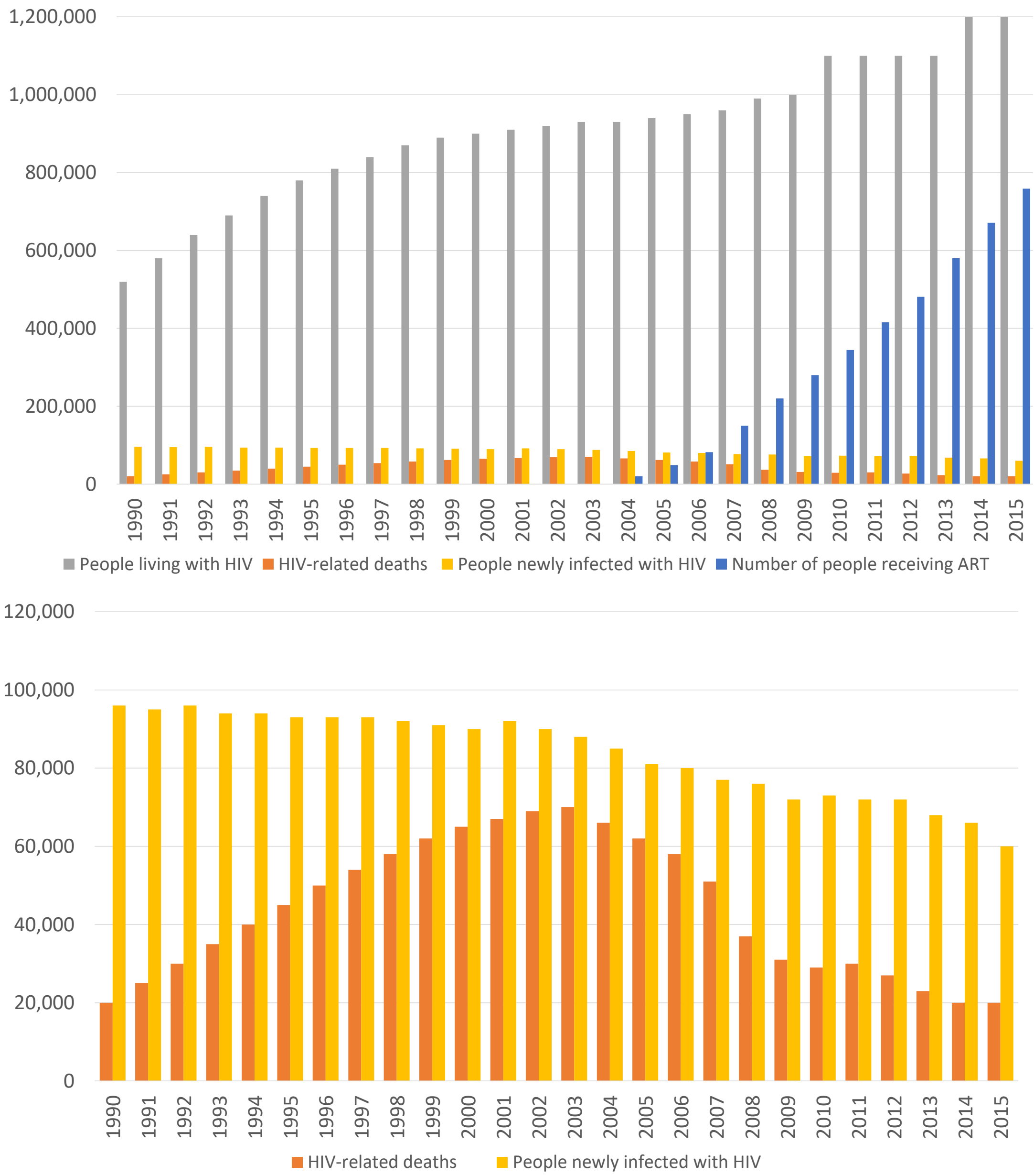
[11] Empirical evidence on behavioral risk compensation in the sense that increased availability of ART leads to increased sexual risk behavior is mixed. On the one hand, de Walque, Kazianga, and Over (2012), for instance, find that risky sexual behaviors in the population increase in response to the perceived changes in risk associated with access to ART. On the contrary, Kennedy et al. (2007) find that condom use is significantly higher among patients receiving ART compared to HIV-positive individuals not receiving ART based on a review of three studies from developing countries.

(World Bank 2015). As a consequence, poverty is especially high and persistent in rural areas. According to the Living Conditions Monitoring Survey (LCMS) 2010, a national representative household survey, 60% of Zambia's population lives below the national poverty line and 42% are considered extremely poor in the sense that their expenditure does not cover a basic food basket. In rural areas, where 65% of the Zambian population lives, 78% are poor and 58% extremely poor (CSO 2012). Similarly, multidimensional poverty measures indicate only marginal improvements in the last decades. The Human Development Index, calculated by the United Nations Development Programme (UNDP) based on health and education indicators as well as gross national income per capita, increased from 0.422 in 1980 to 0.568 in 2014, placing Zambia at the bottom of the countries with a medium human development and at the lower end of all countries, ranking 139$^{\text{th}}$ out of 188 economies. Access to basic amenities, including health and education as well as safe water and sanitation, has improved only marginally in rural areas and remains highly insufficient, hampering the country's development (UNDP 2016).

2.2.2 The HIV/AIDS Epidemic in Zambia

Zambia is heavily affected by HIV/AIDS. According to UNAIDS estimates, 12.9% of the population is currently HIV-positive, placing Zambia on rank 7 among the countries with the highest HIV prevalence worldwide (UNAIDS 2017). Trends in Zambia's HIV/AIDS epidemic are similar as in other countries in SSA. The first HIV cases were diagnosed in the mid-1980s and a rapid spread of the disease followed (GRZ 2015). The incidence rate was highest in the early 1990s at over 2% per year among the population between 15 and 49 years. The prevalence for this age group peaked with a time-delay between the mid-1990s and the early 2000s at about 15 to 16%. Since then, incidence and prevalence have been declining. Figure 2.4 depicts trends in Zambia's HIV/AIDS epidemic in absolute terms. The upper panel depicts the number of people living with HIV, the number of HIV-related deaths, the annual number of people newly infected with HIV, and the number of people receiving ART. The lower panel zooms in on HIV-related deaths and annual new infections for better comparability. Accordingly, the absolute number of people living with HIV has been growing continuously and is at its highest level today with about 1.2 million people, even though the annual number of new infections decreased from 90,000 in 1990 to 60,000 in 2015. This development is associated with the increasing number of HIV-positive people receiving life-prolonging ART beginning in the early 2000s, which has resulted in a decrease in HIV-related deaths from 70,000 in 2003 to 20,000 in 2015. By 2015, about 760,000 people were receiving ART in Zambia (UNAIDS 2017). The course of the HIV/AIDS epidemic is reflected in the development of life expectancy at birth. In the early 1980s, life expectancy in Zambia started to decrease from about 51 years to 41 years in 2000 before it began to increase again quite rapidly to 57 years in 2012 (World Bank 2017). Similar to other countries in SSA, HIV prevalence in Zambia is higher for women (15.1%) than for men (11.3%) and higher in urban areas (18.2%) than in rural areas (9.1%). HIV prevalence is extremely high among divorced or separated and widowed women with 28% and 48%, respectively (CSO, MOH, and ICF 2015).

FIGURE 2.4: Trends in Zambia's HIV/AIDS Epidemic, 1990-2015 (in Absolute Numbers)



Author's depiction according to UNAIDS (2017)

2.2.3 Key Drivers of the Epidemic

Based on the distribution of HIV infections in population subgroups, self-reported sexual behavior patterns, and biological transmission rates, UNAIDS estimates that 90% of new infections in Zambia occurred through sexual contact in 2008. The factors found responsible for the epidemic in Zambia are the practice of having multiple and often concurrent partnerships in combination with low and inconsistent condom use. However, the underlying drivers of these risky sexual behavior patterns are highly complex. They are based on cultural and religious norms and traditions and are reinforced through factors such as poverty, access barriers, and economic dependency, stigma and discrimination, low education and risk awareness, excessive alcohol consumption, and high levels of labor migration. Often, risky sexual behaviors are closely linked to the subordinate status of women in the Zambian society. Biological factors, including low levels of male circumcision and high prevalence of STIs, further promote transmission (Mulenga et al. 2009; GRZ 2015). This section discusses the key drivers of the HIV/AIDS epidemic in Zambia. To begin with, it provides an overview of HIV-related knowledge, risk awareness, and attitudes towards the disease and towards people living with the disease in the Zambian society. Subsequently, the section focuses on the prevalence and significance of multiple and concurrent partnerships as well as patterns of condom use in Zambia. Finally, it discusses women's vulnerabilities to HIV infection and its consequences and gives insights into cultural norms and practices that promote the spread of HIV.

HIV-related Knowledge, Risk Awareness, and Attitudes. Empirical evidence shows that information about prevention and about the benefits of prevention is an important, although not sufficient, factor promoting preventive health behaviors in developing countries (Dupas 2011). Representative national household surveys have collected detailed data on HIV-related knowledge, risk awareness, and attitudes, as well as on sexual behaviors in Zambia since 1996, most notably the Demographic and Health Survey (DHS) and the Zambian Sexual Behaviour Survey (ZSBS).[12] The DHS 2007 was the first household survey in Zambia to collect blood samples of respondents—given their consent—in order to estimate overall HIV prevalence in the population as well as HIV prevalence by sociodemographic characteristics. If not stated otherwise, this sections reports figures on sexual behaviors as well as HIV prevalence by population subgroups from the DHS 2007 (CSO et al. 2009) and the DHS 2013/2014 (CSO, MOH, and ICF 2015) for the age group 15 to 49 years because

[12] The DHS was conducted in 1996, 2001/2002, 2007, and 2013/2014. The ZSBS was conducted in 1998, 2000, 2003, 2005, and 2009.

the DHS provide HIV prevalence estimates, and—owing to standardized questionnaires—are comparable to DHS of other countries.[13]

According to the DHS, awareness about HIV in Zambia is high. At least since the mid-1990s, the Zambian population is fully aware of the existence of HIV, meaning that almost 100% of the survey respondents have heard about the virus. Knowledge about methods of preventing HIV has increased steadily and reached a relatively high level. In 2013/2014, 82% of women and 85% of men knew that using a condom consistently during sexual intercourse can reduce the risk of HIV transmission, compared to 73% and 74% in 2007, respectively. Moreover, 92% of women and 95% of men knew that limiting sexual intercourse to one uninfected partner reduces the risk of HIV transmission, which constitutes a slight increase compared to the already high level of 90% and 89% in 2007. However, the level of comprehensive knowledge about HIV/AIDS is still a matter of concern, especially in rural areas. The DHS defines comprehensive knowledge about HIV/AIDS as knowing that consistent condom use and having only one uninfected and faithful partner can reduce the risk of contracting HIV, knowing that a healthy-looking person can have HIV, and rejecting the two most common local misconceptions about HIV transmission, which are that HIV can be transmitted by mosquitoes and that a person can become infected by sharing food with someone who is HIV-positive. Overall, only 42% of women and 49% of men responded correctly to all of these questions in 2013/2014, a moderate increase from 36% and 39%, respectively, in 2007. For rural areas, the population shares with comprehensive knowledge drop to 34% for women and 40% for men in 2013/2014 compared to 30% and 31% in 2007, respectively. Knowledge increases considerably with education. For instance, only 23% of women with no education had comprehensive knowledge in 2013/2014 compared to 52% of women with secondary education and 75% of women with more than secondary education.

[13] The DHS collect objective physical and biological measures of health conditions, so-called biomarkers, including HIV status among respondents between 15 and 49 years, provided they are willing to be tested. The HIV testing protocol undergoes ethical review of the host country to ensure that both, medical as well as confidentiality guidelines, are followed. Usually, rapid HIV tests are performed in the field by nurses and venous blood is collected in case the test result is positive. The test result is then merged to the respondent's survey data. Concerns may exist that prior knowledge (or presumption) of HIV status may lead to refusal bias. If individuals who know they are HIV-positive have a higher propensity to refuse testing during the DHS survey, the HIV prevalence estimates are downward biased. In addition, women are generally more likely to agree to testing, which may lead to bias in the sex ratio of HIV prevalence. However, overall, non-response analyses for most DHS suggest that the bias is minimal (DHS Program 2017; Reniers and Eaton 2009). In the Zambian DHS 2013/2014, 87% of respondents who were eligible for HIV testing were both, interviewed and tested, 90% of women and 84% of men. Only 7%, in fact, refused to be tested, while the remaining difference results from technical issues in the field as, for example, lost blood specimen (CSO, MOH, and ICF 2015).

Awareness about HIV transmission from mother to child and about ways to prevent it has increased from 63% in 2007 to 78% in 2013/2014 among women and from 46% to 58% among men. In 2013/2014, the Zambian population was fully informed about the existence of antiretroviral drugs to treat HIV-positive individuals.

The expansion of HIV testing and counseling options combined with educational campaigns has increased the share of the population who is aware of the own HIV status. In 2001/2002, only 9% of women reported that they had ever been tested for HIV (CSO, CBH, and ORC 2003). Between 2007 and 2013/2014, the share of women who had ever been tested for HIV and also received the test result increased from 35% to 78%. The share is lower for men at 20% in 2007 and 60% in 2013/2014, among other reasons because women are often tested during pregnancy. Although the increase is substantial, the figures reveal that a fifth of women and two fifths of men do not know whether or not they carry the virus.

HIV risk perception in general is rather low. Men feel slightly less at risk than women: 30% of men and 26% of women in Zambia perceive no risk of HIV infection, 35% and 28% perceive a low risk, 14% and 17% a medium risk, and 15% and 17% perceive a high risk (6% and 12% do not know). There are no clear patterns for risk perception by demographic characteristics. With increasing education, the perception of the population seems to shift from 'no risk' to 'low risk'. Divorced, separated, and widowed respondents more often feel at high risk than people with other marital status, which is consistent with the higher HIV prevalence in these demographic groups.

Multiple and Concurrent Partnerships. The practice of having multiple and concurrent partnerships has been identified as a main driver of the HIV/AIDS epidemics in Sub-Saharan African countries including Zambia (Mulenga et al. 2009). Concurrent sexual partnerships comprise "overlapping sexual partnerships in which sexual intercourse with one partner occurs between two acts of intercourse with another partner" (UNAIDS Reference Group 2010). Concurrent partnerships are considered a decisive factor in explaining the rapid spread of HIV and its persistence in SSA because they create sexual networks that can facilitate disease transmission as compared to serial monogamy, that is, multiple but sequential partnerships. This is due to two reasons: first, concurrency implies that earlier partners are exposed to infection acquired from a later partner, which means that it increases the risk of becoming infected for the partners of those who practice it. Second, the time to onward transmission is reduced because a newly infected individual may have immediate contact with another partner while there is commonly a time gap between two partners in the case of serial monogamy. This is important because onward transmission of HIV is more likely in the first weeks following infection. In this way, for the same number of partners during a lifetime, it is assumed that having them concurrently leads to a more rapid spread of HIV as opposed to having one partner at a time (Epstein and Morris 2011; Goodreau 2011). Furthermore, concurrency implies that individual partnerships are not one-time encounters but longer-term partnerships. As discussed below, condom use is especially low in regular and long-term partnerships that involve trust and emotions, increasing the risk of HIV transmission.

In Zambia, men are much more likely to report multiple and concurrent partnerships than women. However, women may be more inclined to underreport the number of sexual partners or concurrency given that these behaviors are deemed socially more inappropriate for women, resulting in a potential overestimation of gender differences. Yet, the fact that in many ethnic groups in Zambia, men are allowed to have multiple wives means that men engage more frequently at least in the institutionalized form of multiple and concurrent partnerships, which is polygamous marriage. Polygamy poses a risk of acquiring HIV and other STIs if one of the members of the marital union has sexual intercourse outside of the polygamous marriage (Epstein and Morris 2011). In Zambia, the prevalence of polygamy varies greatly between regions and is higher in rural compared to urban areas. In 2013/2014, 17% of married women and 10% of married men were in polygamous unions in rural areas. Regarding multiple sexual partners in general, whether spousal or not, 1.7% of women (1.2% in rural areas) and 15.7% of men (18.6% in rural areas) who ever had sexual intercourse report having had more than one sexual partner in the 12 months prior to the survey. The prevalence of concurrency in a population is difficult to measure because it requires data not only on the number of partnerships but also whether they overlap, making it prone to both, underreporting of socially undesirable sexual partnerships as well as recall bias (Fishel, Ortiz, and Barrère 2012). Keeping these weaknesses in mind, the DHS suggests that about 15% of men in rural areas in 2013/2014 had two or more sexual partners that were concurrent at any time during the 12 months preceding the survey. Not surprisingly, 95% of men in polygamous unions had concurrent partners while the share is 13% among men in non-polygamous unions. For women, the reported prevalence of concurrency is low at less than 1% in rural areas. The great majority of multiple partnerships in Zambia is also concurrent: among the respondents who had multiple partners during the last 12 months, the prevalence of concurrency is 60% for women and 82% for men.

UNAIDS estimates that in 2008, over 20% of new infections in Zambia arose in people who report to have only one sexual partner. This hints towards a substantial role of sexual networks in HIV transmission. Zambia's HIV prevalence by reported sexual behavior does, in fact, point to a relation between HIV infection and multiple and concurrent partnerships. Among women who ever had sexual intercourse, HIV prevalence is highest for those who had more than one partner in the last 12 months (35%, and 40% if the partnerships were concurrent) compared to only one partner (15%) or no partner (23%). Among men who ever had sexual intercourse, HIV prevalence is similar whether they had one or more than one partner in the last 12 months (13%) and somewhat higher in the case of concurrent partnerships (15%). In 2007, 23% of women who had intercourse with a non-regular partner in the last 12 months (and 38% of those who had two non-regular partners) were HIV-positive compared with 15% who only had intercourse with regular partners. Yet, 27% of women who did not have sexual intercourse at all in the last 12 months were tested HIV-positive. Overall, these figures hint to the endogeneity of sexual behaviors to HIV infection. For instance, HIV prevalence may be higher among individuals with no sexual partners because they choose to abstain as a result of knowing to be HIV-positive.

Notwithstanding the correlations between HIV infection and having multiple and concurrent partnerships, it is important to note that the significance of concurrency in explaining the severe HIV/AIDS epidemics in SSA is not without controversy. In fact, there has been a vivid back and forth between proponents and skeptics of the 'concurrency hypothesis' in the literature. Skeptics have criticized that there is a lack of sound evidence to support a) that concurrency is at all higher in Africa than elsewhere and b) that the level of concurrency drives the epidemic (Lurie and Rosenthal 2010). In their systematic review on the evidence of the role of concurrency in HIV transmission, Sawers and Stillwaggon (2010), for instance, criticize that the assumptions made in the mathematical models to simulate the spread of HIV in the presence of concurrency are unrealistic. They argue that proponents of the concurrency hypothesis use estimates for frequency of sexual contact, levels of concurrency, and transmission rates, among others, that are far too high and thus overestimate the impact of concurrency on HIV transmission. Others find a strong effect of having multiple partners on the risk of HIV transmission, but no evidence that having them concurrently increases the risk (Tanser et al. 2011).

Low and Inconsistent Condom Use. In addition to multiple and concurrent partnerships, UNAIDS identifies low and inconsistent condom use as main driver of the HIV/AIDS epidemic in Zambia and concludes that "Condom use has not risen enough to significantly impact HIV transmission" (Mulenga et al. 2009). Given the dominance of the sexual transmission route in Zambia, the potential health impact of condom use is tremendous. According to estimates from 2009, 70% of infections in Zambia occurred in individuals who either themselves or their partners had heterosexual intercourse with a non-regular partner (Mulenga et al. 2009). Hence, benefits of condom use seem particularly promising in casual intercourse. However, evidence suggests that a large share of new infections in Zambia occurs within marriage or cohabitation (Dunkle et al. 2008). With a high prevalence of HIV in the general population and the widespread practice of having multiple and concurrent partnerships, condom use is important among a large part of the population and with all types of sexual partners, including with regular partners such as spouses.

Table 2.1 presents trends in self-reported condom use in Zambia by sex, partner type, and residence (urban or rural) based on the DHS since 1996. The figures reveal that despite a moderate increase during the last two decades, condom use remains a challenge in Zambia. Condom use is low and inconsistent and at the lower end of other highly affected countries in SSA (see a comparison of condom use in the ten countries most heavily affected by HIV in Table A2.1 in the Appendix). Self-reported condom use during the last sexual intercourse is particularly low for women, between regular sexual partners, including married and cohabiting partners, as well as in rural areas. This is consistent with the pattern commonly found in SSA (de Walque and Kline 2011; Reynolds, Luseno, and Speizer 2013). In urban Zambia, 19% of women and 30% of men report having used a condom during last sexual intercourse with any partner in 2013/2014. For rural areas, the corresponding figures are 11% and 21%. Condom use at higher risk sex—defined as sex with a non-marital, non-cohabiting partner or sex among individuals who had multiple partners in the last year—is higher: it ranges from 22% for men and women with multiple partners in rural areas to 61% among men having sexual intercourse with a non-marital, non-cohabiting partner in urban areas. Reported condom use is highest for the last sexual intercourse with a commercial sex worker: 66% of men in urban areas and 54% of men in rural areas report they used a condom during last paid sex. The reasons for low condom use in SSA, some of which are analyzed in this dissertation, are diverse. In many rural regions, a decisive factor is simply the lack of supply. This section has further shown that knowledge about HIV prevention is often not sufficient. Furthermore, a low risk perception has been associated with low condom use (Agha et al. 2002; Maharaj and Cleland 2004). As discussed above, a large part of the Zambian population does not feel at risk of HIV; two-thirds of men and over half of women perceive no or only a low risk of HIV infection. In addition, in many countries including Zambia, condom use is associated with being unfaithful and—especially for women—with being engaged in commercial sex work. Women often do not dare to ask a regular partner to use condoms as this may be taken as a sign of mistrust (Agha et al. 2002; Westercamp et al. 2010; Ochako et al. 2015). Furthermore, religious beliefs, both, traditional as well as conservative Christian denominations, may hamper condom use. Agha, Hutchinson, and Kusanthan (2006) find that adolescents affiliated with conservative religious groups in Zambia delay sexual initiation; however, they are less likely to use a condom during first sexual intercourse. Furthermore, myths and misconceptions, stigma and shame, especially among adolescents, as well as perceived lower pleasure during sexual intercourse counteract consistent condom use in SSA (Westercamp et al. 2010; Ochako et al. 2015).

The Vulnerability of Women. With 60% of the people living with HIV/AIDS being female, SSA is the only region in the world where women are more affected by the disease than men. In Zambia, women account for 57% of HIV infections (UNAIDS 2017). About 15% of women are HIV-positive compared to 11% of men (CSO, MOH, and ICF 2015). Women, and especially married women, are more vulnerable to HIV/AIDS, not only in terms of contracting HIV but also with respect to the adverse consequences of living with the disease. A study on women and the HIV epidemic in Zambia published in 2010 recognizes five areas of interlinked and reinforcing vulnerabilities that specifically apply to or are especially pronounced for women (Duffy and Regan 2010). First, women, especially younger women, are biologically more susceptible to contract HIV during heterosexual intercourse. As mentioned in Section 2.1.1, recent meta-studies estimate the likelihood of becoming infected during penile-vaginal intercourse to be twice as high for women than for men (0.08% and 0.04%) (Boily et al. 2009; Patel et al. 2014). Women's higher biological risk is attributed to a combination of factors, including a larger mucosa surface area for the virus to enter compared to men and a long time of contact of the mucosa with seminal

TABLE 2.1: Condom Use at Last Sex in Zambia, 1996–2014 (in Percent)

Year/ residence	Condom use at last sex with any partner		Condom use at last sex with a non-marital, non-cohabitating partner (higher risk)		Condom use at last sex among those who had multiple partners in the last year (higher risk)		Condom use at last sex with a commercial sex worker	
	Female	Male	Female	Male	Female	Male	Female	Male
1996								
urban	12.3	28.0	28.8	49.7	*n.a.*	*n.a.*	*n.a.*	*n.a.*
rural	5.3	14.0	11.8	31.7	*n.a.*	*n.a.*	*n.a.*	*n.a.*
2001/02								
urban	15.8	26.4	46.6	51.8	*n.a.*	*n.a.*	*n.a.*	60.7
rural	9.4	15.0	22.7	37.1	*n.a.*	*n.a.*	*n.a.*	31.4
2007								
urban	17.9	27.8	47.6	54.9	39.5	35.2	*n.a.*	62.2
rural	8.2	18.3	25.9	45.4	26.6	22.3	*n.a.*	50.2
2013/14								
urban	19.1	29.5	47.9	61.1	34.7	37.2	*n.a.*	65.9
rural	11.3	21.3	33.7	49.7	21.8	22.0	*n.a.*	53.8

Notes: Condom use data is self-reported by respondents in the Demographic and Health Surveys conducted in Zambia in the indicated survey years. It was compiled in July 2016 using the DHS STATcompiler (http://www.statcompiler.com). *Condom use at last sex among those who had multiple partners in the last year* is not available (n.a.) for 1996 and 2001/2002. *Condom use at last sex with a commercial sex worker* is not available for 1996 and generally not collected for women.

fluid and hence with the virus. Differences in young women's genital mucosa place them at even higher risk compared to mature women (Duffy and Regan 2010). Common cultural practices additionally increase the biological risk of infection for women. For instance, dry sex, which describes the practice of women using salts or herbs (orally or inserted vaginally) to dry the vagina, is widespread in Zambia. A dry vagina is thought to increase the pleasure of sex for men due to higher friction and is considered a sign of a woman's fidelity. In a study conducted in Zambia's capital Lusaka in 2009, two thirds of the 800 women interviewed had used dry sex practices before. Women from rural areas and specifically from Eastern Province, where the field experiment was implemented, were particularly likely to report current or past use of dry sex medications. The practice is highly problematic from the perspective of HIV transmission as it causes wounds and increases the risk of broken condoms (Mbikusita-Lewanika, Stephen, and Thomas 2009).

Second, women are more vulnerable due to prevailing social and cultural norms and associated expectations regarding female behavior. In the Zambian society, women have a subordinate social status and their bargaining power is especially low once they are married. This includes decisions of sexual and reproductive health. Women are less likely to negotiate or demand safe sex practices, such as condom use (GRZ 2014). Some ethnic groups have cultural practices which increase the risk for women further. For instance, the Chewa people, which constitute the largest ethnic community in Eastern Province, have a practice which involves young women having unprotected sexual intercourse with an older sexually experienced (usually paid) man when reaching puberty. Risk of infection is high, considering that young women are biologically particularly susceptible and older men, especially with multiple partners, have a higher probability of being infected. In some ethnic groups, women have sexual intercourse with a traditional healer to treat infertility (Mulenga et al. 2009).[14]

Third, women are legally discriminated, making it more difficult for women to protect themselves from and to cope with HIV infection. Similar to other African countries, Zambia has a dual legal system: common law, also known as English law due to its origin in the British colonial legal system, and customary law, the indigenous law that differs between ethnic groups, coexist. The latter is practiced at local courts which handle mainly matters

[14] Cultural practices also pose a direct risk to men. For instance, sexual cleansing involves a widow having sex with either a paid man or a family member of the deceased husband to purge the spirit of the deceased. Furthermore, widow inheritance involves a family member of the deceased to 'inherit' the widow (Embassy of Sweden 2008; Mulenga et al. 2009). Both practices are especially risky because widows have an extremely high HIV prevalence.

of civil law such as marriage and divorce, inheritance, and land rights in the local areas. As such, these courts are the most relevant courts for the majority of the rural population (Embassy of Sweden 2008; Ndulo 2011). While Zambia ratified the Convention on the Elimination of All Forms of Discrimination against Women adopted by the UN General Assembly in 1979, customary law continues to discriminate against women. Traditional marriages entered under customary law, which are about 90% of all marriages in Zambia, can be polygamous if desired by the man, increasing the risk of HIV infection also for the women through sexual networks as discussed above. In most Zambian cultures, the man pays a bride price to the woman's family, which is often interpreted as buying the power in the relationship, including the right to demand sex. Rape within marriage and wife-beating are often not considered an offense (Embassy of Sweden 2008; Duffy and Regan 2010). Among divorced, separated, or widowed women, 57% have experienced physical violence, mainly from the husband, and 25% have experienced sexual violence (CSO, MOH, and ICF 2015). In contrast to statutory marriages, there is no lower age limit for traditional marriages, once again putting young women at risk of HIV. Besides the discrimination of women in their physical and sexual rights, customary law usually restricts women's access to property, in particular owning land, which makes them vulnerable in case of HIV infection. For instance, women are extremely disadvantaged in the case of the husband's death or divorce. Many widows are forced to transfer a large part of their land to the deceased husband's relatives, so that women who lose their husbands, often as a result of HIV and often being HIV-positive themselves, are at a high risk of poverty (Embassy of Sweden 2008).

Fourth, and closely related to the social and legal status of a woman, is her economic vulnerability that results from the dependency on men and in particular her husband. Many women lack control over household resources even though they contribute a large share, they lack access to credit, and, since they largely work in the informal sector, they are not protected when sick or when caring for other sick family members. As a result of the dependency, sex work or transactional sex that involves transfers of money, gifts, and favors, often between older men and very young women, are often the only option to make a living, putting women at extreme risk of HIV infection (Mulenga et al. 2009; Duffy and Regan 2010).

Fifth, all of these aspects are reinforced by the educational disadvantage of women. Although basic education is free in Zambia and important improvements towards gender equality have been made, girls are still more likely to leave school when resources are scarce, family members are ill, or they become pregnant (Duffy and Regan 2010). Men are twice as likely to complete secondary school compared to women. Household surveys indicate a positive relationship between higher education and lower HIV risk factors: better educated women have higher HIV-related knowledge, less experience of sexual violence, and more favorable attitudes towards safer sexual relations with their husband and towards joint decision-making regarding household resources (CSO, MOH, and ICF 2015).

Overall, the international community recognizes that condom promotion activities in developing countries need to be better targeted to women and must address gender-based factors that hinder access to and use of condoms for women (UNFPA, WHO, and UNAIDS 2015).

2.2.4 Zambia's Response to the HIV/AIDS Epidemic

The initial response of the Zambian Government to the public health threat posed by the rapid spread of HIV focused on the safety of blood and blood products in clinical settings. The Zambian Government quickly realized, however, that a more comprehensive approach was needed, which recognized the importance of sexual transmission. New actors, in particular Non-Governmental Organizations (NGOs), faith-based organizations, and international donors joined the fight against HIV/AIDS in the early 1990s (Mulenga et al. 2009). In 2002, the National HIV/AIDS/STI/TB Council was founded to develop strategic frameworks to guide the response and coordinate the different actors. In 2004, the Zambian Government declared HIV/AIDS a national emergency. Prioritized areas of the strategic framework for 2014 to 2016 were (i) treatment, care, and support; (ii) HIV testing and counseling; (iii) elimination of mother-to-child transmission; (iv) voluntary medical male circumcision; (v) condom programming; and (vi) social and behavior change (GRZ 2014).

With respect to HIV prevention, emphasis shifted from blood safety measures in the late 1980s to interventions focusing on the prevention of sexual transmission in the 1990s. Priorities involved education to increase knowledge and change attitudes and sexual behaviors in the population combined with condom promotion and distribution. Education measures centered around the 'ABCs' for HIV prevention: Abstinence, Be faithful, and use Condoms (CSO, MOH, and ICF 2015). Starting in 1999, prevention efforts were supplemented by the promotion of HIV testing. At that time, the Zambian population was for the most part not aware of the own HIV status (CSO, CBH, and ORC 2003). Based on the assumption that knowledge of one's HIV status reduces risky sexual behaviors, access to HIV testing services was rapidly expanded.[15] By 2012, 85% of Zambia's then 2,000 health facilities offered HIV counseling and testing (MOH 2013). Recently, promotion of voluntary medical male circumcision was incorporated in the national HIV prevention strategy. By 2014, over 470 facilities offered male circumcision services and the number of performed circumcisions increased from 30 in 2007 to 200,000 in 2014 (GRZ 2015).

With respect to HIV treatment, until 2000, ART was only available in a few urban private medical practices for those who could afford it. In 2002, the Ministry of Health (MOH) introduced the first public sector provision of ART in Zambia's two largest hospitals. In light of the growing numbers of patients in need, plans evolved to extend access to ART to the level of primary health care (Stringer et al. 2006). In 2003, the Zambian Government launched the policy of providing free and universal access to ART in the country, which was extended two years later to additionally cover all related services such as laboratory tests. The number of public health facilities providing ART increased rapidly, at first in urban Lusaka District, but gradually throughout the country, reaching 592 by 2014 (GRZ 2015). As a consequence, the number of people receiving ART increased substantially. By 2015, the number had reached over 750,000 (UNAIDS 2017). In 2013, over 85% of the adults in need for ART received treatment (UNAIDS 2013).[16] However, treatment adherence remains a major challenge (Sasaki et al. 2012). Simultaneously with the roll-out of ART, PMTCT was expanded substantially in Zambia. Over 90% of women living with HIV who gave birth in 2014 received antiretroviral drugs for PMTCT. HIV transmission rate from mother-to-child in Zambia is estimated to have dropped from 24% in 2009 to 9% in 2014 (GRZ 2015).

The Zambian Government and international donors provide considerable funds to subsidize condom distribution in the country. Similar to other African countries, Zambia imple-

[15]The assumed impact channels from HIV testing to a reduction in risky sexual behaviors are as follows: individuals who learn to be HIV-negative have an incentive to stay so, while those who are HIV-positive feel the responsibility to protect their sexual partners, resulting in an overall decrease in sexual risk behavior. Evidence seems to support the latter assumption. Knowledge about the own HIV status increases demand for condoms or condom use among those tested HIV-positive (see, for instance, Weinhardt et al. (1999), Denison et al. (2008), and Thornton (2008).)

[16]The number of people considered in need for ART is determined based on guidelines of the World Health Organization. They specify a certain stage of the disease at which a HIV-positive person should initiate ART. The guidelines were continuously revised with the tendency to recommend ART initiation at an earlier stage of the disease. This increases the share of people living with HIV in need for treatment and decreases the coverage rate given the same number of people on treatment. Comparison of coverage rates over the years can therefore be misleading. See, for instance, WHO (2016a).

ments a two-pronged approach to make condoms available to the public: on the one hand, condoms are provided free of charge at public health facilities and institutions and sometimes in high-risk locations such as bars. On the other hand, social marketing programs provide specific condom brands at subsidized prices. Usually, non-profit organizations distribute a specific condom brand through private commodity logistics systems so that they can be purchased at subsidized prices in local shops, kiosks, and pharmacies. Wholesalers and retailers are given an incentive to sell condoms in terms of a profit margin with the aim of making condoms more widely available in locations convenient for the population. In addition, the NGOs use branding and commercial marketing techniques as well as information and behavior change campaigns to increase demand for condoms (Sweat et al. 2012).

In Zambia, condom social marketing was initiated in 1992 by Society for Family Health (SFH), a local affiliate of the US organization Population Services International. At that time, condoms were only available in pharmacies in urban areas and not affordable for the large part of the population. Social marketing condoms were thus sold at one-tenth of the price of commercial condoms. The social marketing program was shown to have reduced barriers to condom acquisition and increased equity in access in urban areas, in particular by making condoms available in non-traditional outlets such as kiosks, which are commonly found in low-income neighborhoods (Agha and Kusanthan 2003). The social marketing program was rolled out nationwide and 'Maximum' condoms are the most widely available and best known brand in the country. In 2012, about 52% of all condoms distributed in Zambia were social marketing condoms. Unbranded condoms distributed at the health clinics made up a slightly smaller share of about 45%, while only 2 to 3% were commercial condoms.[17] Yet, social marketing condoms do not reach Zambia's most rural areas. The rural-urban discrepancy is confirmed by the DHS which provides information on the type of condom used by men who reported using a condom during last sexual intercourse. In urban areas, 63% used social marketing condoms, 18% public sector condoms, and 6% commercial condoms (8% do not know) compared to 44%, 30%, and 7% (15% do not know), respectively, in rural areas.

[17]Figures on the market shares were collected during visits at Population Services International as well as the Ministry of Health in Zambia in 2012.

3 The Randomized Price Experiment in Katete, Zambia

The empirical analyses of this dissertation are based on a unique data set which combines condom sales data from a randomized field experiment conducted in rural Zambia and geo-referenced data of the study area. In the field experiment, community health volunteers living in rural villages created new condom sales points in an area where condoms were previously only available at health clinics. More precisely, the volunteers served as condom sales agents and sold the Zambian social marketing condom brand from their homes. In addition, they collected data from every customer for four months by means of a brief survey. Each condom sales agent was randomly assigned one of three prices for a pack of three condoms. In order to enrich the empirical analyses by a spatial dimension, the study area was manually geo-referenced by means of local maps. This chapter presents the setting, design, implementation, and data collection of the field experiment and describes the approach taken to geo-reference the study area. Subsequently, it examines whether the random allocation of prices resulted in a balanced distribution of the sales points' properties across price groups and presents a descriptive summary of condom acquisition and customer characteristics.

3.1 Setting

The randomized field experiment was conducted in 2013 in Katete District, one of nine districts in Eastern Province, Zambia. Eastern Province borders Lusaka Province, Central Province, and Muchinga Province within Zambia as well as the countries Malawi and Mozambique.[18] The province is connected to central Zambia via the Great East Road which runs from the country's capital Lusaka through Katete District to Chipata, the capital of Eastern Province, and continues to Malawi in the east of the country.

Eastern Province is one of Zambia's poorest and least urbanized provinces. According to the LCMS 2010, approximately 78% of its population lives below the national poverty line and 59% of the population is considered extremely poor. The average monthly per capita expenditure in Eastern Province of about 25 US dollars in 2010 is merely half the national

[18]Muchinga Province was newly created in 2011. Besides districts which previously belonged to Northern Province, Muchinga Province comprises Chama District, which used to be part of Eastern Province (compare, for instance, MOH (2011) and MOH (2013)).

average, which renders it the second poorest province in the country.[19] The percentage of the population living in rural areas is the highest in the country at about 91% compared to a national average of 65%. Farming constitutes the livelihood for the majority of the population in Eastern Province: over 90% of households are in some way engaged in agricultural activities, mostly subsistence farming (CSO 2012).

Progress with respect to housing conditions and access to basic facilities has been very slow and living conditions in Eastern Province remain poor. Two thirds of the population lives in traditional huts. Only 5% of the households are connected to the electricity grid; the main source of energy for lighting is kerosene or paraffin (38%), a torch (26%), or a candle (17%) and the great majority of the households, that is, 84% uses collected firewood for cooking. Considerable improvements, however, have been made with respect to safe drinking water: over 70% of the households in Eastern Province use an improved source according to the WHO/UNICEF classification as the main source of drinking water, mostly boreholes (52%) and protected wells (11%). The availability of adequate sanitation, in contrast, remains a great concern in Eastern Province and is among the lowest in the country, posing a serious health risk for the population and especially for children in terms of diarrheal diseases. Only 12% of the households use an improved type of sanitation facility while over 55% use a pit latrine without a slab, which is considered an unsafe technology. A fourth of the households does not have any toilet facility, meaning they mainly go to the bush or field (CSO 2012).[20]

HIV prevalence in Eastern Province is about 9% and therewith similar to the Zambian average in rural areas. Women in Eastern Province are slightly more affected than women in rural areas on average (10.9% compared to 9.9%) while the opposite applies to men (7.7%

[19]The average monthly household expenditure per capita in Eastern Province was 116,000 Zambian Kwacha (ZMK) in 2010 which corresponded to about 25 US dollars. Total household expenditure as defined in the LCMS is the sum of household expenses in various areas, including food and beverages, housing, education, clothing, public utilities, medication, and transport. In addition, household expenditure includes the monetary value of own produce, both, food and non-food goods. In contexts characterized by a high prevalence of subsistence farming, expenditure is preferred over income as poverty measure since neglecting own produce would understate a household's economic well-being (CSO 2012). Note that the LCMS was implemented before the redenomination of the Zambian currency in 2012 which involved replacing the old kwacha (ZMK) with the new kwacha (ZMW) at the rate of 1,000:1. The expenditure data from the LCMS 2010 can therefore not be compared directly to the prices in the field experiment.

[20]For clarification, according to the WHO/UNICEF classification, improved drinking water sources include piped water (into the household's dwelling, yard, or plot), public tap or standpipe, tube well or borehole, protected dug well, protected spring, and rainwater. Improved sanitation facilities are those that hygienically separate human excreta from human contact and include flush toilets, piped sewer system, septic tank, flush or pour flush to pit latrine, ventilated improved pit latrine, pit latrine with slab, and composting toilet (UNICEF and WHO 2015).

compared to 8.1%). In Eastern Province, the following HIV risk factors are particularly pronounced: the province is characterized by one of the highest rates of polygamy (17% of women were living in polygamous unions in 2013/2014 compared to 13% countrywide) and the lowest coverage of male circumcision in the country (6% among men aged 15 to 49 compared to 22% countrywide) (CSO, MOH, and ICF 2015). Cultural practices associated with an elevated risk of HIV transmission such as dry sex are very common among the Chewa people (Mbikusita-Lewanika, Stephen, and Thomas 2009; Mulenga et al. 2009). In addition, condom distribution in Eastern Province was described as low compared to the rest of the country (Mulenga et al. 2009).[21]

The randomized price experiment was conducted in five adjacent public health clinic catchment areas in Katete District which were selected on the basis of their rural status and the lack of condom sales outlets. The five rural health clinics are located between 20 and 50 kilometers from Katete Boma, the small town that serves as Katete District's administrative headquarters.[22] The five clinic catchment areas, which jointly constitute the study area, cover a total population of about 70,000 people, corresponding to about 30% of Katete District's population of 240,818 in 2010 (CSO 2011). The landscape is hilly and several streams run through the study area. The region lacks even basic infrastructural development. Families live in simple one or two-room huts which are neither connected to a water network nor an electricity grid. Except for the Great East Road, which passes through the study area, roads are gravel or dirt roads and the main mode of transport is walking. There are a few small kiosks selling basic items such as soap but otherwise own produce is sold at the side of the gravel road.[23]

The five health clinics are responsible for providing basic medical services to the population in their respective catchment area. Amenities are very sparse: even at the health clinics, water has to be collected from boreholes. Two clinics operate without power, two use solar

[21]The population in the study area participates in various, mostly Christian denominations including, among others, the Catholic Church, the Reformed Church of Zambia, the New Apostolic Church, and the Pentecostal Church. These denominations may express negative attitudes towards condom use and therewith facilitate HIV transmission. However, there was no further investigation whether this constitutes a special risk factor in Eastern Province compared to other Zambian provinces.

[22]According to Zambia's official classification of health care delivery levels, four of the participating clinics are Rural Health Centers while the fifth is a Health Post. Health Posts are intended to serve a smaller population than Rural Health Centers (3,500 compared to 10,000 people) and offer more basic types of health services. Yet, the Health Post involved in the experiment has a similar catchment area and offers similar services as the smallest participating Rural Health Center (MOH 2013). In what follows, the term 'health clinic' is used consistently for all five facilities in the study area.

[23]Appendix A3.1 provides pictures of the study area for an impression of the living conditions.

power, and one uses hydropower. They provide between 0 and 22 beds for patients. Three of the clinics are delivery sites, only one offers laboratory services and emergency obstetric care, and none has an operating theater. All clinics provide HIV testing services (MOH 2013). At the time of the experiment, none of the five clinics provided ART to treat HIV directly; however, three clinics were part of a mobile ART services program carried out by the district hospital while in the other two clinic catchment areas, HIV-positive individuals were referred to the district hospital.[24]

FIGURE 3.1: Zambia and Eastern Province

Source: Nations Online Project (2017)

Clinic catchment areas in rural Zambia are usually of substantial area size, especially in sparsely populated regions. National guidelines stipulate an upper limit of either 10,000 people or a radius of 29 kilometers for Rural Health Centers (IHME 2014). Accordingly, the rural population often has to travel large distances in order to access health care services, commonly by foot and on roads of poor quality. Besides the large distances, rural Zambia faces a critical shortage of human resources for health, especially of health workers. The Zambian health system therefore relies on training volunteers from villages to serve as a connection between the community and the health facility staff. These so-called community health volunteers serve as a contact person for the villagers, help identify health problems,

[24]This information was collected on-site before study implementation.

and provide preventive and basic curative services at community level, including education on HIV/AIDS (MOH 2010).

As described in Section 2.2.4, the Zambian Government pursues a strategy of providing condoms free of charge to the population at all public health clinics. Provided the condoms are not out of stock—which constitutes a permanent problem in rural areas—the population in the study area can thus acquire individually packed and unlabeled condoms free of charge at the five health clinics. At the time of the field experiment, this option was, however, also the only option for the population to acquire condoms in the study area. A previous study on condom supply in one of the five catchment areas found that no outlets selling condoms existed in this rural part of Katete District (Seidenfeld 2014). Investigations prior to this field experiment confirmed that there is neither a market for commercial condoms nor a possibility to acquire social marketing condoms in the study area except during large traditional festivals and fairs when NGOs distribute condoms. The few existing kiosks visited before the experiment began did not sell any condoms, confirming that the clinics are, in fact, the only possibility for the rural population to acquire condoms within the study area.

3.2 Experimental Design, Implementation, and Data

Experimental Design. The design of the field experiment built on the missing condom market in the area and established new condom sales points at village level. This provided the population with the alternative of purchasing condoms near home in addition to the existing option of acquiring free condoms at a health clinic. The study design relied on the universe of preexisting community health volunteers to serve as condom sales agents in the experiment. The area in Katete District is characterized by a spatial grouping of villages. For the most part, between two and five villages form a natural village cluster which is separated from the next village cluster by a gravel road. In order to provide basic health information and services to the rural villages, the health clinics usually train one villager per cluster to become a community health volunteer. Hence, relying on this preexisting system of community health volunteers that assigns villages to volunteers according to geographic proximity resulted in one condom agent for about three clustered villages in the experiment, thus creating a local condom market for each village cluster.[25] The community health

[25]As elaborated below, in a few comparatively large villages, the clinics train two or three community health volunteers to achieve a roughly uniform volunteer-per-population rate in the area. This means that these villages also had two or three condom agents during the experiment.

volunteers are comparatively highly educated and literate in English and the local language Chichewa, which was of great importance for their role of collecting data in the experiment. In order to cover the study area, 125 community health volunteers and thus condom agents were intended to participate in the study.

The condom agents were responsible for the core functions of the study. In concrete terms, these functions involved first, to sell the social marketing condom brand Maximum exclusively from their homes to everyone demanding condoms and second, to collect data on every purchase and customer during a four-month period from mid-June to mid-October 2013 by means of a short survey instrument. At the same time, the health clinic staff continued handing out condoms free of cost at the clinics. During the four months of the experiment, the staff additionally collected data from all clients demanding condoms at the clinic using the same survey instrument as the condom agents. In this way, information on every incidence of condom acquisition in the study area, both, at the clinic and the condom agents, could be collected during the period of the experiment.

The key feature of the study design was the random allocation of prices to condom sales agents: in order to create variation in price, every condom agent was randomly assigned one of three prices before the experiment began and offered condoms at this one fixed price throughout the entire study period. Given that differences may exist between the five clinic catchment areas which affect condom demand—such as the intensity of HIV education or condom promotion carried out by the clinics, the extent of stigmatization prevailing at the clinics, or messages disseminated by churches—randomization of prices was done *within* catchment areas, resulting in an equal proportion of condom agents per price level in all five catchment areas. This so-called stratified or blocked design balances the treatment groups, in this case price groups, before randomization. Similar to controlling for variables *ex post*, stratification increases precision of the estimates but is more efficient (Duflo, Glennerster, and Kremer 2008).

The condom sales agents sold the Zambian social marketing brand Maximum in packs of three condoms. The three price levels selected for the experiment were 25 ngwee, 50 ngwee, and 100 ngwee for a pack, which corresponded to about 0.05, 0.10, and 0.20 US dollars, respectively, at the time of the study.[26] The highest price of 100 ngwee was equal to the

[26] 100 ngwee equals 1 kwacha.

lowest price for an identical pack of Maximum condoms found in Katete Boma, the closest town to the study area.[27] We chose the price of 100 ngwee as the reference price to reflect a potential roll-out of the existing condom subsidization program to rural areas at the same price level found in urban areas and included two lower prices to analyze the demand effects of introducing the condoms at cheaper prices in rural areas. For comparison, a pack of commercial condoms cost about 10 kwacha (2.00 US dollars) in Katete Boma, showing that the social marketing price offered nationally in urban areas and even more so the prices in the experiment are highly subsidized.

The purchasing power of the selected prices in the villages at the time of the study can be illustrated as follows: as reported by villagers, 25 ngwee corresponded to three pieces of candy and 50 ngwee to about four bananas while 100 ngwee were enough to purchase a heap of tomatoes, sufficient for a side dish for two meals for a family of five. Relating these condom prices to the population's expenditure indicates that a couple would have to spend less than 1% of the combined yearly expenditure in order to use condoms consistently. Frequency of sexual intercourse is difficult to assess and subject to recall and social desirability bias; however, several studies from Africa suggest that the number of sexual acts per person is approximately five per month (Johnson et al. 2009; Sawers and Stillwaggon 2010). Taking 60 incidences of sexual intercourse per year as a rough guide, the selected prices in the field experiment imply that for consistent condom use, a couple has to spend approximately 0.2% at the lowest price and approximately 0.7% at the highest price of the combined yearly per capita expenditure of 600 US dollars.[28]

The experiment included incentives for the condom sales agents as well as the clinic staff to carry out condom distribution and data collection according to the study design. The clinics received a monthly payment for collecting data on individuals acquiring condoms in addition to their usual task of distributing condoms free of charge on demand. The condom agents were incentivized financially and in kind: they received a small profit for each condom pack sold and a bicycle for successful participation. The bicycle was given to the sales agents who fully complied with the rules of the study during the entire period, which

[27] SFH, the organization implementing the nationwide social marketing program in Zambia, recommended a price of 70 ngwee for a pack of three Maximum condoms in 2013 but the prices ultimately set by retailers in urban areas deviated both upwards, as in Katete Boma, and downwards, as, for instance, in Lusaka.

[28] Recall that the average monthly household expenditure per capita in Eastern Province was 116,000 ZMK in 2010. This equaled about 25 US dollars per person per month or 600 US dollars per couple per year. Consider also that the converted prices of 0.05, 0.10, and 0.20 US dollars apply to a pack of three condoms.

involved most importantly i) selling condoms only at the assigned price and ii) only from home (in order to represent sales points and limit differences in promotion and outreach activities between agents as far as possible); iii) collecting data from every customer; iv) restocking condoms in time to ensure constant supply; and v) delivering the revenue on a regular basis to the implementing NGO. Bicycles are highly valued in the sparsely populated rural areas of Zambia and are therefore a good incentive for the successful implementation of the study. They also served another purpose: the condom agents borrowed the bicycles for the time of the study to be able to restock condoms at a central place (usually near the clinic). In addition to the bicycle, every agent earned a profit of 10 ngwee per condom pack sold, irrespective of the assigned sales price. Although this profit structure benefits agents with lower prices—provided that demand decreases with price—it was chosen for reasons of simplicity in the implementation for condom agents and the supervision by the NGO. Furthermore, a profit structure increasing proportionally or progressively with price also risks bias owing to *ex ante* uncertainties about quantities sold at each price level.

Implementation. The preparation phase of the field experiment including the trainings of the community health volunteers as well as the clinic staff with respect to their role and responsibilities during the experiment was led by the researchers. Subsequently, the Zambian NGO Family Health Trust (FHT), with a local office and staff in Katete District, managed and supervised the implementation of the field experiment. More precisely, a week before the sales activities began, the soon-to-be condom agents and the clinic staff participated in intensive trainings (one per clinic catchment area) on sales activities and data collection carried out jointly by the researchers and FHT. During the trainings, the condom agents practiced the interaction with customers and the handling of the survey instruments in several rounds. Individual re-trainings were carried out by FHT for the agents to overcome comprehension difficulties and gain routine. At the end of the trainings, one of the three prices for a pack of condoms was randomly assigned to each agent. Some agents expressed their preferences for lower prices during the trainings, but after emphasizing the importance of adhering to the assigned price for the entire duration of the experiment, FHT did not observe deviations. Besides the supervision by FHT, compliance was achieved by means of a control mechanism built into the design: as verified by FHT, the revenue delivered regularly by the sales agents had to correspond to their price and their remaining condom stock. Before the agents began selling condoms, the population in the villages of their respective cluster was informed through an announcement about the sales activities by the village head men. There was no further advertising through billboards or the like. FHT monitored the agents closely via phone calls and personal visits, checked whether they conducted the short interviews with the customers, collected the surveys as well as the revenue (less the incentive) when agents restocked condoms, and checked whether the revenues collected corresponded to the agent's assigned price and remaining condom stock.

Table 3.1 provides key properties of the clinic catchment areas in 2013 as provided by Katete District Health Management Office and compares the experimental design and the actual implementation. The five clinic catchment areas differ considerably with respect to size. The smallest area has a population of 5,444 compared to a population of 27,565 in the largest area. Catchment areas with a smaller population do not only have fewer but also smaller villages. Overall, villages in the study area are very small with an average population of about 225 people. For the two smaller catchment areas, average village population drops to 132 and 136. The catchment areas have different levels of remoteness as measured by the kilometers between the respective health clinic and Katete Boma, which varies between 22 and 48 kilometers. In accordance with the different sizes of the catchment areas, the number of community health volunteers and thus the planned number of condom agents per area varies between 10 and 48. Of the initial 125 agents covering the study area, only 119 participated in the field experiment. Agent attrition was therewith below 5%. Furthermore, the drop out of agents was not correlated to price; yet, it resulted in a few uncovered villages. Of the six agents who dropped out, two did not show up for the trainings and were therefore not assigned a price, one migrated (assigned the price of 50), three were excluded because of either illiteracy (one agent assigned the price of 50 ngwee) or cheating (two agents, assigned the prices of 25 ngwee and 100 ngwee, who tried to swap prices after the trainings). Despite the close monitoring of FHT, it cannot be completely ruled out that the remaining agents had some periods of lower sales activity due to temporary absence. In any case, selling condoms was not their sole activity and differences in the time devoted to their usual work and businesses will have resulted in variations in the time spent at home and therewith availability for selling condoms.

Data Collection and Processing. Within the scope of the field experiment, data was collected on three different levels: first, on the condom sales agents; second, on the villages located in the study area; and third, on all individuals who acquired condoms within the

TABLE 3.1: Experimental Design and Actual Implementation

Clinic catchment area properties					Design		Implementation			
Area	Pop.	Villages	Pop./ village	Km to Katete	Agents	Pop./ agent	Agents	Agents/price		
								100	50	25
1	5,444	40	136	27	10	544	10	4	3	3
2	24,627	94	262	32	43	573	42	14	14	14
3	27,565	104	265	48	48	574	45	14	15	16
4	5,788	44	132	24	10	579	10	3	4	3
5	8,092	36	225	22	14	578	12	4	4	4
Total	71,516	318	225		125	572	119	39	40	40

Notes: Data on clinic catchment areas was collected from Katete District Health Management Office in 2013. Presented figures are absolute numbers. The variable *km to Katete* indicates kilometers from the health clinic in the respective catchment area to Katete District's administrative headquarter Katete Boma.

study area during the four-month period. Regarding the sales agents, we collected basic demographic information including sex, age, education level, and marital status. The data on the villages, mainly size and travel time to the clinic, was provided by the condom agents. In particular, they collected the population size of each village in their cluster from the village head men's registers. In addition, the agents provided information on the travel time from each village in their cluster to the catchment area's health clinic. The travel times were measured by the sales agents themselves: they rode the bicycle provided within the study from the villages to the health clinic and measured the time they needed for the trip. Thus, travel times are estimates that depend on each agent's ability to ride a bike. Yet, given the hilly landscape, streams, and the differences in road quality, these estimates seem to be a valid proxy for the opportunity costs of visiting the clinic as well as the general remoteness of the village, as the clinics are usually both, the geographic center of the catchment area as well as the center of economic and social activity.

The main data set captures incidences of condom acquisition in the study area during the four months, including data on the individuals making the acquisition. By means of a simple two-sided survey instrument, data was collected from every individual who demanded condoms during the experiment, either at one of the five health clinics or at a condom agent (see Figure A3.2 in the Appendix). The clinic staff and the condom agents, respectively, collected basic demographic information on the individuals as well as data on their knowledge of and past behavior related to HIV/AIDS. Respondents were further asked about the reasons for choosing that particular location for acquiring condoms as well as the travel time and chosen travel mode to this location. We expected that a noticeable share of customers would refuse to participate in the survey as it involved sensitive topics related to sexual behavior. In addition, although kept to a minimum, an interview takes some minutes and some customers may prefer to make the condom purchase as quickly as possible in order not to be seen by acquaintances. Sales agents were instructed to sell condoms also if the customer did not agree to respond or only answered part of the questions. In order to nonetheless track all sales, the survey was designed in such a way that the agent or clinic staff was able to fill in the first part even in case the customer chose not to answer the questions (compare questions 1 to 4 of the survey instrument in Figure A3.2 in the Appendix). This ensured that every incidence of condom acquisition in the study area was documented with date, time, and location as well as the number of condoms acquired, and that information at least on the individual's sex was collected.

Overall, customers chose not to answer any questions in only 2% of the purchase incidences. At the same time, however, only 39% of the questionnaires are complete. For sensitive questions, non-response is up to 12%. This includes the questions on whether the respondent had ever been tested for HIV (12% missing) and on the number of sexual partners in the last 12 months (10% missing). The question with by far the most missing values (42%) is on the customer's willingness-to-pay for condoms.[29] We included this question with the aim of evaluating the three prices selected for the experiment against the range of willingness-to-pay reported by the customers. During the experiment it became clear that both, the agents and the customers, experienced difficulties in understanding the hypothetical concept of this question. It seems that many customers believed they were asked for a desired price or even hoped to influence the price with their answer since descriptive analysis of the data reveals that many customers state a lower willingness-to-pay than the price they actually paid. As a side note, this finding emphasizes the need for great caution when interpreting studies based on willingness-to-pay surveys, especially from regions with low levels of education.

The data collection process provides one observation for each incidence of condom acquisition, independent of whether the same individual acquires condoms repeatedly. In order to analyze the extensive and intensive margins of demand for condoms, that is, to what

[29] The exact wording in the survey was 'We will not raise your price. What is the most you are willing to pay for 1 packet of three condoms?'.

extent changes in total demand are due to changes in the number of customers in contrast to changes in the number of condoms acquired per customer, we need to identify those individuals who purchase condoms more than once. For reasons of ensuring anonymity, condom agents and clinic staff did not ask for the customer's name during the interview (nor did they note it down in case it was known). Therefore, we determine repeat customers based on demographic characteristics collected at every purchase. Recall that the villages in the study area are very small with an average population of 225 people. In addition, over 50% of the population in rural Zambia is under the age of 15 (CSO, MOH, and ICF 2015), leaving few people of relevant age from the same village with identical demographic information. Repeat customers are identified based on the following characteristics: village of residence, sex, age, marital status, number of children, and years of education completed. These characteristics are relatively unlikely to change within a four-month period. We further verified the results with the customers' statements in the survey about whether they had purchased condoms from the specific location before. Plausibility checks were performed based on additional variables.[30] We believe that this provides quite accurate estimates; nevertheless, it is a conservative approach to estimating repeat customers. Individuals experiencing a birthday or a child birth within the study period, for instance, will not be identified as the same individual. The same applies if one of the key demographic characteristics is missing. As a result, the intensive margin may be slightly underestimated and, consequently, the extensive margin slightly overestimated.

3.3 Geo-referencing of the Study Area

While the data collection provides a list of the names and sizes of all villages in the study area, it does not provide information on their spatial distribution. For Zambia's remotest and sparsely populated regions including the study area of the field experiment, no large-scale maps indicating villages or other landmarks exist. Also, no geographic data, such as Global Positioning System (GPS) coordinates, was collected on the ground in the course of the field experiment. In order to enable spatial analysis, I determined the GPS coordinates

[30] For instance, it is unlikely that a repeat customer reports never to have been tested for HIV if reported otherwise a few weeks ago. Observations with missing values for one of the six main demographic variables are not matched. We identify 5,178 unique individuals. Among the repeat customers, 9 purchased condoms at two different agents. We neglect this phenomenon, which is insignificant in magnitude, and treat these purchases as different customers at each agent in order to assign them to a price level. This increases the number of distinct customers to 5,187.

of the key landmarks in the study area *ex post* on the basis of hand-drawn clinic catchment area maps and satellite imagery. The purpose of the geo-referencing procedure was to obtain measurements of the distances between the population and the condom agents as well as between the condom agents themselves. The distance measures reflect the spatial distribution of the population and the condom agents and can be incorporated in the empirical analyses.

In concrete terms, I manually mapped the five health clinics whose catchment areas jointly constitute the study area, the villages in these catchment areas, as well as the routes that are taken by the population to travel between these landmarks. I used a geographic information system software (ESRI's ArcGIS for Desktop Version 10.3.1) that displays satellite imagery and provides GPS coordinates. The exact process involved the following steps: as a first reference, I obtained the GPS coordinates of the five health clinics from the Zambian Health Facility Census (HFC). The HFC was conducted by the Zambian Ministry of Health (MOH) and the Japan International Cooperation Agency (JICA) in 2005 and 2006 and provides data on all public and semi-public health facilities in Zambia including their exact location in terms of GPS coordinates (JICA and MOH 2006). I imported the GPS coordinates of the five health clinics into the ArcGIS software and verified by means of satellite imagery that the coordinates, in fact, show a health clinic. This was easily possible because the health clinics are located at the center of each catchment area where all gravel roads meet and, as relatively large buildings, are clearly distinguishable from the standard huts where households live.

In a second step, I manually determined the coordinates of the villages in the study area as follows. The five health clinics maintain hand-drawn maps of their respective catchment area which depict the main landmarks and their names, including the clinic itself, schools, villages, farms, gravel roads, and rivers. Some maps additionally show churches, boreholes, grave yards, and hills. I used the list of villages collected at the beginning of the experiment and these clinic catchment area maps as a basis to identify the villages on satellite imagery and record the GPS coordinates of their centroid. Starting from the clinics that were already located, I identified the villages and roads on satellite imagery according to the spatial arrangement indicated on the hand-drawn clinic catchment area maps. Additionally, I used the population size of each village, the travel time from the village to the health clinic (as reported by the condom agents), and other landmarks to verify that the villages are correctly located on the satellite imagery. For illustration, from a hand-drawn map I know, for instance, the name of the first village on the gravel road leading from the clinic to the north. On the satellite imagery, I can identify the road as well as the first village, as an accumulation of huts, along this road and manually take the GPS coordinates of its centroid in ArcGIS. In this way, I obtained the GPS coordinates of the villages. The condom agents were assigned the coordinates of the village where they live and sell condoms.

In addition to the villages, I mapped the roads in the study area that are used by the population to travel in the area in order to estimate distances between villages on actual roads. This includes the gravel roads indicated on the clinic catchment area maps as well as some smaller roads not indicated but clearly identified on satellite imagery as routes utilized by the population. The roads mapping procedure was technically done as follows: I copied the roads displayed on the satellite imagery in ArcGIS with small line segments and then merged these line segments so that they are connected at all intersections. In order to enable the measurement of distances between all villages, I transformed the connected lines into a single road network with the help of the ArcGIS extension *Network Analyst*. I defined the road network to be unrestricted. This means that in order to calculate the shortest distance between two villages, every road section can be used and in both directions.[31] Ultimately, I calculated the closest route from every village to every agent in ArcGIS based on the criteria of distance in meters.

The mapping of the roads has the advantage that the distances between villages are measured along routes that are actually used by the population. Relying on straight-line distances between landmarks, that is, as the crow flies, could lead to substantial distortions especially in landscapes with hills, forests, and streams, where cutting across country is not an option. In the study area, paths often run around a mountain or to a certain point where a bridge crosses a stream so that villages are often substantially further apart than straight-line distances would suggest. Hence, the distance along routes reflects the opportunity costs and effort required to purchase condoms more accurately.

Overall, the hand-drawn clinic maps are very precise and the satellite imagery's resolution is sufficient to identify the majority of the landmarks in the area. Nevertheless, this *ex post*

[31]The *Network Analyst* is designed to analyze more complex traffic systems where one needs to define one-way-streets and restricted turn and u-turn possibilities, as well as traffic lights in order to adequately calculate distances and analyze advantages and disadvantages of routes (ESRI 2017). However, the roads in the study area are not restricted with respect to directions or type of vehicle allowed and most of the customers travel by foot.

mapping procedure involves some inaccuracies. In four of the five clinic catchment areas, 90% of the villages could be mapped as well as 100% of the agents (which means all condom agents live in a mapped village). However, for the remaining catchment area, almost half of the villages and a fourth of the agents were not mapped because they were not indicated on the clinic catchment area map. A check for differences between villages and agents that were mapped and those that were not mapped reveals that there are no significant differences with respect to agent characteristics such as age, sex, or education. Unmapped agents do, however, report a higher travel time from their homes to the clinic: unmapped agents need on average 57 minutes (median 45 minutes) on their bike while mapped agents only need 44 minutes (median 30 minutes). This finding also holds for the villages: unmapped villages are located significantly further from the clinic than mapped villages in terms of travel time (on average 69 minutes compared to 47 minutes; $p = 0.0001$). They are also significantly smaller in terms of population size (on average 126 people compared to 224 people; $p = 0.0001$).[32] Overall, this is consistent with the finding that mainly small and remote villages at the outskirts of the catchment areas as well as small farms are not indicated on the clinic catchment area map.

Table 3.2 summarizes the results of the mapping procedure. Accordingly, 259 villages, or 77% of the villages in the study area, and 108 condom agents, or 91% of the condom agents participating in the field experiment, were located on satellite imagery and geo-referenced. With respect to the condom purchases, the mapping allows to trace 82% of the purchase incidences, meaning that both, the customer's village as well as the chosen agent's village were mapped. Note that the total number of villages with 337 is larger than the official number of villages provided by the District Health Management Office for the study area at 318 (compare Table 3.1 above). This is because farms or farm blocks are treated as villages in the sense of separate locations in the field experiment, even though they are administratively assigned to a village.

A further limitation of the mapping procedure is that the calculated distances are not the precise distances between a specific customer and a specific agent given that data is only available on the villages the individuals live in and not of their houses. As a consequence, the

[32]For the comparison between unmapped and mapped villages, I have to rely on reported travel time, as the distance measures are not available for the unmapped villages. For the comparison of agent characteristics between unmapped and mapped villages, I refrain from conducting a significance test due to the small number of only 11 unmapped agents.

TABLE 3.2: Results of *Ex Post* Mapping Procedure

	Villages			Agents			Purchases		
Area	Total	Mapped		Total	Mapped		Total	Mapped	
1	40	35	(88%)	10	10	(100%)	480	457	(95%)
2	111	101	(91%)	42	42	(100%)	1,183	1,129	(95%)
3	118	63	(53%)	45	34	(76%)	2,193	1,364	(62%)
4	38	31	(82%)	10	10	(100%)	327	317	(97%)
5	30	29	(97%)	12	12	(100%)	928	913	(98%)
Total	337	259	(77%)	119	108	(91%)	5,111	4,180	(82%)

Notes: Table compares total number of villages in the study area with those villages that were geographically mapped. Mapped agents are those who live and sell condoms in a mapped village. Mapped purchases are those where both, the customer's and the chosen agent's home village were mapped.

distance between an agent and a customer *within* the villages—both, the village of residence of the agent and of the customer, which may or may not be identical—are neglected. For illustration, the distance an individual faces when purchasing condoms in the home village—given there is an agent in this village—will be zero, irrespective of whether the individual truly lives next to the agent or rather at the other end of the village. Yet, villages are small; a rough measurement based on the satellite imagery suggests that the expansion of the majority of the villages is below 500 meters. Given that the significant variation in distances is between villages rather than within villages, the distance measurements obtained through the mapping procedure are considered a very good approximation.

With respect to the mapping of the travel routes, the approach taken here still masks variations in effort and travel time that result from differences in altitude, road condition, or seasonal accessibility. Due to the lack of information on these variables, the ArcGIS *Network Analyst* treats every road section similarly when calculating the closest route. Although altitude of village centroids is available, this is not sufficient to measure the cumulative elevation differences between villages as there may be substantial variation in altitudes in between. Overall, the mapping procedure provides substantially more precise distance estimates than straight-line distances.

3.4 Properties of Condom Sales Points and Randomization Check

The following section presents descriptive statistics on the condom sales points, including agent characteristics as well as spatial properties, and tests for differences by price groups. As shown in Table A3.1 in the Appendix, the random allocation of prices to condom agents resulted in a balanced distribution of observed properties of condom sales points across price groups. For the 119 condom agents who participated in the field experiment, agent characteristics, including sex, age, marital status, and educational level, as well as the population in the agent's village cluster and the travel time to the clinic, do not differ significantly between price groups.

The empirical analyses of this dissertation are based on the agents which were geographically mapped. Table 3.3 therefore presents summary statistics on the observable properties of the 108 geo-referenced condom sales points by price, including spatial attributes, and tests for differences. Similar to the full agent sample, none of the variables differs significantly across price groups. With respect to the characteristics of the condom sales agents, 58% are male, they are on average 33 years old and have completed 9 years of schooling. More than two thirds of the agents are married. The high level of education is no surprise as community health volunteers are comparatively well educated.[33]

Apart from demographic characteristics of the agents, I analyze condom sales points with respect to spatial attributes based on the data obtained by means of the geo-referencing. Recall that for the condom agents, we relied on the preexisting system of community health volunteers which serve a small cluster of villages. As Table 3.3 confirms, there are no significant differences in the spatial attributes of condom sales points between price groups. The average population of a village cluster served by one agent is 560. With an average population of 225 per village, this means that a cluster consists of about three villages. On average, the sales points are located 44 minutes by bike (one-way) from the clinic; yet the median is substantially lower at 30 minutes. Based on the distance measures obtained from the mapping procedure, the average distance from one condom agent to the next closest

[33] As shown in Table A3.1 in the Appendix, the demographic variables of the agents are virtually unchanged for the full sample of 119 condom sales points, confirming that there are no systematic differences between mapped and unmapped agents with respect to sex, age, marital status, and schooling.

TABLE 3.3: Properties of Condom Sales Points and Randomization Test

	Total sample $N = 108$		Price 100 $N = 35$	Price 50 $N = 38$	Price 25 $N = 35$	
	mean	median	mean	mean	mean	p-value
Population in agent's village cluster	559.8	485.5	629.4	558.2	491.8	0.3907
Agent characteristics:						
Male (%)	58.3	*male*	60.0	57.9	57.1	0.9696
Age in years	32.9	32.0	32.6	34.6	31.5	0.2934
Married (%)	67.6	*married*	65.7	71.1	65.7	0.8556
Years of schooling completed	9.1	9.0	9.2	8.9	9.2	0.7537
Spatial attributes						
Travel time to clinic with bicycle (minutes)	43.8	30.0	39.5	50.7	40.7	0.4150
Distance to closest agent (meters)	840.3	510.9	963.8	824.8	733.7	0.5456
Other agent in 500 meters distance (%)	50.0		45.7	47.4	57.1	0.5910
Other agent in 1,000 meters distance (%)	67.6	*yes*	60.0	68.4	74.3	0.4459
Number of agents in 500 meters distance	0.7	0.5	0.6	0.7	0.9	0.3550
Number of agents in 1,000 meters distance	1.2	1.0	1.0	1.2	1.4	0.3442

Notes: Sample includes 108 condom sales points (agents) that were geographically mapped. *Population in agent's village cluster* indicates the number of people living in the village cluster served by the respective condom agent. *Male* and *Married* are binary variables indicating a male and a married condom agent, respectively. *Travel time to clinic with bicycle* is for a one-way trip from the respective condom sales point (agent home) and measured by the respective agent. The other spatial attributes are calculated with ArcGIS according to the procedure described in Section 3.3. *Other agent in 500 meters distance* and *Other agent in 1,000 meters distance* are binary variables indicating the existence of at least one other agent in the respective distance. p-values are for the joint test of equality of means across price groups.

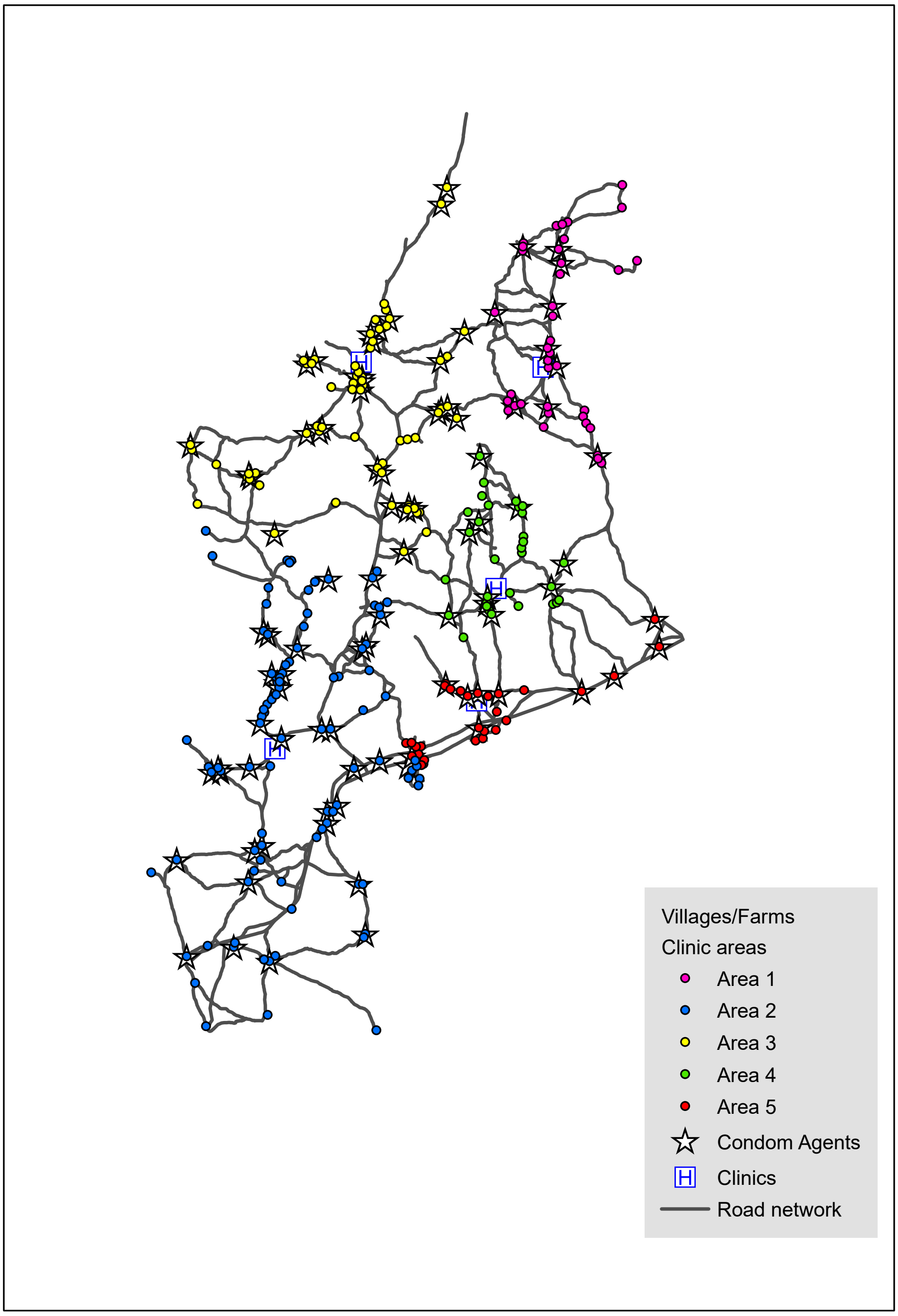
agent is 840 meters but the range of this variable reveals substantial differences in agents' remoteness. Nine large villages exist with more than one agent (seven villages with two agents and two villages with three agents). For these agents, the distance to the closest agent is zero since I cannot measure distances within one village because GPS coordinates are only available for the villages' centroids. On the other extreme, the remotest condom agent is 3,770 meters away from the next condom agent. Overall, 50% of the agents have at least one other agent within 500 meters distance (on average 0.7 agents) and 68% have at least one agent within 1,000 meters distance (on average 1.2 agents).

Figure 3.2 depicts the study area and the spatial distribution of villages by means of a map created with the geo-referenced data in ArcGIS. More precisely, the map depicts the villages (dots), the condom agents (stars), and the road network (lines). The color coding of the clinic catchment areas confirms that they are of very different size. The extent of the study area, meaning the straight-line distance between the most distant villages, is about 45 kilometers.

An examination of the spatial distribution of condom agents in the experiment and of the village clusters they serve confirms that for 95% of the villages, the condom sales agent assigned to them according to the system of community health volunteers is, in fact, the closest agent (or one of the closest agents in the cases with more than one agent). For the remaining villages, barriers other than distance such as streams justify their assignment to a certain condom agent. Consequently, the village clusters can be thought of as local condom markets in the form of Thiessen Polygons, describing the area around an agent in which all villages are closer to this particular agent than to any other agent. Or in other words, every village is, in fact, assigned to the community health volunteer, and therewith condom sales agent, that is closest to this village.

Yet, as expected for a setting with naturally evolved villages, the map clearly reveals that the condom agents are not evenly distributed in the study area. More precisely, even though there are no statistically significant differences in spatial attributes of condom sales points by price groups, substantial variation in distances between agents exists. For the subsequent empirical analyses, it is in particular important to note that some agents are rather close to each other. While village clusters are clearly delineated in most cases, in more densely populated areas, villages are closer to each other and not as clearly grouped, with the result that a village at the margin of one cluster is also close to the next cluster. As discussed in the next chapter, this is relevant for the empirical analyses because agents who are located relatively close to each other may influence the condom sales of each other given they are not restricted to selling condoms only to the population in their village cluster.

FIGURE 3.2: Spatial Distribution of Condom Sales Points



Notes: Map was created with ESRI's ArcGIS software based on the coordinates obtained by means of the mapping procedure.

3.5 Descriptive Summary: Condom Acquisition and Customer Characteristics

Condom Acquisition. During the four months of the experiment, data was collected of every incidence of condom acquisition by means of the survey, both, at the condom agents as well as the five health clinics. The condom agents sold packs of three condoms while the clinic distributed individually packed condoms. In total, 42,524 condoms were acquired in the study area, 72.7% at the condom agents and 27.3% at the five clinics. The 119 condom agents sold a total of 30,903 condoms (10,301 packs) during 5,532 individual visits while the clinics handed out a total of 11,621 single condoms during 442 visits. This implies that, on average, condom agents sold 5.6 condoms (1.9 packs) per client visit whereas the clinics handed out 26 single condoms per visit. Therefore, with respect to the incidences of acquisition, that is, individual visits from the population, the condom agents account for the substantial share of 92.6%.

Based on the available data, no definite conclusion can be made regarding the extent to which sales at condom agents reflect additional condom demand or rather 'switchers' who previously acquired condoms at the clinic or even at sales locations outside the study area. Data on the number of customers receiving condoms at the clinics in the study area prior to the experiment is only available for a few months from administrative records and is missing entirely for the clinic with the second largest catchment area. Nevertheless, extrapolating the data for this one clinic suggests a cumulative distribution of 1,836 condoms per month at the five clinics during the four months preceding the study. This figure is, in fact, considerably lower than the number of condoms distributed per month at the five clinics during the experiment with about 2,900 condoms.[34] Rather than a stimulation of demand for clinic condoms, the increase in the number of condoms distributed at the clinics during the months of the experiment is likely to be the result of improved documentation due to the implemented survey and the fact that during the experiment, continuous condom supply

[34] The extrapolation was done as follows. In the four clinics for which administrative data on condom distribution before the experiment is available (Clinics 1,3,4,5 in Table 3.1), 185 incidences of condom acquisition took place in the four months preceding the experiment. Assuming that as during the experiment, 26 condoms were given out per visit, 1,203 condoms or—with a population of 46,889 in the four clinic catchment areas—0.0257 condoms per person were distributed on average per month. Applying this per capita condom distribution to the fifth clinic (Clinic 2) results in 633 condoms per month. This number is likely to be an upper bound because the distribution in Clinic 2 was rather low compared to other clinics during the experiment.

was ensured also at the clinics. Yet, the clinic staff also gave their impression that condom distribution at the clinics increased during the experiment. Thus, with over 30,000 condoms sold at the condom agents and a distribution at the clinics that at least did not decrease as a consequence, it seems safe to say that the introduction of the decentralized condom sales points through community health volunteers increased total condom acquisition in the area considerably. However, relating the total number of condoms acquired in the study area of 42,524 to the population above 14 years of age (considered the sexually active population) of about 35,750 implies that only approximately 1.2 condoms were acquired per person in four months.[35] This coverage is very low, even if we assume that most people have sexual partners within the area and therewith about 2.4 condoms available per couple.

Based on the method described in Section 3.2, I identify 5,187 distinct customers at the condom agents, suggesting a share of repeat customers of approximately 5%. I interpret this figure as a lower bound of repeat customers; nevertheless the share is very low. On average, a customer purchases two packs, that is, six individual condoms during the four months of the experiment. Assuming again approximately five acts of sexual intercourse per month, this would imply that even for individuals who purchase condoms, only 30% of the sexual acts are condom protected and that condom use is therefore not consistent.

Characteristics of Customers. In the following, I discuss key characteristics of individuals acquiring condoms based on the survey implemented during the experiment. In a further step, I compare agent customers with clinic customers as well as male customers with female customers. Individuals acquiring condoms constitute a self-selected group so that inference to the general population in the area is not possible. Nevertheless, where available, I use Zambian representative household survey data, the DHS and the LCMS, to obtain some indications about how individuals acquiring condoms compare to the general population in Eastern Province or in rural areas of Zambia.

The descriptive statistics of the total sample of individuals demanding condoms, including agent and clinic customers, confirm that acquiring condoms is a male preserve: 86% of the customers are men, both, at the agents and the clinics. The average customer is 26.6 years old (median 25.0) and has 2.2 children (median 2.0). For both, female and male condom customers, the median years of education completed is 7.0 which corresponds to completed

[35]In rural Eastern Province, 50% of the population is 14 years and younger (CSO 2011).

primary school in Zambia. This suggests that individuals acquiring condoms are better educated than the general population in the area. The DHS indicates that in 2013/2014, Eastern Province had the lowest median years of education completed in Zambia with 2.6 years for women and 3.2 years for men (CSO, MOH, and ICF 2015).[36]

As one might expect, HIV-related knowledge is high among condom customers. Overall, 95.3% of individuals acquiring condoms in the experiment agree that one can reduce the risk of contracting HIV by having only one uninfected sexual partner; 82.0% believe that condoms are very effective in preventing HIV if used every time a person has sexual intercourse and an additional 12.7% believe they are somewhat effective. Yet, as discussed in Section 2.2.3, this type of knowledge is high throughout Zambia and the respective figures are similar in the general population in Eastern Zambia (94.7% of men and 86.1% of women agree that limiting sexual intercourse to one uninfected partner prevents HIV; 73.4% of women and 84.4% of men agree that using condoms prevents HIV (CSO, MOH, and ICF 2015)).

The individuals acquiring condoms during the experiment are poor: 94% report they cook with collected firewood, the type of energy most clearly correlated with being extremely poor according to the Zambian national poverty line. The respective figure for the general population in Eastern Province is 84%, which is based, however, also on more urban areas in the province which are generally less poor (CSO 2012).

With respect to HIV-related behaviors, 88.0% of individuals acquiring condoms report they have been tested for HIV before and received the results. This figure is higher than the average share in Eastern Province with 80.0% for women and 62.6% for men (CSO, MOH, and ICF 2015). The most striking difference between individuals acquiring condoms in the experiment and the general population in Eastern Province exists with respect to multiple sexual partners. While only 0.9% of women and 21.0% of men between 15 and 49 years in Eastern Province report having had more than one partner in the last 12 months in 2013/2014, the corresponding shares among individuals acquiring condoms in the experiment are 40.4% among women and 62.3% among men. In addition, among individuals acquiring condoms in the experiment, the share reporting to have used a condom during last sexual intercourse is extremely high at 82.0%. To what extent the high numbers of multiple partners

[36]Note that the figures from the DHS cannot be directly compared to the condom customers as they are based on the total population aged 6 and over while the condom customers are aged 10 and over. Thus, the DHS data includes more individuals who have not yet completed their education due to their age.

and condom utilization found in the experimental data are due to a selection effect of individuals with risky sexual behavior and previous experiences with condoms into condom purchase or due to overreporting cannot be determined.

Individuals acquiring condoms during the experiment who report they did not use a condom during last sexual intercourse were asked an open question regarding the main reason. Table A3.2 in the Appendix provides a categorization of the answers. The majority (56.1%) states that insufficient availability of condoms was the main reason (including availability in the area or at home as well as difficulties with respect to the clinic in terms of long distances, stock outs, or inconvenient opening hours). For about 19.6% of the individuals, the main reason for not using a condom during last sexual intercourse was related to the type of partnership. For instance, a condom was not used because the person trusted or loved the partner or because the partner was the customer's wife. This is consistent with previous research showing that condoms are mainly used with non-regular partners rather than with marital or other regular partners in Zambia (compare Section 2.2.3). For 5.6% of the individuals, the reason was lack of information in a broad sense, including lack of knowledge where to find condoms but also how to use them; and 5.0% stated that either they or their partner had a preference for sex without condom. The low share of 3.2% who stated that the reason was lack of money or the price was too high is in line with the fact that before the experiment, condoms were not available for purchase in the area.

Table 3.4 provides a summary of the demographic and HIV-related characteristics of individuals acquiring condoms separately by place of acquisition, that is, condom sales agent or health clinic. While there is no difference with respect to the gender distribution between individuals purchasing condoms at an agent and individuals collecting free condoms at the clinic, the sample split reveals significant differences for several other characteristics (all differences reported in the following are statistically different from zero). Compared to the clinics, condom agents reach a population which is on average slightly younger (26.4 compared to 29.2 years), which—probably related to the age difference—has more often never been married (33.1% compared to 22.4%) and has on average fewer children (2.2 compared to 2.6). It may be that the younger population feels more comfortable to visit an agent rather than a clinic for reasons of anonymity, as the latter are very busy places and mainly visited by older people as well as women and children, so that younger men are likely to attract attention.

TABLE 3.4: Characteristics of Individuals Demanding Condoms, by Place of Acquisition

	Agent customers (92.2%)					Clinic customers (7.8%)					
	N	mean	median	min	max	N	mean	median	min	max	p-value
Demographic and socioeconomic characteristics											
Male (%)	5,172	86.1				435	85.7				0.8391
Age (years)	4,929	26.4	25.0	10.0	70.0	400	29.2	28.0	15.0	72.0	0.0000
Education completed (years)	4,913	7.1	7.0	0.0	15.0	410	5.9	7.0	0.0	16.0	0.0000
Marital status											
never married (%)	4,976	33.1				407	22.4				0.0000
married (%)	4,976	58.0				407	68.6				0.0000
divorced/separated (%)	4,976	6.4				407	6.9				0.6869
widowed (%)	4,976	1.2				407	2.2				0.0916
living together (%)	4,976	1.3				407	0.0				0.0203
Number of children	4,929	2.2	2.0	0.0	15.0	407	2.6	2.0	0.0	10.0	0.0001
Main type of energy for lighting											
kerosene/paraffin (%)	4,983	2.3				408	5.1				0.0004
torch (%)	4,983	63.5				408	82.1				0.0000
candle (%)	4,983	15.0				408	2.5				0.0000
solar panel (%)	4,983	16.9				408	9.8				0.0002
Main type of energy for cooking											
collected firewood (%)	5,020	93.5				408	99.3				0.0000
purchased firewood (%)	5,020	2.9				408	0.5				0.0039
charcoal (%)	5,020	2.7				408	0.0				0.0007

TABLE 3.4 continued

	Agent customers (92.2%)					Clinic customers (7.8%)					
	N	mean	median	min	max	N	mean	median	min	max	p-value
HIV-related characteristics											
Number of sexual partners in last year	4,665	2.2	2.0	0.0	50.0	384	1.9	1.0	0.0	60.0	0.0050
Had multiple partners in last year (%)	4,665	59.4				384	43.5				0.0000
Condom was used last sex (%)	4,896	82.6				404	76.2				0.0012
Has ever been tested for HIV (%)	4,498	87.1				393	98.5				0.0000
Main reason for buying condoms											
prevention of HIV (%)	4,968	39.8				370	27.0				0.0000
prevention of pregnancy (%)	4,968	16.8				370	11.1				0.0042
prevention of both (%)	4,968	43.4				370	55.7				0.0000
other	4,968	0.1				370	6.2				0.0000

Notes: Descriptive statistics are for individuals acquiring condoms accounting for repeat customers by place of acquisition (condom agent or clinic). All variables except *Age*, *Education completed*, *Number of children*, and *Number of sexual partners in last year* are binary variables. For the variables *Main type of energy for lighting* and *Main type of energy for cooking*, only the most frequent answers are presented. *p*-values are for the joint test of equality of means across groups.

Agent customers seem to be slightly less poor than clinic clients. They less often use kerosene as the main type of energy for lighting (2.3% compared to 5.1%) and more often use purchased firewood for cooking (2.9% compared to 0.5%). However, although the differences are statistically different from zero, their magnitude is rather small.[37]

With respect to HIV-related behaviors, agent customers seem to take more risks in terms of multiple sexual partners than clinic customers: 59.4% of agent customers report to have had multiple partners compared to 43.5% of clinic customers and the average number of partners is 2.2 for agent customers compared to 1.9 for clinic customers. Yet, I cannot rule out that the differences are (partly) due to systematic differences in reporting behavior of the individuals depending on the location of condom acquisition. For instance, individuals may feel more secure to openly speak about sexual activities at the agents than at the clinic. Furthermore, 98.5% of clinic customers report to have been tested for HIV before compared to 87.1% of agent customers.

As shown in Table A3.3 in the Appendix, agent customers were additionally asked why they purchase condoms instead of collecting free condoms at the clinic. Again, factors related to the availability of condoms are most important. For 55% of agent customers, the main reason is geographic proximity and 16% report that the clinic is closed when they want condoms. About 10% report they are not aware of free condoms while 9% say they do not find enough privacy at the clinic.

Table 3.5 compares characteristics of individuals purchasing condoms at an agent between men and women. Besides the overall gender discrepancy in purchasing condoms at all, statistically significant differences also exist with respect to characteristics between men and women. Women are less educated than men, which is consistent with the overall gender disparities in education levels in Zambia. The most pronounced differences between male and female customers exist with respect to marital status and sexual partners. A striking share of 20.2% of women purchasing condoms is divorced or separated compared to only 4.1% of men. In addition, 4.3% of women are widowed while this is only the case for 0.7% of men. In line with the analysis of the vulnerability of women in Section 2.2.3, possible reasons for the disproportionate number of unmarried women among condom customers

[37] Agent customers also own significantly more solar panels for lighting than clinic clients (16.9% compared to 9.8%); however, solar panels are often distributed by development projects and often target specifically poor households so that I refrain from interpreting this difference.

is a greater independence of uncommitted women who can decide more freely over money and enforce their wish to use condoms, a higher HIV prevalence among these groups, and possibly a higher engagement in transactional sex or prostitution of these women. With respect to HIV-related behaviors, gender differences are also consistent with the literature. Men have more sexual partners than women (2.3 compared to 1.7 in the last 12 months) and more often report multiple partners (62.3% compared to 40.4%); women have more often been tested for HIV, however, not by much (90.6% for women compared to 86.5% of men). There is no significant difference with respect to the utilization of condoms during last sexual intercourse.

TABLE 3.5: Characteristics of Individuals Demanding Condoms at Agents, by Sex

	Male customers (86.1%)					Female customers (13.9%)					
	N	mean	median	min	max	N	mean	median	min	max	p-value
Demographic and socioeconomic characteristics											
Age (years)	4,222	26.4	25.0	10.0	70.0	695	26.3	25.0	11.0	60.0	0.5878
Education completed (years)	4,211	7.2	7.0	0.0	12.0	689	6.5	7.0	0.0	15.0	0.0000
Marital status											
never married (%)	4,265	34.2				699	26.6				0.0001
married (%)	4,265	59.8				699	47.1				0.0000
divorced/separated (%)	4,265	4.1				699	20.2				0.0000
widowed (%)	4,265	0.7				699	4.3				0.0000
living together (%)	4,265	1.2				699	1.9				0.1674
Number of children	4,222	2.1	2.0	0.0	15.0	694	2.5	2.0	0.0	13.0	0.0000
Main type of energy for lighting											
kerosene/paraffin (%)	4,276	2.5				694	1.2				0.0304
torch (%)	4,276	64.1				694	59.4				0.0163
candle (%)	4,276	13.8				694	22.2				0.0000
solar panel (%)	4,276	17.3				694	14.6				0.0776
Main type of energy for cooking											
collected firewood (%)	4,300	93.9				707	91.4				0.0128
purchased firewood (%)	4,300	2.6				707	4.7				0.0028
charcoal (%)	4,300	2.7				707	3.4				0.2632

TABLE 3.5 continued

	Male customers (86.1%)					Female customers (13.9%)					
	N	mean	median	min	max	N	mean	median	min	max	p-value
HIV-related characteristics											
Number of sexual partners in last year	4,020	2.3	2.0	0.0	50.0	633	1.7	2.0	0.0	10.0	0.0000
Had multiple partners in last year (%)	4,020	62.3				633	40.4				0.0000
Condom was used last sex (%)	4,221	82.5				662	83.2				0.6511
Has ever been tested for HIV (%)	3,888	86.5				597	90.6				0.0055
Main reason for buying condoms											
prevention of HIV (%)	4,269	43.1				686	19.1				0.0000
prevention of pregnancy (%)	4,269	15.3				686	26.4				0.0000
prevention of both (%)	4,269	41.6				686	54.2				0.0000

Notes: Descriptive statistics are for individuals acquiring condoms at the condom agents accounting for repeat customers by sex of customer. All variables except *Age*, *Education completed*, *Number of children*, and *Number of sexual partners in last year* are binary variables. For the variables *Main type of energy for lighting* and *Main type of energy for cooking*, only the most frequent answers are presented. *p*-values are for the joint test of equality of means across groups.

4 The Sales Perspective: The Effects of Price on Condom Demand

4.1 Introduction

Worldwide, public subsidies are used to encourage preventive health behaviors by reducing the costs for the consumer. The motivations for governments to intervene in health markets are twofold: to increase equity and to overcome market failures. While the former is based on the human right to health and the goal of ensuring access to health care regardless of an individual's financial means, the second aims at improving the allocation of resources in line with welfare economics (Mwabu 2008; Dupas 2014b). Both reasons are particularly relevant with respect to disease prevention in low-income countries. Widespread poverty, but also insufficient knowledge about the benefits of prevention and liquidity constraints are common reasons why private investment in disease prevention is low in developing countries (Dupas 2011; Tarozzi et al. 2014). Furthermore, poor countries suffer from a high prevalence of diseases that are contagious. In 2015, over 50% of deaths in low-income countries were caused by communicable diseases and conditions related to pregnancy and birth, compared to merely 7% in high-income countries (WHO 2017c). Prevention of communicable diseases is associated with positive externalities because, in addition to the consumers of prevention themselves, others benefit from a reduced disease transmission. Public interventions therefore aim at increasing the consumption of preventive health goods towards the social optimum (Mwabu 2008).

While governments and international donors largely agree on the need to subsidize prevention in developing countries, the level of subsidization has been subject of controversial discussion (Dupas 2014a). Should preventive health products be available free of charge or rather be offered at a positive consumer price? And in case of the latter, at what price level? In light of scarce public resources, charging positive consumer prices is considered conducive to the sustainability of health programs by generating at least some sales revenue. Yet, this argument is often made without fully considering the demand response to price, which is crucial to determine whether, and to what extent, higher product prices increase revenue. In addition, a better understanding of how consumers respond to prices of preventive health products is fundamental to assess potential health benefits of different pricing strategies. It has been argued that prices affect health benefits of preventive products in terms of avoided diseases through four main channels, as elaborated most notably by Cohen and Dupas (2010) and Ashraf, Berry, and Shapiro (2010). First, health benefits of different subsidization levels depend on the effect of price on product take-up in the population. Standard microeconomic theory on the price elasticity of demand predicts that an individual's response to price is greater the less essential the individual considers the product, the higher the price relative to the individual's budget, and the better the availability of substitutes. Second, besides the overall population coverage, the preventive health benefits of different pricing strategies depend on the risk of illness among consumers in the absence of prevention. Prices may improve targeting of preventive health products to those individuals with the highest risk of illness, who consequently realize the largest health benefits from using them. In other words, if the risk of illness is known to the individual and thus reflected in the willingness-to-pay, higher prices shift the composition of buyers towards individuals with high needs and high expected health benefits, while individuals with lower expected health benefits are screened out. This is referred to as selection or screening effect based on risk of illness. Third, in particular for prevention goods which, after acquisition, have to be actively used in order to generate health benefits such as condoms, insecticide-treated bed nets, or water treatment products, it has been argued that prices promote actual utilization of the acquired product, thereby increasing health benefits and efficiency of public resource allocation. The assumed mechanisms through which prices stimulate utilization are selection effects based on usage propensity, sunk cost effects, and signaling effects. Selection effects based on usage propensity imply that prices target the product to individuals with the highest propensity to use the product, while screening out individuals with a low usage propensity, with the result of reducing wastage of subsidies on individuals unlikely to use the product. Sunk cost effects imply that prices increase actual use of the product among those who purchased it through a psychological effect: an individual who purchased a product may feel the need to justify the investment by using it. Ultimately, signaling effects exist if prices are interpreted by the consumer as a signal of product quality or value, thereby encouraging utilization. Fourth, in the case of contagious diseases, health benefits of pricing strategies depend on whether, and to what extent, preventive behaviors affect others by reducing overall disease transmission. Thus, as summarized in Cohen and Dupas (2010), for preventive health products which have to be actively used by the individual, the overall health benefits of different subsidization levels depend on 1) how price affects take-up of the product, that is, the price sensitivity of demand; 2) how price affects the composition of buyers regarding expected health benefits, that is, selection effects based on risk of illness; 3) how price affects actual utilization of the product, which includes selection effects based on usage propensity, sunk cost effects, and signaling effects; and 4) how utilization of the preventive product affects others, that is, the extent of health externalities.

This study investigates the first two channels with respect to condoms in the context of HIV/AIDS. More precisely, I estimate the price sensitivity of demand for condoms and analyze how price affects the share of condom sales to HIV risk groups in rural Zambia. HIV/AIDS is the single disease that received the highest amount of global public spending in the last decades (IHME 2015). Total resources for the HIV/AIDS response in low and middle-income countries from domestic and international sources amounted to 19 billion US dollars in 2015 (UNAIDS 2016b). Despite a recent declining trend in transmission, in 2015, HIV/AIDS was responsible for 1.1 million deaths worldwide and over 2 million people became newly infected with the virus, the great majority in Sub-Saharan Africa (UNAIDS 2016a). Due to the progressive deterioration of health caused by the disease and the fact that the working-age population is most affected, HIV/AIDS has devastating economic and social implications for individuals and their families. Infection with HIV has been shown to adversely affect labor market participation and productivity (Fox et al. 2004; Larson et al. 2008; Thirumurthy, Zivin, and Goldstein 2008; Levinsohn et al. 2013) as well as human capital investment (Zivin, Thirumurthy, and Goldstein 2009; Fortson 2011).

As the global threat of the HIV/AIDS epidemic became clear in the early 1990s, developing countries witnessed a massive expansion of large-scale, mostly donor-funded subsidization programs for condoms (Sweat et al. 2012; UNAIDS 2016b). Condoms are highly effective in preventing sexual transmission of HIV (Weller and Davis-Beaty 2002). Between 2005 and 2010, donors provided between 80 and 100 million US dollars annually to finance condom distribution globally (UNFPA 2011). In most highly affected countries, especially in Sub-Saharan Africa, the goals of providing access to condoms also for impoverished populations on the one hand, and of promoting conditions closer to the market on the other hand, resulted in a two-pronged approach with respect to pricing: condoms are commonly distributed for free at public health clinics while so-called social marketing programs promote the sale of own condom brands at subsidized prices in stores and pharmacies, usually accompanied by advertising and HIV education campaigns. In 2014, about 2 billion condoms were sold through 78 social marketing programs implemented by non-profit organizations globally (DKT International 2015). Charging a consumer price is a key principle of social marketing. In many Sub-Saharan African countries, rumors circulate that condoms distributed free of charge are of poor quality. Furthermore, free condom distribution has strongly been associated with a waste of resources, presuming that condoms are distributed to individuals who do not need or use them, either not at all, or not for the intended purposes of preventing sexual transmission of HIV and other infections as well as unwanted pregnancies. Positive prices of social marketing condoms are intended to stimulate demand, encourage use, and reduce wastage by attaching a value to the condom, by signaling product quality, and by targeting it to the individuals with the highest health benefits (Lewis 1986; Meekers 1997; Armand 2003; Brent 2010; Chapman et al. 2012).

Although condoms are at the center of the contested health pricing debate, empirical evidence of consumer responses to condom prices is rather scarce. In recent years, a growing body of randomized field experiments has analyzed how prices affect take-up and use of other preventive health products in developing countries, in particular insecticide-treated bed nets to prevent malaria and water treatment solutions to prevent diseases associated with contaminated water. These experimental studies predominantly find that increasing prices reduce overall demand substantially, while failing to encourage actual utilization among customers. Prices are also not found to be effective at targeting the preventive products to the populations with the highest expected health benefits, but rather on the contrary, lead to counterproductive selection effects in terms of screening out the neediest. Consequently, findings from experimental studies are largely in favor of high subsidization or even free distribution of preventive health products in developing countries (Ashraf, Berry, and Shapiro 2010; Cohen and Dupas 2010; Meredith et al. 2013; Tarozzi et al. 2014; Comfort and Krezanoski 2017). Given the long history of condom social marketing, the lack of experimental studies on demand for and utilization of condoms is striking. Especially in the wake of stagnating funds for the HIV/AIDS response in recent years (UNAIDS 2016b), understanding how the level of subsidization affects health benefits of condom programs gains even more importance. Evidence on price effects for other preventive health products is not directly transferable to condoms for several reasons. First, compared to most other preventive health products which have been studied, especially insecticide-treated bed nets, condoms are comparatively cheap. Yet, they have to be acquired continuously to provide effective protection. Evidence from marketing research suggests that price sensitivity is higher among consumers with high purchase frequency or high purchase volume (Kim and Rossi 1994). Comparing results from recent experimental studies on preventive health products seems to confirm that price elasticity is higher for frequently needed products, such as water treatment products, soap, and vitamins, than for long-lasting products, including bed nets or shoes.[38] This suggests that price sensitivity is stronger for condoms than for other common preventive health products. Second, given the widespread rumors about the poor quality of free condoms in many developing countries, the role of price in signaling product quality may be more pronounced for condoms than for other health products. This may, to some extent, counteract a drop in demand at higher prices. Third, the great majority of diseases throughout the world, but especially in developing countries, is associated with poverty and a lack of basic amenities such as adequate housing, hygienic conditions, or clean drinking water sources. Consequently, most preventive health products, including bed nets, water treatment solutions, soap, and vitamins, exhibit the largest health benefits among the poorest populations. HIV/AIDS, however, is an exception: in Sub-Saharan Africa, HIV prevalence is higher among wealthier population groups (Mishra et al. 2007), implying that the benefits of condom use are not concentrated in the poorest populations. If a higher willingness-to-pay resulting from high expected health benefits is not hampered by a low ability-to-pay, taking advantage of price-induced selection effects based on risk of illness may be a relevant instrument for increasing efficiency of public resource allocation.

The empirical analyses of the price sensitivity of condom demand and price-induced selection effects in this study are based on data from a randomized field experiment conducted in rural Zambia. Zambia is heavily affected by HIV/AIDS. Currently, an estimated 12.9% of the population is living with HIV (UNAIDS 2017). Condom subsidization programs were introduced in 1992 and improved condom availability in urban areas (Agha and Kusanthan 2003), but access to condoms remains a great challenge in less populated areas (Seidenfeld 2014). The point of departure for the experiment was the missing condom market in rural areas. More precisely, we conducted a four-month randomized price experiment in a remote

[38] Meredith et al. (2013) provide an overview of recent experimental studies which includes estimated price elasticities for various preventive health products.

area in eastern Zambia covering a population of about 70,000, where previously condoms were only available free of charge at five public health clinics. We worked with the preexisting system of community health volunteers who are responsible for providing basic health services to the rural communities. In the experiment, 119 community health volunteers served as condom sales agents, creating new condom sales points at village level. The key feature of the study design is the random allocation of condom prices: each sales agent was randomly assigned one of three prices for a pack of three condoms and offered condoms at this one fixed price during the four months of the experiment. The three prices were 25, 50, and 100 ngwee, which corresponded to 0.05, 0.10, and 0.20 US dollars at the time of the experiment. The highest price of 100 ngwee was equivalent to the social marketing price found in the closest town to the study area. It was therefore selected as the reference price which allows to analyze demand in rural areas given a potential roll-out of the condom subsidization program already existing in urban areas. For comparison, at the time of the study, the social marketing price of 100 ngwee found in urban areas accounted for one tenth of the market price for commercial brands, indicating that even the highest price in our experiment is highly subsidized.

The empirical strategy of this study is based on the comparison of sales outcomes at agent level during the experiment at the three alternative consumer prices. More precisely, to analyze price sensitivity of condom demand, I estimate the effect of price on total condom sales at agent level, and further broken down into the number of customers per agent (the extensive margin of demand) and the average number of condoms sold per customer (the intensive margin of demand). To analyze selection effects based on risk of illness, I estimate the effect of price on the share of condom purchases made by individuals belonging to certain HIV risk groups. In the absence of biomedical data on the HIV status of condom customers and their partners, I rely on demographic characteristics and self-reported behaviors that are associated with an elevated HIV prevalence in the Zambian population as proxies for potential health benefits from condom use.

While every condom agent in the experiment was initially assigned to cover several villages in the experiment, the agents were not restricted to selling condoms exclusively to the population of their respective villages. In other words, the population in the study area was free to purchase condoms at any agent. Survey data collected from the customers at the time of purchase suggests that individuals in fact travel to more distant sales agents for various reasons, including convenience, privacy, as well as price. This implies that spillover effects occur between the agents in the study area. If these spillover effects are correlated with the price treatment—imagine individuals seeking cheaper prices at more distant agents—the simple difference-in-means comparison of agent level outcomes by price as they occurred in the experiment will yield biased estimates of the price effects. Hence, I assume a data-generating process according to which the sales outcomes at agent level are determined by the agent's own price as well as the price of other agents. For the empirical estimation, I exploit the variation in prices of surrounding condom agents—which is exogenous as a result of the random assignment of prices—to control for spillover effects between agents. While this provides an unbiased estimate of the counterfactual effect of price on agent level outcomes in the absence of spillover effects, the relevant question from a policy perspective is how sales differ between alternative pricing strategies, that is, between the scenarios in which one price is uniformly introduced in the whole area. Due to individual decision-making about where to purchase condoms, which may be influenced by the desire to find a higher degree of privacy or convenience in purchasing close to where a sexual partner lives, spillover effects also occur when all agents sell at a uniform price in the study area. The magnitude of such spillovers may vary between pricing strategies. Thus, compared to the hypothetical reference scenario in which all agents sell at the highest price of 100 ngwee, I derive average treatment effects which measure the differences in sales outcomes when uniformly introducing 50 ngwee or 25 ngwee, respectively, in the whole area.

I find that condom sales at agent level increase significantly and substantially as the price decreases, indicating that the population responds very sensitive to the price of condoms. Considering that 100 ngwee corresponded to one tenth of the market price for commercial condom brands underlines that the strong effect of price occurs at very low prices. In fact, price sensitivity is not constant at the prices considered in the experiment, but is substantially higher at the lower prices: controlling for spillover effects, an agent offering condoms at 50 ngwee sells 37% more condoms than an agent offering condoms at 100 ngwee, and an agent offering condoms at 25 ngwee sells 87% more condoms than an agent selling at 50 ngwee. This results in an arc price elasticity of -0.47 for the counterfactual price effect between 100 and 50 ngwee and -0.91 for the counterfactual price effect between 50 and 25 ngwee, and therewith an average arc price elasticity of -0.69. The increase in total condom sales at lower prices results from both, an increase in the number of customers as well as an increase in the average sales per customer at agent level. However, the percentage increase in the number of customers, that is, at the extensive margin of demand, is larger than the percentage increase in average sales per customer, that is, at the intensive margin. This suggests that lowering condom prices is more effective at attracting new customers than at encouraging existing customers to purchase more condoms. This is in spite the fact that the average quantity of condoms purchased per customer falls short of the number needed for full protection during the period of the experiment. In the Zambian context, the moderate effect of lower prices on the quantity purchased per customer may be explained by the common neglect of condom use in regular partnerships, since this limits the demand for condoms to the number needed to cover irregular sexual partners. Furthermore, while I find some evidence that sales agents with the medium and the high price are negatively affected by agents selling at the lowest price in their neighborhood, overall, price-induced spillover effects are of minor economic significance in the condom experiment. The average treatment effect estimate hence suggests that introducing a uniform price of 25 ngwee in the whole study area instead of 100 ngwee would lead to an increase in total condom demand of 144%. This indicates that scaling up the condom program to rural areas at prices below the price in urban areas would lead to a substantial increase in coverage, especially due to more customers entering the market.

With respect to price-induced selection into purchasing of HIV risk groups, I find ambiguous effects that are likely to result from the economic situation of the individual risk groups. On the one hand, the share of condoms purchased by population groups with an above-average HIV prevalence increases at lower prices for those groups which, according to relevant literature, are at the same time financially constrained. For instance, widows have an extremely high HIV prevalence rate in Zambia of 46% and are also extremely economically disadvantaged (CSO, MOH, and ICF 2015). The average share of sales to widows estimated based on the experimental data is very low at about 1% at a uniform price of 100 ngwee. However, it increases significantly by 2.3 percentage points at a uniform price of 25 ngwee. This indicates that higher prices induce a counterproductive selection effect by screening out a group of individuals which poses an extremely high threat to others in terms of transmitting HIV. On the other hand, I find that the share of condom sales to HIV risk groups decreases at lower prices for groups that are not associated with being disproportionately financially constrained. For instance, the estimated share of sales to customers who had multiple sexual partners in the last year decreases from 61% at a uniform price of 100 ngwee in the study area to approximately 50% at both, 50 ngwee and 25 ngwee. This provides evidence that higher prices in fact induce efficiency enhancing selection effects in terms of targeting condoms to high-risk groups, as far as these groups are able to pay. However, the economic significance of these latter selection effects is negligible when considered in relation to the overall price sensitivity of condom demand, as the absolute number of high-risk individuals purchasing condoms is substantially higher at lower prices. In other words, for the HIV risk groups for which I find intended selection effects, the substantial increase in condom demand at lower prices largely outweighs the decrease in the share of sales to these groups.

The study contributes to existing research in two ways. First, and most importantly, it contributes to the international debate on preventive health product pricing and expands the body of experimental evidence by a prevention good of utmost importance in many developing countries for the effective prevention of a widespread and incurable disease. To the best of my knowledge, this is the first randomized price experiment investigating demand and selection effects for condoms. By observing actual purchase decisions at different prices, the study avoids potential biases associated with simple willingness-to-pay surveys or studies relying on country level condom distribution data. The study substantiates the findings from recent field experiments for other preventive health products in that first, demand is very sensitive to price in developing countries and second, higher prices lead to worse targeting of preventive products for which health benefits are largest among the poorest populations by screening out the neediest (Ashraf, Berry, and Shapiro 2010; Cohen and Dupas 2010; Meredith et al. 2013; Blum, Null, and Hoffmann 2014; Dupas 2014c; Spears 2014; Tarozzi et al. 2014; Comfort and Krezanoski 2017). Moreover, this study adds the following new insights to the pricing debate: first, the fact that, in comparison to other preventive health products studied in previous experiments, the estimated average price elasticity for condoms is at the higher end (Meredith et al. 2013), is consistent with the hypothesis that price sensitivity is higher for frequently purchased products, emphasizing a particular need for prudent pricing strategies also for inexpensive products, as costs for the individual multiply rapidly if the product is needed frequently. Other than previous experiments, I disaggregate total demand into the extensive and the intensive margins of demand. The finding that lowering prices is more effective at attracting new customers than at encouraging existing customers to purchase more condoms suggests that distinguishing between the extensive and the intensive margins for frequently needed preventive products provides valuable information on the consistency of preventive behavior. By showing that the share of sales to some high-risk groups is higher at higher prices, this study suggests that for products where health benefits are not concentrated among the poorest, charging higher prices may be in fact a reasonable instrument to increase efficiency of public resource allocation. This could be relevant for some non-communicable diseases, which—although increasingly widespread also in developing countries—are not especially pronounced among the poorest. However, this requires a careful analysis of the distribution of the respective disease by wealth groups. In particular, as the results of this study show, the overall increase in demand at lower prices may be large enough to outweigh intended selection effects, meaning that the absolute number of high-risk individuals and hence the magnitude of the health benefits are substantially larger at lower prices. Overall, the findings that introducing condom prices below the prevailing price of social marketing programs leads to a substantial increase in demand for condoms, while selection effects are of minor economic importance, lead to the conclusion—in line with previous literature—that lowering prices is a highly effective instrument to increase take-up of preventive health products. Or conversely, charging even moderate prices leads to a significant drop in population coverage and thus potential health benefits. The drop in demand is especially important given the positive health externalities of HIV prevention for sexual partners and—in the case of women—for unborn children of individuals using prevention. What is more, the finding that the price elasticity between the medium and the low price is close to unity indicates that charging higher prices does not necessarily result in higher revenues, ultimately also undermining the argument of achieving higher sustainability by increasing prices.

The second contribution of this study is to the growing body of randomized experiments addressing spillover effects which has surged with the increasing importance of social networks and peer effects in the economics literature. I follow previous experimental studies, in particular Miguel and Kremer (2004), in taking advantage of the exogenous variation in treatment of neighboring sales agents that results from the randomization to control for spillover effects. I make the following extensions: first, existing studies commonly allow for heterogeneous spillover effects from treated units, meaning that treated units affect other treated units and untreated units differently. Yet, the studies assume an identical spillover effect from untreated units on treated and untreated units. In many situations, however, the effect of untreated units may also differ for treated and untreated units. Consider, for instance, the case of vaccination: an unvaccinated child will affect other unvaccinated children very differently than vaccinated children. Applied to the present case, an agent offering condoms at the low price will affect the sales of an agent also offering condoms at the low price differently than the sales of an agent offering condoms at a higher price. Thus, I derive a more general framework that includes three treatment states and allows for interaction between all states. Second, the focus of existing studies is commonly limited to evaluating program impacts in the presence of spillover effects, that is, on isolating the counterfactual effect of treatment from the spillover to untreated units. In practice, however, the full roll-out of a program ultimately means that untreated units are treated as well, which is likely to change the magnitude of the spillover effects. This study goes a step further by deriving average treatment effects of full treatment, that is, the difference in outcomes between alternative treatment scenarios in the presence of spillover effects.

Finally, from the perspective of ensuring equity in access to condoms, the experiment constitutes a practical example of how access to condoms can be improved for the commonly underserved populations in rural areas of developing countries by making use of the existing system of community health volunteers. In the presence of tight health budgets and a lack of health staff to cover rural areas, many developing countries, including Zambia, increasingly rely on community health volunteers to provide basic health services at village level to make progress towards universal health coverage (Cotlear et al. 2015). The total number of condoms sold during the condom experiment in eastern Zambia amounted to about 31,000. Set in relation to about 35,000 people above 14 years in the study area assumed to be sexually active, this quantity reveals that the number of condoms purchased per person is very low at less than one condom in four months. However, clinic level data indicates that the number of condoms distributed at clinics, while being very low, did not decrease during the experiment. Therefore, it is reasonable to say that the condom experiment led to a considerable increase in the amount of condoms acquired in the study area, suggesting that providing incentives to community health volunteers for selling condoms close to where the population lives has potential to considerably improve access to and take-up of condoms in rural areas and thus to contribute to the prevention of HIV/AIDS.

The remainder of the study is structured as follows. Section 4.2 summarizes empirical evidence on the effects of price on demand for and utilization of preventive health products in developing countries, including price sensitivity, selection and sunk cost effects. Section 4.3 presents the empirical strategy for estimating the effects of price on condom demand. After a general discussion of causal inference from randomized experiments in the presence of spillover effects in Section 4.3.1, Section 4.3.2 derives the counterfactual effect of price on condom demand and the average treatment effects of full treatment with different price levels. Section 4.4 presents the empirical results on price sensitivity of condom demand in Section 4.4.1 and selection effects based on HIV risk in Section 4.4.2. Section 4.5 concludes.

4.2 Literature Review: How Price Affects Demand for and Use of Preventive Health Products

Over the past decade, considerable progress has been made with respect to understanding how prices affect demand for and utilization of preventive health products in developing countries. The following section summarizes relevant empirical evidence on the price sensitivity of demand and, where available, on price-induced selection and sunk cost effects. Section 4.2.1 presents results from recent randomized field experiments for various preventive health products, while Section 4.2.2 focuses specifically on empirical evidence with respect to condoms.

4.2.1 Empirical Evidence from Randomized Field Experiments

A series of field experiments in which preventive health products are offered to individuals or households at randomized prices has made important empirical contributions with respect to the effects of price on product take-up and use, including the studies of Cohen and Dupas (2010) and Ashraf, Berry, and Shapiro (2010). By observing actual purchase decisions of the population when offered different prices instead of relying on stated preferences, field experiments avoid biases associated with simple hypothetical willingness-to-pay surveys. In addition, the randomization creates exogenous variation in price which allows to identify causal effects of price on demand and utilization rather than only correlations.

The design of such randomized field experiments involves offering a certain preventive health product at randomized prices either to the general population or to a specific target group as, for instance, pregnant women. This is usually done by distributing vouchers for the respective product which guarantee a randomly varied discount at redemption and hence, a random purchase price; or by simply offering the product for purchase at a randomly determined price to clients at health clinics or during door-to-door campaigns. Demand is then measured in terms of actual purchases made at each price level, either in absolute numbers or in terms of the population share purchasing or redeeming the distributed vouchers. This method is also referred to as 'take-it-or-leave-it' (TIOLI) offers (Berry, Fischer, and Guiteras 2015). While most experiments include several positive prices, some additionally include a 'zero price' to investigate, as discussed in psychology and behavioral economics, the existence of a particularly strong demand response at the threshold from provision free of charge to charging a small positive price due to psychological reasons (Shampanier, Mazar, and Ariely 2007).[39] For instance, experimental evidence on the effects of a program providing deworming drugs to children in Kenya—in fact a treatment rather than prevention program—suggests that take-up of deworming drugs decreases sharply when the consumer price changes from zero to a small positive price, while demand is not sensitive to the exact price level once it is above zero (Kremer and Miguel 2007). Results from experiments involving a zero price can feed into the debate about the advantages and disadvantages of free distribution versus charging a price for health products.

Whereas some experiments focus on estimating the price elasticity of demand for a certain preventive health product, others additionally analyze whether price affects the buyer's decision to use the product later on and estimate a 'price elasticity of use'. Yet, an observed positive correlation between the price paid and actual use can be the result of either selection effects based on usage propensity—if individuals who have a higher propensity to use the product also have a higher willingness-to-pay—or sunk cost effects—if a high purchase price induces individuals to use the product. The experiments of Cohen and Dupas (2010) as well as Ashraf, Berry, and Shapiro (2010) were the first specifically designed to disentangle whether potential differences in utilization by price are due to selection effects based on usage propensity or sunk cost effects. Both implement a two-stage-randomization design that was initially used by Karlan and Zinman (2009) to study information asymmetries in

[39]Shampanier, Mazar, and Ariely (2007) examine the 'zero price effect' in a series of laboratory experiments and find a dramatic increase in demand at the zero price that contradicts a standard cost-benefit perspective. Accordingly, individuals act as if a zero price of a good not only decreases its costs but also increases its benefits. The authors conclude that affective reactions are the main explanation for this behavior.

credit markets. In the first stage, the product is offered to the individual or the household at a random price, which allows to measure willingness-to-pay. In the second stage, a subsample of individuals who agree to purchase the product at the random price determined in the first stage is then offered a random discount which determines the ultimate purchase price. This allows to analyze whether individuals who purchased at a higher ultimate price, conditional on their willingness-to-pay elicited in the first stage, are more likely to use the product due to a psychological sunk cost effect.[40]

Empirical evidence from randomized field experiments for preventive health products is presented in detail below. The main findings can be summarized as follows: first, regarding the effect of price on demand, results for various products consistently show that demand is very sensitive to price in developing countries. According to an overview of recent experiments with randomized prices provided in Meredith et al. (2013), arc price elasticities for preventive health products predominantly fall in the range between -0.4 and -0.9.[41] In contrast to the finding for deworming treatment by Kremer and Miguel (2007), studies on preventive health products rather indicate that the zero price is not a special threshold, as they do not reveal a particularly sharp drop in demand from zero to the next lowest price (Cohen and Dupas 2010; Meredith et al. 2013; Dupas 2014c). Second, most of the experiments analyzing selection effects do not find that prices are effective at targeting the preventive health product to individuals who have the highest expected health benefits from using them, leading to the conclusion that these individuals are also those most constrained in their financial means. Third, there is no evidence of sunk cost effects in the sense that the actual price paid, holding willingness-to-pay constant, has an effect on actual utilization of preventive products.

Price Sensitivity of Demand. Existing field experiments on preventive health products show both, a geographical focus as well as a focus on certain products: the majority was

[40]For practical illustration, the second stage randomization was implemented as a lottery in Cohen and Dupas (2010): a subsample of individuals who agreed to purchase at the price determined in the first randomization process was surprised with a lottery in which the ultimate purchase price was determined. Actual utilization of the product was observed at the individuals' homes during a follow-up survey. Any variation in utilization among individuals who agreed to a certain price in the first stage, but ultimately paid different amounts due to the lottery, is then due to a sunk cost effect.

[41]All price elasticities reported in the following are arc price elasticities, that is, calculated at the mean price and the mean purchase probability or purchase amount, respectively. Note that economically, the range between -0.4 and -0.9 indicates inelastic demand, meaning that the percentage change in demand is less than the percentage change in price and revenue increases with price. However, for preventive health products, which can be considered as essential goods needed to sustain health, the relevant literature cited here interprets this range as very price sensitive.

conducted in Kenya and many address either insecticide-treated bed nets (ITNs), an effective measure to prevent malaria when hung over the bed at night, or water treatment products used to purify drinking water to prevent diarrheal diseases associated with contaminated water. In the aforementioned experiment, Cohen and Dupas (2010) randomized the price at which pregnant women can purchase ITNs during their antenatal care visit at 20 health clinics in Kenya. They find a large reduction in demand even at moderate prices: the take-up rate of ITNs drops by 60 percentage points when the price increases from zero to the highest price in the experiment of 0.60 US dollars. Yet, demand is not sensitive to small increases in price from zero. Overall, the authors estimate a price elasticity of -0.37. Subsequent experiments in Kenya (Dupas 2014c), and also in India (Tarozzi et al. 2014), and Madagascar (Comfort and Krezanoski 2017) confirm that the negative effect of price on demand for ITNs in developing countries is not confined to pregnant women. In fact, the general population seems to be considerably more sensitive to price: Comfort and Krezanoski (2017), for instance, estimate a price elasticity of -0.8 in the general population in Madagascar. This is consistent with women being more health-conscious, especially when they are responsible for the health of their unborn baby.

Regarding water treatment products, in the experiment implemented by Ashraf, Berry, and Shapiro (2010), chlorine water purification was offered at randomized prices to the female household head during a door-to-door marketing campaign in peri-urban Zambia. Again, the authors find a strong effect of the offer price on the propensity to purchase the product, resulting in a price elasticity of -0.60. Kremer and his colleagues conducted a series of experiments with different treatment arms to investigate take-up of chlorine water treatment among households in Kenya. They find that take-up of chlorine is high when delivered to the household's home at zero cost and zero price. Yet, distributing a voucher with a 50% discount compared to the market price to be redeemed at local shops does not have an impact on the take-up rate compared to the full price (Kremer, Ahuja, and Peterson-Zwane 2010).[42] Blum, Null, and Hoffmann (2014) confirm the price sensitivity of demand for water treatment products in their experiment, also in Kenya, in finding that 35% of

[42]The study itself is unpublished, however, the main results are summarized in Kremer, Ahuja, and Peterson-Zwane (2010). The authors conclude from their results that demand is very elastic at the threshold from zero to a low price and inelastic as the prices increase further. However, comparison is very difficult as the zero price group received home-delivery, while the 50% discount vouchers had to be redeemed at the local shop. As discussed in Chapter 5, evidence shows that convenience is an important factor affecting demand, emphasizing that the interpretation of the authors must be taken with great caution.

the households purchase the product when offered at the market price, while 67% purchase at a 50% discount. Berry, Fischer, and Guiteras (2015) complement a common (TIOLI) randomized price experiment with a Becker-DeGroot-Marshak (BDM) auction for water filters in Ghana and compare the results on willingness-to-pay. In the BDM mechanism, an individual first makes a bid for the product before a random price is drawn. If the bid is greater than or equal to the randomly drawn price, the individual purchases the product. Otherwise, the individual does not pay and does not receive the product. Hence, this mechanism provides an incentive for the individual to state the true maximum willingness-to-pay. While the willingness-to-pay produced by the BDM mechanism is somewhat lower than that found in the TIOLI experiment, both methods produce a similar pattern of an inverse demand curve.

Apart from ITNs and water treatment products, Meredith et al. (2013) confirm a high price sensitivity of demand for preventive products in a series of experiments involving soap for hand washing and vitamins in Guatemala, India, and Uganda. In their main experiment in Kenya, they find a price elasticity of demand of -0.41 for rubber shoes for children, an effective measure to prevent hookworm infection through the skin of the feet.

Selection Effects. Existing studies focus on two types of selection effects. Selection effects based on risk of illness exist if individuals with high expected benefits from prevention also have a higher willingness-to-pay and select into purchase. Considered indicators for expected health benefits are either collected health biomarkers or proxies for health status or risk of illness based on demographic information. Selection effects based on usage propensity, on the other hand, exist if individuals who are more likely to use the product have a higher willingness-to-pay. Usage is commonly observed during follow-up household surveys after the purchase incidence.

Cohen and Dupas (2010) find that pregnant women who are willing to pay a higher price for ITNs are not sicker as measured by their baseline hemoglobin levels, which the authors interpret as an indicator of malaria in pregnancy. Similarly, Comfort and Krezanoski (2017) fail to find evidence for price-induced selection effects in purchasing ITNs based on self-reported fevers at baseline; however, they note that this may be due to a small sample size and the lack of an objective measure of malaria risk. Kremer, Ahuja, and Peterson-Zwane (2010) report that having many children in the household, who are most vulnerable to diarrheal diseases and thus likely to benefit substantially from clean water, does not increase willingness-to-pay for water treatment solutions. As one of the few studies, Ashraf, Berry, and Shapiro (2010) find evidence for selection effects; however, only based on usage propensity: households with a higher willingness-to-pay for water treatment products are also more likely to use the product as measured by the chemical level of chlorine in the households' stored water during the follow-up survey. Yet, while households select into purchase based on usage propensity, these households do not appear to be those with the largest expected health benefits. Using the number of children below the age of five as well as pregnancy of the female household head as proxies, the authors find that the selection effects do not occur based on the household's potential health benefits, implying that prices are not effective at targeting the product to those most in need.

However, Tarozzi et al. (2014), who study the role of liquidity constraints as a barrier to demand for ITNs by means of an experiment which involves offering micro-loans to households to enable the purchase of ITNs in India, find strong evidence of selection into purchase based on past exposure to malaria. Compared to households with no self-reported malaria episodes in the last six months, the probability of ITN purchase increases by 27 percentage points among households in which every member had been affected. The respective increase amounts to 20 percentage points when measured by positive blood tests during the experiment. The authors conclude that the failure to detect a higher willingness-to-pay among high-risk populations in previous experiments is likely to be the result of a positive correlation between high-risk populations and liquidity constraints. More precisely, individuals with high expected benefits from using preventive goods may be willing to pay more but at the same time are unable to do so. Spears (2014) proposes another explanation for why using prices to target those in need may fail. Deliberation costs, that is, costs for processing information and carefully considering an offer, increase price sensitivity especially among the poor according to the following argument. For poor people, the threshold below which they purchase a good without deliberating is very low. If deliberation costs are high and even low prices are high enough to require deliberation, a household may simply ignore a valuable offer to avoid costly 'thinking'. In an experiment involving soap in India, Spears (2014) used specific survey questions to indirectly invoke the treatment group to deliberate about whether to purchase soap before it was offered at a randomized price, while the control group was asked irrelevant questions. Price sensitivity is lower in the treatment group which unknowingly had already deliberated by means of the survey questions and hence, had lower deliberation costs at the time of the offer. Furthermore, in the treatment group, buyers at the higher price have a greater need for soap than buyers at the lower price as measured by having children and having at least one child with loose stool in the previous week. This does not hold for the control group, indicating that high deliberation costs may be a barrier to targeting preventive products to the poor, which are often those with the highest expected prevention benefits.

Sunk Cost Effects. Randomized experiments analyzing sunk cost effects, including Cohen and Dupas (2010), Ashraf, Berry, and Shapiro (2010), Berry, Fischer, and Guiteras (2015), and Comfort and Krezanoski (2017), do not find any evidence that the actual price paid, holding willingness-to-pay constant, has an effect on actual utilization of preventive health products.

In sum, existing experimental evidence clearly shows that increasing prices for preventive health products leads to a substantial drop in demand, while failing to encourage actual use as well as to allocate the product to the population with the highest expected health benefits. As a consequence, the prevailing opinion among researchers has shifted towards advocating very low prices or even free distribution of preventive health products; especially when health externalities are large and if those with the highest health benefits are also those least able to afford the product.

4.2.2 Empirical Evidence on Condoms

While the evidence base has thus grown substantially for some preventive health products, robust empirical evidence on demand for and utilization of condoms is surprisingly scarce considering the long history of condom subsidization programs in developing countries. Although a vast number of studies, surveys, and program reports evaluating condom social marketing programs exists, many of these suffer from methodological weaknesses. To the best of my knowledge, no field experiment using randomized prices and actual purchase decisions has been carried out which rigorously analyzes the causal effect of price on condom demand. Available studies addressing the price sensitivity of condom demand, the majority of which quite dated, rely on price variation stemming either from non-experimental price changes introduced in social marketing programs as a result of strategic decisions or from cross-country differences; or are based on simple hypothetical willingness-to-pay surveys. As a result, the reliability of existing evidence on price sensitivity of condom demand is limited and findings are mixed. Although the key arguments of social marketing programs for charging positive prices include that prices are needed to screen out those who do not use condoms for the purpose of preventing infections and unwanted pregnancies, and to guarantee that the acquired condoms are actually used, evidence on selection and sunk cost effects is virtually non-existent.

The prominent methodological problem in studies analyzing condom demand is the failure to isolate the effect of price from the effects of other factors influencing demand, including physical access, substitute goods, or simultaneously implemented initiatives. Much of the debate on condom pricing has focused on differences between free distribution and charging some positive consumer price. However, social marketing condoms that are sold differ not only in the monetary consumer price from condoms that are distributed for free, but also in location, since social marketing condoms are sold in shops and pharmacies while free condoms are distributed in public health clinics. In addition, condom social marketing programs involve branding, advertising, and educational campaigns. Convenience, anonymity, brand recognition, and perceived condom quality are important factors affecting condom demand, rendering the identification of the pure price effect more difficult. With the aim of contributing to the debate about whether free or subsidized provision of health goods results in higher use and hence prevention benefits, O'Reilly et al. (2014) intended to conduct two systematic reviews on the impacts on condom utilization of social marketing programs on the one hand, and of free distribution on the other hand. For the review on social marketing programs, six studies were found which met the inclusion criteria, none of which are randomized experiments, however. It finds that exposure to condom social marketing increases self-reported utilization of condoms during the last sexual encounter, but cannot disentangle the effects of individual program components such as price (Sweat et al. 2012). The intention to conduct a systematic review on free condom distribution failed, however, because the authors found it impossible to isolate the effect of free distribution on condom demand from other interventions implemented simultaneously, leading them to conclude that "given the vast number of free condoms distributed each year, it is surprising how little is known about the actual effect on condom use" (O'Reilly et al. 2014).

Besides the challenge of isolating the effects of different factors in condom distribution programs, the difficulty of measuring actual utilization, and consequently the effect of price on utilization, is particularly pronounced for condoms. For ITNs and water treatment products, researchers can use proxies for utilization, such as whether or not the ITNs have been hung above the beds or the level of chlorine in a household's drinking water (see Cohen and Dupas (2010) and Ashraf, Berry, and Shapiro (2010), respectively). Observing actual condom use, in contrast, is practically impossible. As a result, studies rely on self-reported condom use, which may be subject to social desirability bias that can lead to both, overreporting or underreporting, depending on whether the individual wants to hide risky sexual behavior, that is, non use of condoms or instead hide condom use. The latter is relevant in contexts where condoms are stigmatized as being mainly used with sex workers or directly associated with being sick (Meekers and Rossem 2005).

Price Sensitivity of Demand. Existing empirical evidence on the price sensitivity of demand for condoms is summarized as follows. Two early literature reviews provide an overview of results from studies analyzing the impacts of price changes on demand for contraceptives in developing countries, some of which include condoms. Lewis (1986) concludes that charging a moderate price for contraceptives reduces demand relatively little, if at all, compared to free distribution, and in some cases even leads to demand increases because consumers distrust free products, suggesting a backward bending demand curve. Note that this implies that demand responds contradictory to what is suggested by the zero price effect discussed above. Janowitz and Bratt (1996) review evidence that emerged in the decade that followed and point out that studies analyzing cross-sectional survey data, for example Demographic and Health Surveys, find demand for contraceptives to be more inelastic than studies relying on actual, mostly non-experimental, price changes. However, the authors emphasize that all studies reviewed suffer from substantial methodological problems, including the failure to account for substitution patterns, meaning shifts in demand to other contraceptives, and that more rigorous studies are needed to make recommendations regarding pricing.

With respect to condoms specifically, an early study by Akin and Schwartz (1988), who model the choice of contraceptive methods in a discrete choice framework based on survey data of women in Jamaica and Thailand, finds that—as opposed to other contraceptives—demand for condoms is rather sensitive to price: the calculated price elasticities of demand for condoms are -1.5 for Jamaica and -0.7 for Thailand. Studies assessing actual price increases implemented in social marketing programs confirm a strong negative relation between price and demand. For instance, Ciszewski and Harvey (1995) report that doubling the price of social marketing condoms in Bangladesh in the early 1990s led to a 29% decline in sales. Based on survey data in Pakistan, Agha and Davies (1998) find that in areas where the condom price increased by 50%, 21% of the respondents reported they had discontinued condom use. In areas that experienced a 100% increase, this is the case for 56% of the respondents. The most widely cited study on price elasticity of condom demand is the multi-country analysis by Harvey (1994). Based on data from 24 social marketing programs, the author finds a clear negative correlation between consumer prices (as a percentage of per-capita gross national product) and per-capita sales, leading him to conclude that condom prices must be very low to achieve a satisfactory coverage among the population. Using panel data from social marketing programs in 52 countries between 1997 and 2009, Terris-Prestholt and Windmeijer (2016) analyze the impact of demand creation tools, including price, on condom sales. They estimate that a 10% increase in price generates a 0.82% decrease in condom sales in the short run, which increases to 1.92% in the long run.

In contrast, studies based on self-reported willingness-to-pay surveys, including those carried out specifically to inform social marketing programs with respect to their pricing strategies, often come to the conclusion that the population is willing to pay a price above the current price for condoms. Winfrey (2003), for instance, reports for a social marketing program in Ghana that 75% of clients from randomly selected outlets in ten regions of the country are willing to pay a price at least 50% above the current price. Evans et al. (2011) find that price is not a major barrier to condom use in Zimbabwe based on a willingness-to-pay survey. Instead, the authors conclude that a person's perception of quality and value of the brand is the main driver of condom acquisition and use.

Selection and Sunk Cost Effects. A key argument cited in favor of charging a price in condom social marketing programs is that individuals use what they pay for, which could be the result of selection effects based on usage propensity or psychological sunk cost effects. While this claim has been made for the past 30 years (compare Ciszewski and Harvey (1995), Meekers (1997), and Brent (2010)), there is little empirical evidence to support it. Several studies including Brent (2010) and Chapman et al. (2012) have analyzed the discrepancy between the annual sum of condoms distributed for free and sold in social marketing programs in a country on the one hand, and the number of condoms used estimated based on national survey data on the other hand. They interpret the 'condom gap', meaning that more condoms are distributed than estimated to have been used, as the level of wastage. The studies usually come to the conclusion that the majority of the wasted condoms are those distributed for free. Chapman et al. (2012), for instance, use data on condom sales from social marketing programs and the number of free condoms distributed in the public sector and compare these figures with self-reported condom use according to the Demographic and Health Survey in Kenya, which asks for the type of condom used. The authors estimate that overall, 3% and 15% of the condoms distributed were not used during sexual intercourse in 2007 and 2009, respectively, and that the share of condoms not used is significantly higher for free condoms at 11% in 2007 and 36% in 2009. However, as discussed in Meekers and Rossem (2005), this approach to estimating non-utilization of condoms is highly problematic. Apart from potential biases associated with self-reported condom use as mentioned above, condom distribution data is not reliable, especially for the free public sector condoms. The number of condoms distributed is usually approximated by the total number of condoms provided at country level, since the number of condoms that actually reach the population is unknown. In view of the weak logistics systems in the health sector of most developing countries, especially regarding supply to rural areas, inconsistencies between the number of condoms 'distributed' and reported use may just as likely reflect stocks at national warehouses or health clinics rather than wastage at population level.

An important indication about the existence of selection effects in condom demand is provided by Thornton (2008). Based on experimental data from Malawi, she analyzes how randomly assigned monetary incentives induce individuals who have been tested for HIV to pick up their test result. In addition to her main finding that even small incentives double the share of individuals who receive their test result, she reports that sexually active HIV-positive individuals who learned about their status are three times as likely to purchase subsidized condoms when offered two months later than HIV-positive individuals who did not pick up their results. In addition, learning to be HIV-positive is positively correlated, however, statistically insignificant, with self-reported purchase of condoms at local stores at the market price during the two months after receiving the test results. Although evidence is not sufficient to make a conclusive assessment, these findings suggest that individuals who are aware of their positive HIV status and hence the risk of transmitting the virus have a higher willingness-to-pay for condoms and select into purchase. An earlier indication that paying a price may lead to higher utilization—either through selection or sunk cost effects—comes from Meekers (1997) based on a survey of adolescents in Cameroon. The author finds that free condoms are more effective at reaching young people without sexual experience than social marketing condoms. Yet, adolescents who paid for condoms are much more likely to report condom use than those who obtained free condoms.

In sum, this review of empirical evidence emphasizes the need for more and in particular more robust studies on the response of condom demand to prices in order to assess health benefits of different subsidization levels. In addition, while the debate often focuses on the differences between free condoms and charging some positive price, analyzing the effects of different condom prices is just as important to provide a sound evidence base to inform the numerous social marketing programs worldwide on the impacts of their pricing strategies.

4.3 Empirical Strategy

The empirical strategy for estimating the effect of price on demand for condoms and on selection into purchase based on HIV risk is based on the comparison of condom sales at agent level during the experiment at the three alternative consumer prices. Randomized controlled trials (RCTs), in which individuals or units are randomly assigned to different treatment groups—most commonly to one treatment and one control group—are considered the gold standard for estimating causal effects because the randomization of treatment eliminates selection bias (Angrist and Pischke 2009). However, comparing observed outcomes between different treatment groups in the RCT only provides an unbiased estimate of the treatment effect if the treatment state of one individual does not affect the outcome of another individual, that is, in the absence of spillover effects. In the condom experiment, sales agents were randomly assigned to different price groups, ruling out selection bias. Yet, the condition of no interference between agents may be violated. While every condom agent was initially assigned to cover several villages, the population in the study area was free to purchase condoms at any agent, suggesting that spillover effects exist. If the sales outcomes of one agent in the experiment are influenced by the price of other agents, the simple comparison of agent level outcomes by price group will yield biased estimates of the price effects. Section 4.3.1 begins with a general discussion of causal inference from RCTs in the presence of spillover effects and provides a brief overview of common approaches found in the recent development economics literature to address spillover effects. Section 4.3.2 presents the empirical approach to estimating unbiased price effects on condom demand based on data from the field experiment in Zambia. I derive the counterfactual price effect as well as average treatment effects of full treatment and demonstrate how neglecting spillover effects results in biased price estimates.

4.3.1 Causal Inference from Randomized Controlled Trials in the Presence of Spillover Effects

The empirical analysis of causal effects is commonly established along the counterfactual framework of causal inference, also referred to as the potential outcomes framework. It was formalized by Rubin (1974) but draws on contributions from various authors in the field of statistics and economics, the earliest being Jerzy Neyman in 1923 (Morgan and Winship 2007). Suppose that each individual in the population can be in two clearly defined treatment states: $T = 1$ if the individual receives treatment and $T = 0$ otherwise, referred to as treatment and control state. Individual i has a potential outcome under each treatment state, irrespective of whether the individual actually receives treatment or not: $Y_{1,i}$ is the outcome of individual i when treated and $Y_{0,i}$ is the outcome of individual i, that is, the *same* individual, when not treated. The individual causal effect of treating individual i is thus the difference in the potential outcomes, $Y_{1,i} - Y_{0,i}$. The fundamental problem of causal inference, as termed by Holland (1986), is that we can never observe both, $Y_{1,i}$ and $Y_{0,i}$, for any one individual. With every individual being in either the treatment state *or* the control state and the outcome under the alternative treatment state, the counterfactual outcome, remaining unobserved, individual level treatment effects cannot be estimated.

As a consequence, empirical research relies on the estimation of average treatment effects (ATEs) in the population by comparing observed average outcomes of treated individuals and untreated individuals, $E[Y_i|T = 1] - E[Y_i|T = 0]$. However, this so-called naïve difference-in-means comparison of average outcomes by treatment states is a combination of first, the effect of interest, the average effect of treatment on the treated, $E[Y_{1,i}|T = 1] - E[Y_{0,i}|T = 1]$, and second, the difference in the average outcomes between treatment groups had both not been treated, the selection bias, $E[Y_{0,i}|T = 1] - E[Y_{0,i}|T = 0]$:

$$E[Y_i|T = 1] - E[Y_i|T = 0] = E[Y_{1,i}|T = 1] - E[Y_{0,i}|T = 1] + E[Y_{0,i}|T = 1] - E[Y_{0,i}|T = 0]$$

If the selection bias is unequal to zero, treated and untreated individuals differ in their potential outcomes. As a result, one cannot distinguish whether observed differences in outcomes between treatment groups are a causal effect of treatment or due to differences between the groups even in the absence of treatment. In other words, the difference in average outcomes we observe between treatment groups is only an unbiased estimator of the average causal effect of treatment, if treatment groups are in expectation equal, that is, if there is no selection bias. The strength of RCTs stems from the fact that they solve the selection problem: randomization ensures that actual treatment is independent of potential outcomes so that $E[Y_{0,i}|T=1] = E[Y_{0,i}|T=0]$ and the selection bias is zero (Morgan and Winship 2007; Angrist and Pischke 2009).

However, even if treatment is randomly assigned and selection bias avoided, causal inference from RCTs by means of the naïve difference-in-means comparison requires that there is no interference between individuals (or units), termed the *stable unit treatment value assumption* (SUTVA) by Rubin (1980). SUTVA implies that the potential outcome of individual i is unrelated to the treatment state of any other individual j, $i \neq j$, ruling out spillover effects (Angrist, Imbens, and Rubin 1996). If SUTVA does not hold, individual i experiences an indirect effect from other individuals depending on their treatment state. The treatment state of other individuals can affect both, treated and untreated individuals, and not necessarily equally (Hudgens and Halloran 2008). Rather than having two potential outcomes (in the case of one treatment state and a control state), in the presence of interference, an individual has multiple potential outcomes that depend on the vector of treatment assigned to other individuals, rendering causal inference more complex (Rosenbaum 2007). For illustration, if treatment of individuals randomly assigned to the treatment group also affects individuals assigned to the control group, the average observed outcome of the control group is not equal to the potential outcome in the absence of the RCT.

While in laboratory research, avoiding interference between treatment groups may be feasible, in settings where individuals interact, isolation of experimental treatment groups is challenging. In many mostly earlier experimental studies, the assumption of no interference has been implicitly made without further verification (Hudgens and Halloran 2008). Yet, with increasing significance of social networks and peer effects in economics, the last decade has witnessed a rise in empirical work that accounts for or explicitly focuses on spillover effects, in particular also in field experiments conducted in developing countries (Baird et al. 2014; Aral 2016). Common types of spillover effects in the context of development interventions that have been addressed in empirical research include externalities in health, spillover effects induced by social and economic interactions between treated and untreated individuals or households, and equilibrium effects induced by changes in social norms or equilibrium prices (Angelucci and Di Maro 2015). Externalities in health mainly take place in the context of interventions to contain contagious diseases, when the administration of drugs or vaccination to the treatment group also benefits untreated individuals. For instance, Miguel and Kremer (2004) and Banerjee et al. (2010) show that deworming and vaccination interventions, respectively, improve health and educational outcomes also of untreated children because they benefit from a reduction in overall disease transmission. With respect to spillover effects induced by social and economic interactions, the most prominent examples in the context of development economics come from cash transfer programs. Evidence shows that beneficiaries who receive cash transfers share resources and also information within networks of neighbors, friends, and relatives, affecting, for instance, consumption (Angelucci and De Giorgi 2009) or schooling decisions (Lalive and Cattaneo 2009) of non-beneficiaries. Spillover effects may also arise in terms of changes in equilibrium prices, for example, when a development project increases local prices by increasing demand (Angelucci and De Giorgi 2009).

The simplest approach to account for potential spillover effects is to randomize treatment at cluster level, for example, at the level of villages or schools rather than at the individual level. If spillovers only occur within clusters but do not spread between clusters, this technique allows to estimate the overall treatment effect. It cannot, however, distinguish between the direct treatment effect and the indirect spillover effect within the cluster (Duflo, Glennerster, and Kremer 2008). In order to analyze the extent and the magnitude of spillover effects, some RCTs use a partial population experiment design. This design involves treatment and control clusters similar to the classical cluster level RCT, but differs in that within the clusters randomly selected for treatment, only a fraction of the individuals is treated. The difference in outcomes of untreated individuals in the control group and untreated individuals in the treatment group then captures the spillover effect. An advancement to the partial population design involves the variation of treatment intensity across clusters in the treatment group: in a two-level randomization, first, clusters are randomly assigned to treatment and control groups and in a second step, the share of individuals within the treatment clusters who are treated is randomly varied (Duflo, Glennerster, and Kremer 2008; Baird et al. 2014).

Regarding the empirical approach to account for spillover effects, this study is most closely related to the approach of Miguel and Kremer (2004) to study spillover effects in the deworming program in Kenya, and used in a similar manner in other experimental studies including Ichino and Schündeln (2012), Bobba and Gignoux (2014), and Dupas (2014c). The authors make use of the fact that, as a result of the random assignment of treatment, the local density of treatment surrounding the unit of observation is exogenous and exploit this random variation to identify spillover effects. More precisely, in the estimating equation, they control for the overall number of units as well as the number of treated units within certain distances of the unit of observation. In Miguel and Kremer (2004), deworming treatment was randomly assigned at primary school level. To measure health and educational spillover effects of deworming across schools, the authors control for whether the child is in a treatment school, and in addition account for the overall number of school children as well as the number of treated school children within certain distances of the child's school. They find evidence of substantial spillover effects in terms of health and school participation improvements also among untreated children, which imply an underestimation of the treatment benefits suggested by the naïve difference-in-means estimator. Speaking more generally, the key to the identification of the spillover effects is the randomization of treatment which renders the interaction between units exogenous. This avoids the problem that in the absence of randomization, interaction between individuals is endogenous because unobserved characteristics affect both, formation of the network and the outcome of interest (Goldsmith-Pinkham and Imbens 2013).

4.3.2 Estimating the Effects of Price on Condom Demand

I analyze the effects of price on condom demand by means of a reduced-form model of sales outcomes at agent level during the experiment as a function of price. Since uninterrupted condom supply at the agents was ensured in the experiment, condom sales reflect the population's demand at fixed prices. The price of 100 ngwee (P_{100}), at which social marketing condoms were offered in the closest town to the study area, was chosen as the reference price in the experiment against which I compare the lower prices 50 ngwee (P_{50}) and 25 ngwee (P_{25}). I define treatment with P_{100} as the reference state T_0 and treatment with P_{50} and P_{25} as treatment state T_1 and treatment state T_2, respectively. I aim at estimating the counterfactual effects of the two binary treatments T_1 and T_2 on condom demand.

The relevant question from a policy perspective, however, goes beyond the counterfactual price effect and is as follows: if a condom subsidization program is to be introduced at a uniform consumer price in the study area, how will demand differ depending on the price level, that is, subsidization level? I define the hypothetical case in which all agents in the study area uniformly sell condoms at P_{100} as the reference scenario. Hence, in practical terms, the reference scenario would result from scaling up the condom subsidization program already existing in urban areas at the time of the study at the prevailing price to the rural study area. I am interested in how condom demand in the study area differs if, instead of the reference price, a lower condom price is introduced in the area, namely P_{50} or P_{25}. More precisely, I aim at estimating the differences in expected average outcomes at agent level, for example condom sales, between the reference scenario of full treatment with T_0 (all agents sell at P_{100}), denoted FT_0, and the outcomes realized at full treatment with T_1 (all agents sell at P_{50}) and T_2 (all agents sell at P_{25}), respectively, denoted FT_1 and FT_2. The two average treatment effects of interest are thus the difference in expected condom sales outcomes Y between FT_1 and the reference scenario FT_0, and the difference in expected condom sales outcomes between FT_2 and the reference scenario FT_0:

$$ATE^{FT_1} = E[Y|FT_1] - E[Y|FT_0] \text{ and}$$
$$ATE^{FT_2} = E[Y|FT_2] - E[Y|FT_0]$$

The condom agents in the experiment were initially assigned to cover several villages each, corresponding to their geographic area as community health worker. However, they were not restricted to selling condoms exclusively to the population of these villages and the population in the study area was free to purchase condoms at any agent. The agents collected information on the village of residency of every customer during every incidence of condom acquisition which allows to track the movement of the customers. I find that a share of about 25% of the purchases did not occur at the condom agent closest to the customer's village, implying that considerable spillover effects occur in the study area. Survey data collected from the condom customers at purchase suggests that the reasons are diverse and related, among others, to convenience, including private or work-related visits to other areas, as well as the search for confidentiality further away from home. The spillover effects may be correlated to price, the simplest example being an individual purchasing condoms at a more distant agent to pay a lower price. As I will show in detail below, this has the following implications for the counterfactual price effect and the average treatment effects of full treatment. First, if the sales outcomes of an agent are influenced by the treatment state, that is, the price of other agents, SUTVA is violated and the naïve comparison of agent level outcomes in the experiment will yield biased estimates of the counterfactual price effect. Second, even if I account for spillover effects and obtain an unbiased estimate of the counterfactual price effect in the absence of interference between agents, the average treatment effects of full treatment, that is, the difference in outcomes between uniform pricing strategies may deviate from the counterfactual effects. This is because spillover effects do not only occur in the RCT but also under full treatment and may vary between pricing strategies.

In the following, I derive the counterfactual effect of price in the presence of spillover effects as well as the ATEs of full treatment in the study area as defined above. In addition, I demonstrate the bias of the naïve difference-in-means estimator by adopting an omitted variable framework. For simplicity, consider first a standard RCT with only one treatment arm: without treatment, condom agents sell condoms at the reference price P_{100}. In the RCT, a share of randomly selected agents is treated with T_1 and thus sells condoms at P_{50}. I assume a data-generating process according to which a direct treatment effect and indirect spillover effects from other agents make linear additive contributions to the observed outcome at agent level. In addition, the spillover effects depend on the own treatment state of the agent and originate from both, treated and untreated agents. The most general specification for outcomes with such heterogeneous spillover effects from treated and untreated units is

$$Y_i = \beta_0 + \beta_1 T_{1,i} + \gamma_0 \overline{T_{1,i}} + \gamma_1 T_{0,i} \overline{T_{1,i}} + \lambda_0 \overline{T_{0,i}} + \lambda_1 T_{1,i} \overline{T_{0,i}} + u_i \tag{4.1}$$

where Y_i denotes the outcome of agent i, for example condom sales or customers. $T_{1,i}$ and $T_{0,i}$ are treatment state indicators with $T_{1,i} = 1$ if agent i sells condoms at P_{50} (treated agent) and zero otherwise; and $T_{0,i} = 1$ if agent i sells condoms at P_{100} (untreated agent) and zero otherwise. In addition to the own treatment state, the outcome of agent i depends on the treatment state of neighboring agents: $\overline{T_{1,i}}$ and $\overline{T_{0,i}}$ denote the average state of treatment and non-treatment, respectively, of other agents. Assume, for instance, the number of treated and untreated agents within a certain distance of agent i. How the average state of treatment in the neighborhood affects Y_i depends on whether agent i sells condoms at the low or the high price. Accordingly, the interaction terms $T_{0,i}\overline{T_{1,i}}$ and $T_{1,i}\overline{T_{0,i}}$ allow the effects of neighboring treated and untreated agents on Y_i to differ by treatment state of agent i, implying that spillover effects are heterogeneous. This specification is more general than the one assumed in Miguel and Kremer (2004) in that it allows for heterogeneous spillover effects not only from treated but also from untreated units. In their study on deworming treatment, the authors specify spillover effects from treated units to differ by own treatment state but assume the effect of untreated units to be equal across treatment states. For the condom experiment, where treatment is a lower price, the distinction by treatment state is crucial: spillover effects may originate from both, treated agents and untreated agents and are likely to be very different in magnitude depending on the own treatment state. An untreated agent selling condoms at P_{100} is likely to affect a treated agent very differently than an untreated agent, and the same applies to an agent selling condoms at P_{50}. Ultimately, u_i is an error term.

Given that $T_{1,i}$ and $\overline{T_{1,i}}$ and therewith $T_{0,i}$ and $\overline{T_{0,i}}$ are exogenous due to randomization of treatment, the average treatment effect of the RCT compared to the reference scenario of full treatment with T_0, ATE^{RCT}, is given by the difference in expected outcomes between the RCT (when a share of the agents is treated and the other share is not) and expected condom sales in the reference scenario, where all agents sell at P_{100} so that $T_1 = 0$ and $\overline{T_1} = 0$:

$$\begin{aligned} ATE^{RCT} &= E[Y|RCT] - E[Y|FT_0] \\ &= \beta_1 E[T_1^{RCT}] + \gamma_0 E[\overline{T_1}^{RCT}] + \gamma_1 E[T_0^{RCT}]E[\overline{T_1}^{RCT}] \\ &+ \lambda_0(E[\overline{T_0}^{RCT}] - E[\overline{T_0}^{FT_0}]) + \lambda_1 E[T_1^{RCT}]E[\overline{T_0}^{RCT}] \end{aligned}$$

where $E[T_1^{RCT}]$ denotes the share of treated agents and $E[T_0^{RCT}]$ the share of untreated agents in the RCT. $E[\overline{T_1}^{RCT}]$ is the average composition of treated agents and $E[\overline{T_0}^{RCT}]$ the average composition of untreated agents in the neighborhood resulting from the RCT, while $E[\overline{T_0}^{FT_0}]$ is the average composition of untreated agents in the reference scenario FT_0. The effect of interest, the average treatment effect of full treatment, ATE^{FT_1}, is the difference in expected outcomes at full treatment with T_1 and the reference scenario:

$$ATE^{FT_1} = E[Y|FT_1] - E[Y|FT_0]$$

$$= \beta_1 + \gamma_0 E[\overline{T_1}^{FT_1}] - \lambda_0 E[\overline{T_0}^{FT_0}]$$
$$= \beta_1 + (\gamma_0 - \lambda_0) E[\overline{N}]$$

because under full treatment with T_1, the share of treated agents $E[T_1] = 1$, while $E[T_0] = 0$ and $E[\overline{T_0}] = 0$. Note that $E[\overline{T_1}^{FT_1}] = E[\overline{T_0}^{FT_0}] = E[\overline{N}]$ is simply the average composition of agents in the neighborhood, which are uniformly treated under FT_1 and uniformly untreated under FT_0. Furthermore, β_1 is the counterfactual effect of price on condom sales if the agents were completely isolated from each other and no spillover effects existed. To obtain the difference in condom sales between the two scenarios of full treatment, FT_1 and FT_0, one has to consider the interference between agents and add the difference in the spillover effects between FT_1 and FT_0, namely $(\gamma_0 - \lambda_0)E[\overline{N}]$. For this, it is crucial to realize that spillover effects also exist under full treatment scenarios, that is, when agents sell at a uniform price in the whole study area. In fact, this may be especially relevant in the case of condoms when individuals seek higher privacy to purchase condoms. Imagine, for instance, individuals who do not purchase condoms in their home village because they are afraid to be seen by neighbors or family members. However, when given the opportunity, they purchase condoms at more distant locations. Similarly, an individual may not purchase condoms in the home village because—as it is common in Zambia—condoms are not used with regular partners. However, the individual may purchase condoms in another village when visiting an irregular sexual partner. The magnitude of such spillover effects can be different under the two full treatment pricing scenarios and hence, this difference must be accounted for to estimate the average treatment effect of full treatment.

For the demonstration of the bias in the naïve difference-in-means estimator, assume now that the interference between agents in the data-generating process is neglected and the spillover components $\overline{T_{1,i}}$, $T_{0,i}\overline{T_{1,i}}$, $\overline{T_{0,i}}$ and $T_{1,i}\overline{T_{0,i}}$ of the true model given by Equation (4.1) omitted, which results in the naïve comparison of sample means of treated and untreated agents:

$$Y_i = \alpha_0 + \alpha_1 T_{1,i} + v_i$$

Accordingly, I estimate the average treatment effects as

$$\begin{aligned} ATE^{RCT}_{naïve} &= E[Y|RCT] - E[Y|FT_0] \\ &= \alpha_1 E[T_1^{RCT}] \end{aligned}$$

and with $E[T_1] = 1$ under full treatment with T_1

$$\begin{aligned} ATE^{FT_1}_{naïve} &= E[Y|FT_1] - E[Y|FT_0] \\ &= \alpha_1 \end{aligned}$$

This naïve estimator converges in probability to $\hat{\alpha_1} = \beta_1 - \gamma_1 E[\overline{T_1}^{RCT}] + \lambda_1 E[\overline{T_0}^{RCT}]$, where $\gamma_1 E[\overline{T_1}^{RCT}]$ denotes the difference in the effect of surrounding treated agents on treated and untreated agents in the RCT and $\lambda_1 E[\overline{T_0}^{RCT}]$ denotes the difference in the effect of untreated surrounding agents on treated and untreated agents.[43] The magnitude of the bias is ultimately an empirical question; however, I make the following plausibility considerations about the direction in the one-treatment RCT. Assuming that in the RCT, the spillover effects from surrounding agents with P_{50} is smaller (probably negative) for agents with P_{100} than for agents who sell at P_{50} themselves—because they lose more customers to cheaper agents than cheap agents themselves—implies that $\gamma_1 < 0$. Similarly, assuming that the spillover effects from surrounding agents with P_{100} is larger for agents with P_{50} than for agents with P_{100}—because they attract customers—implies that $\lambda_1 > 0$. This implies that the naïve estimator $\hat{\alpha_1} = \beta_1 - \gamma_1 E[\overline{T_1}^{RCT}] + \lambda_1 E[\overline{T_0}^{RCT}]$ is upward biased, overestimating the counterfactual price effect for isolated agents. The overestimation of the price effect when not accounting for spillover effects makes intuitive sense: untreated agents sell less in the RCT than they would in the absence of the RCT because they lose customers to treated agents, and treated agents sell more in the RCT than they would under full treatment with T_1 because they attract customers from untreated agents.

[43] The estimator $\hat{\alpha_1}$ converges to $plim\ \hat{\alpha_1} = \beta_1 + \gamma_0 b_1 + \gamma_1 c_1 + \lambda_0 d_1 + \lambda_1 e_1$, where $\overline{T_{1,i}} = b_0 + b_1 T_{1,i} + q_i$, $T_{0,i}\overline{T_{1,i}} = c_0 + c_1 T_{1,i} + r_i$, $\overline{T_{0,i}} = d_0 + d_1 T_{1,i} + s_i$, and $T_{1,i}\overline{T_{0,i}} = e_0 + e_1 T_{1,i} + w_i$. With $\hat{b_1} = 0$ and $\hat{d_1} = 0$ and $\hat{c_1} = -E[\overline{T_1}^{RCT}]$ and $\hat{e_1} = E[\overline{T_0}^{RCT}]$, $plim\ \hat{\alpha_1} = \beta_1 - \gamma_1 E[\overline{T_1}^{RCT}] + \lambda_1 E[\overline{T_0}^{RCT}]$ (see derivation in Table A4.1 in the Appendix).

The bias in the ATE of full treatment is consequently:

$$\begin{aligned} Bias^{FT_1}_{naïve} &= ATE^{FT_1}_{naïve} - ATE^{FT_1} = \hat{a_1} - ATE^{FT_1} \\ &= -\gamma_0 E[\overline{T_1}^{FT_1}] - \gamma_1 E[\overline{T_1}^{RCT}] + \lambda_0 E[\overline{T_0}^{FT_0}] + \lambda_1 E[\overline{T_0}^{RCT}] \\ &= -((\gamma_0 - \lambda_0)E[\overline{N}] + \gamma_1 E[\overline{T_1}^{RCT}] - \lambda_1 E[\overline{T_0}^{RCT}]) \end{aligned}$$

which corresponds to the bias in the naïve counterfactual effect and the difference in spillovers between the full treatment scenarios. For a stepwise illustration of the bias, imagine that we observe mean condom sales of treated and untreated agents in the RCT and estimate the ATE as the difference between these mean sales. However, under FT_0, when all agents uniformly sell at the highest price, average sales of untreated agents are different than in the RCT because they are not influenced by treated neighboring agents selling at a lower price. Instead, they are influenced by a larger number of untreated agents compared to the RCT because under FT_0, the untreated agents are still surrounded by the same number of agents only now, all of them sell at T_0. Thus, obtaining the expected sales in the absence of treatment, $E(Y|FT_0)$, requires first, subtracting the effect of neighboring treated agents on untreated agents in the RCT, which is $(\gamma_0 + \gamma_1)E[\overline{T_1}^{RCT}]$ and second, adding the effect of additional untreated neighboring agents on the untreated, which is $\lambda_0(E[\overline{T_0}^{FT_0}] - E[\overline{T_0}^{RCT}])$. For the expected sales under full treatment with T_1, the following effects have to be accounted for: first, in the RCT, treated agents are influenced by other treated agents in terms of $\gamma_0 E[\overline{T_1}^{RCT}]$. Under FT_1, however, all agents in the neighborhood are treated so that there is an additional influence of $\gamma_0(E[\overline{T_1}^{FT_1}] - E[\overline{T_1}^{RCT}])$. Second, under FT_1, the effects of untreated neighboring agents on both, treated and untreated agents, $\lambda_1 E[\overline{T_0}^{RCT}]$ and $\lambda_0 E[\overline{T_0}^{RCT}]$ disappear. Taken together, these effects yield $\gamma_0 E[\overline{T_1}^{FT_1}] + \gamma_1 E[\overline{T_1}^{RCT}] - \lambda_0 E[\overline{T_0}^{FT_0}] - \lambda_1 E[\overline{T_0}^{RCT}]$, the bias in the naïve estimation of ATE^{FT_1}.

Moving from the simplified one-treatment RCT to the condom experiment as it was implemented, that is, with a reference price and two price treatments, the data-generating process given in Equation (4.1) is expanded by $T_{2,i}$ indicating treatment with P_{25}, as well as by spillover effects originating from neighboring agents selling condoms at P_{25}, $\overline{T_{2,i}}$, again interacted with the treatment state of agent i:

$$Y_i = \beta_0 + \beta_1 T_{1,i} + \beta_2 T_{2,i} + \lambda_0 \overline{T_{0,i}} + \lambda_1 T_{1,i}\overline{T_{0,i}} + \lambda_2 T_{2,i}\overline{T_{0,i}}$$

$$+ \gamma_0 \overline{T_{1,i}} + \gamma_1 T_{0,i} \overline{T_{1,i}} + \gamma_2 T_{2,i} \overline{T_{1,i}}$$
$$+ \mu_0 \overline{T_{2,i}} + \mu_1 T_{1,i} \overline{T_{2,i}} + \mu_2 T_{0,i} \overline{T_{2,i}} + u_i \tag{4.2}$$

Following the same procedure as in the one-treatment RCT, I derive the ATE of the two-treatment RCT as

$$\begin{aligned} ATE^{RCT} &= E[Y|RCT] - E[Y|FT_0] \\ &= \beta_1 E[T_1^{RCT}] + \beta_2 E[T_2^{RCT}] \\ &+ \lambda_0 E[\overline{T_0}^{RCT}] + \lambda_1 E[T_1^{RCT}] E[\overline{T_0}^{RCT}] + \lambda_2 E[T_2^{RCT}] E[\overline{T_0}^{RCT}] \\ &+ \gamma_0 E[\overline{T_1}^{RCT}] + \gamma_1 E[T_0^{RCT}] E[\overline{T_1}^{RCT}] + \gamma_2 E[T_2^{RCT}] E[\overline{T_1}^{RCT}] \\ &+ \mu_0 E[\overline{T_2}^{RCT}] + \mu_1 E[T_1^{RCT}] E[\overline{T_2}^{RCT}] + \mu_2 E[T_0^{RCT}] E[\overline{T_2}^{RCT}] - \lambda_0 E[\overline{T_0}^{FT_0}] \end{aligned}$$

and the ATEs of full treatment with T_1 and T_2, respectively

$$\begin{aligned} ATE^{FT_1} &= E[Y|FT_1] - E[Y|FT_0] \\ &= \beta_1 + \gamma_0 E[\overline{T_1}^{FT_1}] - \lambda_0 E[\overline{T_0}^{FT_0}] \\ &= \beta_1 + (\gamma_0 - \lambda_0) E[\overline{N}] \end{aligned} \tag{4.3}$$

$$\begin{aligned} ATE^{FT_2} &= E[Y|FT_2] - E[Y|FT_0] \\ &= \beta_2 + \mu_0 E[\overline{T_2}^{FT_2}] - \lambda_0 E[\overline{T_0}^{FT_0}] \\ &= \beta_2 + (\mu_0 - \lambda_0) E[\overline{N}] \end{aligned} \tag{4.4}$$

Note that ATE^{FT_1} in the two-treatment RCT is identical to ATE^{FT_1} in the one-treatment RCT. This is because T_2 does not play a role for calculating expected condom sales under full treatment with FT_0 and FT_1; however, the parameters used are estimated controlling for T_2 and $\overline{T_2}$. With three prices, the spillover effects are most likely not only different in magnitude depending on own treatment state but partly also in opposite directions, for instance, if agents with P_{50} in the neighborhood affect sales of agents with P_{100} negatively but agents with P_{25} positively.

I estimate the effects of price on condom demand based on the following equation:

$$
\begin{aligned}
Y_{ih} = \beta_0 + \beta_1 P_{50,i} + \beta_2 P_{25,i} + \lambda_0 N_{P100,r} + \lambda_1 P_{50,i} N_{P100,r} + \lambda_2 P_{25,i} N_{P100,r} \\
+ \gamma_0 N_{P50,r} + \gamma_1 P_{100,i} N_{P50,r} + \gamma_2 P_{25,i} N_{P50,r} \\
+ \mu_0 N_{P25,r} + \mu_1 P_{50,i} N_{P25,r} + \mu_2 P_{100,i} N_{P25,r} + \alpha_h + u_i
\end{aligned}
\tag{4.5}
$$

where Y_{ih} is an indicator of condom demand at agent $i = 1, ..., 108$ as elaborated below in clinic catchment area $h = 1, ..., 5$, aggregated from individual level purchase data. Condom price, the main explanatory variable, is introduced in terms of binary variables indicating the alternative treatments, with the reference price P_{100} serving as the reference category. The remaining terms capture the heterogeneous spillover effects as discussed above. Following Miguel and Kremer (2004), I measure intensity of treatment with each price level in the neighborhood in terms of the number of agents with P_{100}, P_{50}, and P_{25} in a certain radius r of agent i, $N_{P100,r}$, $N_{P50,r}$, and $N_{P25,r}$, and interact these spillover terms with the price of agent i. Ultimately, α_h are clinic level fixed effects and u_i is an error term.

I estimate the model with different indicators of condom demand as dependent variables. In Section 4.4.1, I analyze price sensitivity of condom demand by means of three indicators: to assess (1) aggregate demand, Y_{ih} is the total number of condom packs sold by agent i during the study period. In addition, I investigate the extent to which variations in aggregate demand are driven by the extensive and the intensive margins of demand. For this purpose, I decompose total condom packs sold into (2) the number of customers per agent and (3) the mean number of condom packs bought per customer at agent level. In Section 4.4.2, I analyze price-induced selection effects based on the composition of buyers. More precisely, Y_{ih} then denotes the shares of purchases at agent level that are made by six groups associated with an above-average HIV risk, namely 1) women, 2) divorced or separated individuals, 3) widows, 4) individuals with multiple partners, 5) individuals who used a condom during last sexual intercourse, and 6) individuals who have been tested for HIV before.

4.4 Empirical Results

4.4.1 The Price Sensitivity of Demand for Condoms

The following section presents the results on the price sensitivity of demand for condoms. Table 4.1 provides descriptive statistics on the three dependent variables (1) total condom packs sold, (2) number of customers, and (3) mean number of condom packs sold per customer, all at agent level. In addition, the table presents descriptive statistics on the spillover variables for radius r of 500 meters and 1,000 meters, respectively. They depict the average number of neighboring agents within each radius by price group.

In order to be able to control for spillover effects, the sample of condom agents is reduced from the 119 agents who participated in the experiment to 108 agents who were geographically mapped. As discussed in Section 3.3, the unmapped agents do not differ with respect to demographic characteristics. Excluding these agents means excluding sales from the population in the villages these agents cover but also sales from individuals from villages covered by other agents who travel there. Yet, the unmapped agents are significantly further away from the health clinics as measured by travel time, which is consistent with them being at the outskirts of the catchment areas and therefore not shown on the hand-drawn clinic maps. This also means they are comparatively isolated and the number of sales they receive from individuals not living in their coverage area is low: while overall, about 25% of sales do not occur at the closest agents, the unmapped agents sell below 8% to villagers not living in their area.

On average, an agent sold 72 packs of three condoms during the four months of the experiment to 38 distinct customers who purchased on average 1.9 condom packs each. The variation in the dependent variables is large. The number of condom packs sold per agent, for instance, ranges from 9 to 243. The descriptive analysis provides a first indication of the role of price in affecting demand for condoms: the mean of all three dependent variables increases with lower condom prices. With respect to the spillover variables, Table 4.1 shows that the average number of neighboring condom agents $E[\overline{N}]$ is 0.72 within 500 meters of an agent and 1.22 within 1,000 meters of an agent. Accordingly, while the area around the agent increases four-fold when the radius increases from 500 to 1,000 meters, the average number of agents does not even double, implying that condom agents are rather grouped in the study area.[44] The expected number of agents in the neighborhood with a certain price is slightly lower for agents with the same price, as the number of other agents in the experiment with this price is reduced by one. Nevertheless, one value of neighboring agents stands out as particularly low. The mean number of agents with P_{100} in the neighborhood of agents who themselves sell at P_{100} is only 0.06, both, within 500 meters and 1,000 meters, compared to 0.24 and 0.45 for agents selling at P_{50} and 0.31 and 0.49 for agents selling at P_{25} in 500 and 1,000 meters respectively.

TABLE 4.1: Descriptive Statistics – Condom Demand at Agent Level

	Total sample $N = 108$		Price 100 $N = 35$		Price 50 $N = 38$		Price 25 $N = 35$	
	mean	sd	mean	sd	mean	sd	mean	sd
Dependent Variables								
Condom sales (packs)	71.52	51.57	41.34	21.21	62.87	42.71	111.09	57.46
Customers	38.08	24.38	27.91	14.01	36.13	22.84	50.37	28.99
Mean pack/customer	1.87	0.69	1.52	0.40	1.77	0.63	2.32	0.75
Spillover Variables								
Within 500 meters								
No. agents	0.72	0.82	0.63	0.81	0.66	0.78	0.89	0.87
with P_{25}	0.29	0.51	0.31	0.53	0.26	0.55	0.29	0.46
with P_{50}	0.23	0.47	0.26	0.51	0.16	0.37	0.29	0.52
with P_{100}	0.20	0.43	0.06	0.24	0.24	0.49	0.31	0.47
Within 1,000 meters								
No. agents	1.22	1.06	1.03	1.04	1.24	1.08	1.4	1.06
with P_{25}	0.45	0.66	0.49	0.70	0.47	0.65	0.40	0.65
with P_{50}	0.44	0.62	0.49	0.66	0.32	0.47	0.51	0.70
with P_{100}	0.33	0.51	0.06	0.24	0.45	0.60	0.49	0.51

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Variables are aggregated to agent level from individual purchase data from the population in the study area only. Sd indicates standard deviation.

Table 4.2 presents the regression results of the effects of price on demand for condoms. The upper part of the table depicts ordinary least squares (OLS) estimates from regressing the three indicators of condom demand on price. The lower part depicts the average treatment effects ATE^{RCT}, ATE^{FT_1}, and ATE^{FT_2} calculated as linear combinations of the point estimates as derived in the previous section. I analyze total condom demand as well as the extensive and the intensive margins of demand; thus, the dependent variable is total condom sales in Models (1)–(3), the number of customers in Models (4)–(6), and the average number of condom packs bought per customer in Models (7)–(9), all at agent level. As the distri-

[44]This finding is visualized in Figure 3.2 showing a map of the spatial distribution of condom sales agents. I calculate the relation of circle areas for 500 and 1,000 meters based on the circle area formula $A = \pi r^2$, and thus $\frac{\pi(2r)^2}{\pi r^2} = 4$.

butions of the dependent variables are right-skewed, I use the logarithmic transformations, which are approximately normally distributed and less susceptible to extreme observations (see Figure A4.1 in the Appendix). Accordingly, presented coefficients capture the change in the natural log of the dependent variable when the explanatory variable increases by one. Percentage changes in the dependent variable are calculated from the regression coefficients as $\%\Delta y = 100 * (exp(\beta) - 1)$. For each of the three dependent variables, Table 4.2 presents three model specifications. The first model presents the estimates of the naïve specification which ignores potential spillover effects. The second model includes the full set of spillover variables as given in Equation (4.5) derived in the previous section. Thus, it controls for the number of neighboring agents in each price group interacted with the agent's own price. The third model controls for a reduced set of spillover variables: it includes only the number of neighboring agents in each price group but omits the interaction terms with the agent's own price. Results are shown for spillover effects within a distance of 500 meters ($r = 500$); yet, results are similar for a distance of 1,000 meters (see Table A4.3 in the Appendix). All models control for the five clinic catchment areas.

The results clearly show that price is a major determinant of condom demand: lower prices have a highly significant and large positive effect on total condom sales at agent level. Recall that the coefficient estimates of the two price indicator variables, β_1 and β_2, capture the counterfactual effects of P_{50} and P_{25}, respectively, compared to the reference price P_{100} in the case of isolated agents, that is, in the absence of interference between agents. In the present specification, this means having no other agent within 500 meters distance. Both price coefficient estimates are of substantial magnitude and statistically significant for all indicators of demand and in all but one model specification. In addition, compared to the naïve specification in Models (1), (4), and (7), the magnitude of the coefficients changes only marginally when controlling for spillover variables, indicating that price-induced spillover effects are of minor economic significance in the experiment. In the fully parameterized Models (2), (5), and (8), the spillover effects are imprecisely estimated. I attribute this to the sample size of 108 agents, which is relatively small for the number of regressors included in the full specification, as well as to a potential issue of multicollinearity. The latter may arise, for instance, because the loss or gain of sales for one agent due to interference between agents is highly correlated to the reverse effect for another agent. Consequently, for the interpretation of the coefficient estimates, I focus on the reduced specifications presented in Models (3), (6), and (9), where the spillover interaction terms are omitted. The remaining spillover effects and the corresponding ATEs are consequently estimated with higher precision. While this comes at the expense of unbiasedness, it seems to be a reasonable approach given the minor role of price-induced spillover effects.

Accordingly, the price coefficient estimates in Model (3) show that total condom sales of an isolated agent are approximately 37% higher at P_{50} and approximately 156% higher at P_{25}, both compared to the reference price P_{100}. This implies that price sensitivity is not constant at the prices considered but substantially higher at lower prices. While the drop in price is 50% for both, P_{100} to P_{50} and P_{50} to P_{25}, the increase in sales is approximately 37% for the former price change and 87% for the latter price change.[45]

Furthermore, the increase in aggregate demand for condoms at lower prices occurs at both, the extensive and the intensive margin of demand. Regarding the extensive margin, Models (4) to (6) show that an isolated agent selling condoms at P_{50} has approximately 20% more customers and an agent selling condoms at P_{25} has approximately 70% more customers than an agent selling condoms at P_{100}. Regarding the intensive margin, Models (7) to (9) reveal that an agent with P_{50} sells on average 14% more condoms per customer and an agent with P_{25} sells on average 50% more condoms per customer, both compared to the average number of condoms sold per customer by an agent with P_{100}. Thus, the price-induced percentage change is larger with respect to the number of individuals purchasing condoms than with respect to the number of condom packs each individual purchases on average. This suggests that lowering condom prices is more effective at attracting customers to enter the condom market than at encouraging customers in the market to purchase a larger amount. This is despite the fact that the quantity of condoms purchased per individual during the experiment falls short of the assumed sexual activity. On average, a customer purchases six condoms during the four months of the experiment. Assuming approximately five acts of sexual intercourse per month (Johnson et al. 2009; Sawers and Stillwaggon 2010), this would imply that even for individuals who purchase condoms, only 30% of the sexual acts are condom protected and that condom use is therefore not consistent. This may be related to the evidence showing that condoms are rarely used in regular partnerships in Zambia (see

[45] The change in sales from P_{50} to P_{25} cannot be seen in Table 4.2 since the reference category is P_{100}. Yet, it is easily calculated knowing that $Q_{50} = 1.37 * Q_{100}$ and $Q_{25} = 2.56 * Q_{100}$, where Q_p with $p \in \{25, 50, 100\}$ indicates the number of condom sales at the different price levels: $\frac{2.56 * Q_{100} - 1.37 * Q_{100}}{1.37 * Q_{100}}$=0.87.

Section 2.2.3), so that the number of condoms an individual needs for irregular partnerships sets a limit to the effect of lower prices. Given the low estimate of repeat customers of 5% (see Section 3.5), the differences in the intensive margin across price groups are mainly driven by differences in the amount of condom packs purchased *per visit*.

The fact that the coefficient estimates of the two price indicator variables barely change when introducing the spillover variables to the model means that the naïve estimator is not substantially different from the estimator obtained when controlling for spillover effects. This indicates that price-driven spillover effects play a minor role in determining condom sales at the agents in the experiment. The F-test for joint significance of the spillover variables depicted at the bottom of Table 4.2, performed for both, the full set of spillover variables as well as for only the interaction terms, confirms that the null-hypothesis that the spillover variables are jointly equal to zero cannot be rejected at conventional significance levels (with the exception of Model (6)). Nevertheless, the fully specified models provide some evidence for price-driven spillover effects. Model (2) shows that the number of agents selling condoms at P_{25} within 500 meters distance significantly reduces the sales of agents selling at P_{50} and even stronger so of agents selling at P_{100}. This suggests that in the experiment, agents assigned the medium and the high price lose sales to agents offering condoms at the lowest price in their neighborhood. While the spillover effects are not significant in Model (5) explaining the number of customers per agent, I find in Model (8) that the average number of condom packs sold to customers at P_{50} decreases with the number of cheaper agents in the neighborhood. This may mean that even if customers buy condoms at the closest agent, they purchase less packs knowing there are cheaper condoms available relatively close by.

The results discussed above apply to the counterfactual effect of price in the absence of spillover effects, that is, in the case of isolated agents. Based on the average treatment effects of full treatment as derived in Section 4.3.2, I calculate how condom demand differs between pricing strategies when a uniform price is introduced in the study area and interference between agents occurs. Recall that ATE^{FT_1} gives the difference in average outcomes between the scenario in which all agents sell at P_{50} and the reference scenario in which all agents sell at P_{100}. Similarly, ATE^{FT_2} gives the difference in average outcomes between the scenario in which all agents sell at P_{25} compared to the reference scenario. Further, in the naïve specification, ATE^{FT_1} and ATE^{FT_2} are equal to the coefficient estimates of the price indicator variables P_{50} and P_{25} since it assumes no spillover effects, whereas they are given by the linear combinations of the point estimates $\beta_1 + (\gamma_0 - \lambda_0)E[\overline{N}]$ and $\beta_2 + (\mu_0 - \lambda_0)E[\overline{N}]$, respectively, when accounting for spillover effects (see Equations (4.3) and (4.4) in Section 4.3.2 as well as an overview of the ATEs provided in Table A4.2 in the Appendix). I use the sample mean for the expected neighboring treatment as shown in the descriptive statistics in Table 4.1. Accordingly, $E[\overline{N}] = 0.72$ is the average number of agents within 500 meters distance of agent i. ATE calculations are presented in the lower part of Table 4.2.

The sizes of ATE^{FT_1} and ATE^{FT_2} calculated based on the coefficients from the reduced specification in Model (3) confirm that price-induced spillover effects play a minor role in the experiment as the percentage changes in condom sales remain similar to the naïve estimates. However, ATE^{FT_1} is not statistically significant. Thus, introducing lower condom prices in the study area instead of scaling up the social marketing program that existed in urban areas at the time of the study at P_{100} leads to a substantial increase in condom demand. Based on the coefficient estimates from the reduced specification, ATE^{FT_2} suggests that total condom demand in the study area is 144% higher at a uniform price of 25 ngwee compared to a uniform price of 100 ngwee. For the number of customers, the model suggests an increase by 72% from full treatment with P_{100} to full treatment with P_{25} (ATE^{FT_2} in Model (6)). The percentage increase in average sales per customer is smaller with 41% from full treatment with P_{100} to full treatment with P_{25} (ATE^{FT_2} in Model (9)).

TABLE 4.2: Effect of Price on Condom Demand at Agent Level

	Total Condom Packs			Customers			Condom Packs per Customer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Price 50 (P_{50})	0.326***	0.388**	0.314**	0.192*	0.267*	0.186	0.134**	0.121	0.127**
	(0.122)	(0.149)	(0.126)	(0.108)	(0.143)	(0.112)	(0.062)	(0.074)	(0.061)
Price 25 (P_{25})	0.930***	0.917***	0.939***	0.521***	0.571***	0.540***	0.409***	0.346***	0.399***
	(0.116)	(0.180)	(0.123)	(0.100)	(0.168)	(0.109)	(0.066)	(0.089)	(0.068)
No. agents w. P_{100}		−0.035	−0.046		0.087	−0.080		−0.122	0.034
		(0.408)	(0.139)		(0.260)	(0.095)		(0.214)	(0.098)
No. agents w. P_{50}		−0.420	−0.119		−0.396	−0.133		−0.024	0.015
		(0.365)	(0.125)		(0.273)	(0.100)		(0.137)	(0.059)
No. agents w. P_{25}		0.200	−0.114		0.077	−0.073		0.122	−0.041
		(0.158)	(0.086)		(0.148)	(0.075)		(0.123)	(0.048)
P_{50}*(no. agents w. P_{100})		−0.003			−0.241			0.237	
		(0.457)			(0.298)			(0.252)	
P_{25}*(no. agents w. P_{100})		−0.140			−0.227			0.087	
		(0.457)			(0.311)			(0.244)	
P_{100}*(no. agents w. P_{50})		0.480			0.428			0.052	
		(0.445)			(0.328)			(0.171)	
P_{25}*(no. agents w. P_{50})		0.237			0.155			0.082	
		(0.384)			(0.285)			(0.163)	
P_{100}*(no. agents w. P_{25})		−0.435**			−0.240			−0.195	
		(0.198)			(0.186)			(0.141)	
P_{50}*(no. agents w. P_{25})		−0.384*			−0.138			−0.246*	
		(0.203)			(0.181)			(0.142)	
Constant	4.068***	4.053***	4.069***	3.465***	3.428***	3.461***	0.603***	0.626***	0.608***
	(0.157)	(0.173)	(0.159)	(0.169)	(0.184)	(0.171)	(0.077)	(0.079)	(0.077)

TABLE 4.2 continued

	Total Condom Packs			Customers			Condom Packs per Customer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ATE^{RCT}	0.416***	0.377	0.378***	0.236***	0.140	0.230**	0.180***	0.237	0.148**
	(0.067)	(0.283)	(0.119)	(0.059)	(0.192)	(0.095)	(0.036)	(0.149)	(0.070)
ATE^{FT_1}	0.326***	0.110	0.261	0.192*	−0.082	0.148	0.134**	0.191	0.113
	(0.122)	(0.397)	(0.210)	(0.108)	(0.280)	(0.162)	(0.062)	(0.186)	(0.114)
ATE^{FT_2}	0.930***	1.087***	0.890***	0.521***	0.564**	0.545***	0.409***	0.522***	0.344***
	(0.116)	(0.312)	(0.180)	(0.100)	(0.227)	(0.154)	(0.066)	(0.183)	(0.110)
F-Test restr. specification	0.2557		0.1499	0.1810		0.0791	0.5813		0.4179
N	108	108	108	108	108	108	108	108	108
R^2	0.495	0.538	0.506	0.450	0.494	0.465	0.371	0.413	0.377

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Dependent variables: (1)–(3) total number of condom packs sold, (4)–(6) total number of customers, and (7)–(9) mean number of condom packs sold per customer; all in the logarithmic transformation and aggregated from individual level purchase data (from within the study area only) to agent level. P_{100}, P_{50}, and P_{25} are binary variables indicating the assigned agent price. Spillover variables capture the number of agents with each price in 500 meters radius of the considered agent. All models control for the five clinic catchment areas. Results are from OLS estimations; robust standard errors in parentheses. F-test for restricted specification shows p-values for joint significance of all spillover variables in Models (1), (4), and (7) and for the interaction terms only in Models (3), (6), and (9). Average treatment effects are estimated as linear combinations as summarized in Table A4.2. Indicated significance is $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

I calculate the price elasticity of condom demand $PE_{Y,P}$ as the average of the two arc price elasticities η_1 and η_2, where η_1 is the arc price elasticity for the change in counterfactual condom sales when the agent's price decreases from P_{100} to P_{50}, and η_2 is the change in counterfactual condom sales when the price decreases from P_{50} to P_{25}. Arc price elasticity is defined as the change in expected condom sales relative to expected midpoint sales, divided by the change in price relative to the midpoint price:

$$\eta_1 = \frac{\dfrac{E[Y|T_1] - E[Y|T_0]}{0.5 * (E[Y|T_1] + E[Y|T_0])}}{\dfrac{P_{50} - P_{100}}{0.5 * (P_{50} + P_{100})}} \tag{4.6}$$

$$\eta_2 = \frac{\dfrac{E[Y|T_2] - E[Y|T_1]}{0.5 * (E[Y|T_2] + E[Y|T_1])}}{\dfrac{P_{25} - P_{50}}{0.5 * (P_{25} + P_{50})}} \tag{4.7}$$

Given that the dependent variables are in the logarithmic form, the estimated coefficients do not give us the change in expected sales but the change in the natural log of condom sales between prices. Thus, for the reduced specification in Model (3), $exp(\beta_1) - 1 = exp(0.314) - 1 = 0.37$ provides the proportionate change $(E[Y|T_1] - E[Y|T_0])/E[Y|T_0]$. By transforming and inserting the term into Equation (4.6), I calculate an arc price elasticity of $\eta_1 = -0.47$ for the change in counterfactual condom sales between P_{100} and P_{50}. Similarly, based on Equation (4.7), I estimate $\eta_2 = -0.91$ for the change in counterfactual condom sales between P_{50} and P_{25} based on the reduced specification.[46] Thus, I arrive at an average arc price elasticity of $PE_{Y,P} = -0.69$. This is basically identical to the price elasticity calculated based on the naïve specification. For the average treatment effects of full treatment, I calculate a slightly lower average price elasticity of $PE_{Y,P} = -0.65$ based on the reduced model, resulting from $\eta_1 = -0.39$ (based, however, on an insignificant ATE^{FT_1}) and $\eta_2 = -0.91$.

[46] Again, while Table 4.2 provides the coefficient estimate for the effect of P_{50} compared to P_{100}, β_1, with which I can calculate η_1, it does not provide the coefficient estimates for the effect of P_{25} compared to P_{50} needed to calculate η_2, because P_{100} is the reference category. In addition, it does not show the estimate of the average treatment effects for the change from a uniform price of P_{50} in the study area to P_{25}. Both can be obtained by estimating the model with P_{50} as the reference category. In this way, I obtain a coefficient estimate for the effect of P_{25} compared to P_{50} of 0.625^{***} and an average treatment effect coefficient of 0.628^{***} for the change from P_{50} to P_{25} in the area based on estimates from the reduced specification.

I perform two checks that confirm the robustness of the results. First, the coefficient estimates of the counterfactual price effects and hence the price elasticity barely change when controlling for spillovers within 1,000 meters instead of 500 meters (see Table A4.3 in the Appendix). Similar to the fully specified model with spillovers within 500 meters, there is a significant negative effect of the number of neighboring agents with P_{25} on agents selling condoms at P_{100}; however, the other spillover coefficients are not statistically significant. The average treatment effects of full treatment suggest a slightly higher average arc price elasticity of 0.76; yet, ATE^{FT_1} is also not significant. Second, the results are robust to including control variables, in particular agent characteristics such as age, sex, marital status as well as distance to the clinic, where substitute products in terms of free condoms are available. This confirms that randomization led to a balanced distribution across price groups. None of the control variables has a significant effect on condom sales (see Table A4.4 in the Appendix).

To summarize the main results, I find that demand for condoms is very sensitive to price and that price sensitivity is substantially higher at lower prices. Controlling for spillover effects, I find that an agent with P_{50} not affected by other agents sells 37% more condoms than at P_{100}, and an agent with P_{25} sells 87% more condoms than at P_{50}, resulting in an average arc price elasticity of -0.69. While the increase in total condom sales results from both, an increase at the intensive as well as the extensive margin of demand, the percentage increase at the extensive margin is larger, suggesting that lowering prices is more effective at attracting new customers than at encouraging existing customers to purchase more condoms. I find some evidence that agents with P_{50} and P_{100} are negatively affected by agents with P_{25} in their neighborhood in the experiment; however, overall, price-induced spillover effects are of minor economic importance. The average treatment effects thus suggest that introducing a uniform price in the whole study area below the prevailing price in urban areas would lead to a substantial increase in demand in the study area: at a uniform price of P_{25}, condom sales are 144% higher compared to the reference price of P_{100}, suggesting that offering condoms at a very low price results in a substantial increase in condom sales, especially due to new customers entering the market.

4.4.2 The Effect of Price on Selection into Purchasing by HIV Risk Group

In the following, I examine the argument of price-induced selection effects based on risk of illness, namely that charging higher prices for preventive health products targets the products to those individuals who have the highest expected health benefits from using them. In other words, higher condom prices are assumed to increase efficiency of public resource allocation by screening out individuals who do not need or use condoms for the prevention of HIV and other STIs. Since actual condom use is not observed, I cannot analyze selection effects based on usage propensity and focus on selection effects based on risk of HIV. In the context of a generalized HIV epidemic as in Zambia, where most of the sexually active population is at some risk of infection, the intention of screening out groups with lower risk may seem out of place. Yet, in light of stagnating funds for condom promotion and for the HIV response overall, the discussion about efficiency in terms of achieving the highest health benefits for a given amount of resources is highly relevant.

In the case of a contagious disease such as HIV, generating the largest health benefits requires targeting condoms to individuals with the highest risk of being HIV-positive or of contracting HIV in order to avoid as many new HIV infections as possible. In the absence of biomedical data on the HIV status of condom customers and their sexual partners in the condom experiment, I rely on proxies for expected preventive health benefits from condom use. More precisely, I analyze the share of condom purchases at each price level that is made by customers with certain characteristics associated with an elevated risk of HIV infection in Zambia. If individual HIV risk is reflected in a higher willingness-to-pay for condoms and higher prices accordingly screen out individuals with a lower need for condoms, one would expect to find a greater share of purchases from high-risk populations at higher prices.

HIV risk factors were extensively discussed in Section 2.2.3. The Zambian Demographic and Health Survey involves HIV testing of survey respondents and thus allows to analyze HIV prevalence by sociodemographic characteristics and certain behaviors related to HIV. According to the DHS 2013/2014, 13.3% of the Zambian population is HIV-positive. I use the following six proxies for an above-average risk of HIV infection: the demographic characteristics of 1) being female; 2) being divorced or separated; and 3) being widowed, as well as the HIV-related behaviors of 4) having had multiple partners in the last 12 months;

5) having used a condom during last sexual intercourse; 6) and having had a HIV test before and received the results. HIV prevalence among women is 15.1% compared to 11.3% among men. With respect to marital status, HIV prevalence is extremely high among divorced or separated individuals with 27.4% and among widows with 46.3%, compared to 14.4% among married and 7.2% among never married individuals. Regarding HIV-related behaviors, HIV prevalence is higher for individuals with no sexual partners at 17.1%—indicating a behavioral response to HIV infection in terms of higher abstinence—and for individuals with multiple partners at 15.1% in the last 12 months compared to only one partner at 14.3%. The differences are particularly pronounced for women: 22.9% of women with no sexual partners and 35.2% of women with multiple partners are HIV-positive, compared to 15.4% of women with only one sexual partner in the last 12 months. Furthermore, HIV prevalence is higher among individuals who used a condom during last sexual intercourse compared to those who did not, namely 23.1% compared to 12.2%, also indicating that individuals adapt their behavior to their HIV status. Again, the difference is especially pronounced for women with 31.6% compared to 13.1%. Ultimately, individuals who had previously been tested for HIV, meaning before the DHS testing, are also more likely to be HIV-positive, with a prevalence of 16.1% compared to 9.3% among individuals who report they have never been tested for HIV.[47]

Table 4.3 begins with a descriptive comparison of condom customers and the general Zambian population. It compares the shares of men and women meeting each HIV-related characteristic discussed above in the general population with the respective shares among condom customers in the experiment. More precisely, for the demographic characteristics and the HIV-related behaviors, Column (1) depicts the share in the general Zambian population and Column (2) the HIV prevalence rate in the respective group, both based on the DHS 2013/2014. Columns (3) to (7) are based on the condom purchase data from the experiment. Column (4) depicts the overall share of condom customers meeting the respective characteristic. Columns (5) to (7) compare differences between the three prices: Column (5) shows the share of customers at the reference price P_{100} for each characteristic and Column (6) and Column (7) present the difference in the shares at P_{50} and P_{25}, respectively, both compared to P_{100}.

[47] Note that these are national figures for Zambia as not all are available for Eastern Province.

The comparison between condom customers and the general population clearly indicates that individuals select into purchasing condoms based on their HIV risk. Most strikingly, while in the general population, only 15.7% of men and 1.7% of women report they had multiple partners in the last year, the corresponding figures are 59.0% and 40.8% among condom customers in the experiment. This substantiates findings from existing literature that condoms are mainly used outside monogamous relationships in Sub-Saharan Africa (de Walque and Kline 2011; Reynolds, Luseno, and Speizer 2013). In addition, around 80% of both, male and female condom customers report they used a condom during last sexual intercourse. This is extremely high considering the respective shares in the general population of 24.8% for men and 14.6% for women. While it is very likely that new local condom sales options mainly attract individuals who have experience with condom use, the difference to the general population is so large that it raises the question of whether customers in the experiment overreport their past condom use. It may be that villagers are more likely to overreport condom use when asked by another villager, the condom agent, who in addition is a community health worker promoting preventive behaviors, than when asked by an unknown enumerator in the DHS. However, if this is the case, one would also expect condom customers to underreport multiple partners as this behavior is similarly criticized as promoting HIV transmission. Yet, as mentioned above, the share of condom customers in the experiment reporting multiple partners is substantially higher than the share of the general population reporting multiple partners in the DHS.

With respect to price-induced selection effects, the descriptive statistics suggest a mixed picture. As a general tendency, the share of high-risk customers as indicated by demographic characteristics increases as price decreases. The shares of female customers as well as widowed customers, both male and female, are higher at the lower prices compared to P_{100}. In the experiment, the average share of female customers at agents selling at P_{100} is 10.3%, while the share increases to 13.8% at agents with P_{50} and 15.6% at agents with P_{25}, and the differences (compared to P_{100}) are significantly different from zero. Furthermore, although the overall share of widowed customers is very low, there is a significant difference between P_{100} and P_{25}. While at P_{100}, 0.3% of male customers and 1.0% of female customers are widows, the percentages increase to 1% and 8.2% respectively, at P_{25}, corresponding to a 3-fold and 8-fold increase for men and women, respectively. There is no clear picture for divorced or separated customers.

In contrast to the demographic groups, the share of high-risk customers as indicated by their HIV-related behavior tends to be higher at higher prices, with the exception of condom use at last sexual intercourse. This supports the argument that higher prices are effective at targeting high-risk groups. For instance, for agents selling at P_{100} in the experiment, the share of male customers who report having had more than one sexual partner in the last 12 months is 61.8%, which is 4.0 percentage points higher than for agents with P_{25}. For women, the share of customers with multiple partners also decreases at lower prices and the difference of 11.2 percentage points between P_{100} and P_{50} is statistically significant. Most pronounced are the declines at lower prices for the share of customers who have been tested for HIV before. Overall, 85.4% of male customers and 88.5% of female customers have previously been tested for HIV. While this seems very high, it must be noted that HIV testing has received substantial support in Zambia and about 60% of men and 80% of women have ever been tested nationwide according to the DHS 2013/2014. With respect to male condom customers, the share of customers who had been tested before is approximately 11 percentage points lower at both, P_{50} and P_{25}, compared to P_{100}. For women, the share is approximately 7 percentage points lower at both, P_{50} and P_{25}, compared to P_{100}. This suggests that individuals who are aware of their HIV status have a higher willingness-to-pay for condoms.

TABLE 4.3: Condom Customers by HIV-related Characteristics and Price

	Population		Condom customers				
	Share in pop.	Share HIV-pos.	N	Share of cust.	Share at P_{100}	Differences in shares $P_{50} - P_{100}$	$P_{25} - P_{100}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				MEN			
Demographic characteristics							
Male	1.000	0.113					
Divorced/separated	0.036	0.252	3,462	0.039	0.031	0.006	0.014*
						(0.008)	(0.008)
Widowed	0.004	0.342	3,462	0.007	0.003	0.001	0.007*
						(0.003)	(0.004)
HIV-related behaviors							
Multiple partners	0.157	0.126	3,280	0.590	0.618	−0.033	−0.040*
						(0.023)	(0.022)
Used condom at last sex	0.248	0.178	3,440	0.822	0.798	0.015	0.046***
						(0.018)	(0.016)
Ever tested for HIV	0.595	0.141	3,166	0.854	0.939	−0.109***	−0.114***
						(0.016)	(0.015)
				WOMEN			
Demographic characteristics							
Female	1.000	0.151	4,100	0.138	0.103	0.035**	0.053***
						(0.014)	(0.014)
Divorced/separated	0.085	0.282	554	0.211	0.270	−0.047	−0.090*
						(0.053)	(0.047)
Widowed	0.035	0.477	554	0.049	0.010	0.011	0.072**
						(0.016)	(0.028)
HIV-related behaviors							
Multiple partners	0.017	0.352	502	0.408	0.483	−0.112*	−0.079
						(0.066)	(0.061)
Used condom at last sex	0.146	0.316	519	0.811	0.832	−0.094*	0.015
						(0.055)	(0.043)
Ever tested for HIV	0.783	0.174	460	0.885	0.941	−0.071*	−0.068*
						(0.042)	(0.039)

Notes: For each characteristic and separately for men and women, Column (1) shows the share of the population aged 15 to 49 meeting this characteristic and Column (2) shows the share of HIV-positive individuals in this group, both based on data from the Demographic and Health Survey 2013/2014. Columns (3) to (7) are based on customer data from the condom experiment and show the share of customers meeting the respective characteristic in Column (4), the corresponding share at P_{100} in Column (5), and the differences in shares at P_{50} in Column (6) and P_{25} in Column (7), both compared to P_{100}. Standard errors in parentheses. Indicated significance is $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

While the descriptive statistics discussed above reveal interesting correlations between price and HIV-related characteristics of condom customers, for statistical inference, I perform multivariate analyses of selection effects. I use the same estimating equations and corresponding ATEs that were used to analyze price sensitivity of condom demand in the previous section. Instead of absolute indicators of condom demand, the dependent variables are now the share of total condom sales at agent level to individuals belonging to the six HIV risk groups, namely: the share of total condom sales at agent level to women, separated or divorced customers, widows, customers with multiple partners, customers who used a condom during last sexual intercourse, and customers who had been tested for HIV before. In contrast to the descriptive statistics above, where I compared condom customers to the general population, I now consider the share of total condom sales to individuals belonging to the respective risk group, because focusing on customers could mask differences in purchase quantities per risk group.

Table 4.4 presents summary statistics of the dependent variables by price group. For the demographic risk groups, the overall share of sales in the experiment is extremely low. A third of all condom agents does not have any female customers and about 83% of the agents do not have any widowed customers. Accordingly, I do not separate by sex of the customers as this would reduce the shares even more. The spillover variables presented are identical to those used in the regressions on price sensitivity.

The regression results of the effect of price on the share of sales to high-risk individuals are presented in Table 4.5 for the demographic variables and in Table 4.6 for the behavioral variables. Again, coefficients are OLS estimates. The dependent variables are introduced in the level-form which allows a straightforward interpretation of the coefficients as the change in the dependent variable, that is, the change in the share of sales to individuals in each HIV risk group. For each dependent variable, results are presented for the naïve, the full, and the reduced specification. Average treatment effects comparing the respective shares between full treatment with each price in the study area are depicted in the bottom part of the tables.

Overall, the regression results provide support for the pattern already indicated by the descriptive statistics: the shares of condom sales to high-risk individuals as indicated by their demographic characteristics tend to increase at lower prices, while the shares of condom sales to high-risk individuals as indicated by their reported past behavior tend to decrease at lower

TABLE 4.4: Descriptive Statistics – Shares of High-Risk Customers at Agent Level

	Total sample $N = 108$		Price 100 $N = 35$		Price 50 $N = 38$		Price 25 $N = 35$	
	mean	sd	mean	sd	mean	sd	mean	sd
Dependent Variables								
Share of condom sales to customers who								
are female	0.11	0.14	0.10	0.16	0.10	0.11	0.12	0.16
are divorced/separated	0.05	0.07	0.06	0.08	0.05	0.07	0.05	0.06
are widowed	0.01	0.03	0.00	0.01	0.01	0.02	0.02	0.05
had multiple partners	0.55	0.24	0.62	0.22	0.51	0.22	0.53	0.26
used condoms last sex	0.81	0.18	0.82	0.16	0.79	0.20	0.82	0.18
had been tested for HIV	0.84	0.22	0.91	0.13	0.81	0.27	0.81	0.22
Spillover Variables								
Within 500 meters								
No. agents	0.72	0.82	0.63	0.81	0.66	0.78	0.89	0.87
with P_{25}	0.29	0.51	0.31	0.53	0.26	0.55	0.29	0.46
with P_{50}	0.23	0.47	0.26	0.51	0.16	0.37	0.29	0.52
with P_{100}	0.20	0.43	0.06	0.24	0.24	0.49	0.31	0.47
Within 1,000 meters								
No. agents	1.22	1.06	1.03	1.04	1.24	1.08	1.4	1.06
with P_{25}	0.45	0.66	0.49	0.70	0.47	0.65	0.40	0.65
with P_{50}	0.44	0.62	0.49	0.66	0.32	0.47	0.51	0.70
with P_{100}	0.33	0.51	0.06	0.24	0.45	0.60	0.49	0.51

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Variables are aggregated to agent level from individual purchase data from the population in the study area only. Sd indicates standard deviation.

prices. As shown in Table 4.5, I find a significant positive effect of P_{25} compared to P_{100} on the share of condoms purchased by widows. Controlling for spillover effects, the share of sales to widows is 1.9 percentage points larger if the agent sells at P_{25} compared to P_{100} (see reduced specification in Model (9)). The corresponding ATE^{FT_2} suggests that introducing P_{25} in the study area leads to an increase of 2.3 percentage points in the share of condom sales to widows compared to the reference scenario of full treatment with P_{100}. Given the extremely low share of purchases from widows under full treatment with P_{100} of about 1% ($\beta_0 + \gamma_0 E[\overline{N}]$) and considering that widows have the highest HIV prevalence of all marital status, this increase is substantial. For the model explaining the share of female customers, the effects are not statistically significant. Note that I find a relatively strong spillover effect for all three dependent variables in the reduced specifications in Models (3), (6), and (9), which may be an indicator that these risk groups have a stronger motivation to find cheaper prices.

Table 4.6 provides support for the hypothesis that higher prices lead to a selection into purchase of high-risk individuals based on past behaviors related to an elevated HIV prevalence. While the two price coefficient estimates are negative for all dependent variables throughout the different specifications, I find significant effects, both, statistically and economically, for the share of condom sales to customers with multiple partners as well as customers who had been tested for HIV before. More precisely, in the absence of spillover effects, Model (3) suggests that the share of condoms sold to customers with multiple partners is 11.3 percentage points lower at P_{50} compared to P_{100}, where the respective share is 61.2%. The effect for P_{25} is of similar magnitude, however, barely not significant at the 10%-level (p-value = 0.1006). The average treatment effects based on the reduced specification suggest that compared to an estimated share of 64.1% of condom sales to customers with multiple partners under full treatment with P_{100}, the share decreases by 15.2 percentage points at full treatment with P_{50} (ATE^{FT_1}) and by 10.9 percentage points at full treatment with P_{25} (ATE^{FT_2}). Similarly, Model (9) suggests that in the absence of spillover effects, the share of purchases from previously tested customers decreases from 93.9% when the agent sells at P_{100} to 83.3% at P_{50} (−10.6 percentage points) and to 84.6% at P_{25} (−9.4 percentage points). The ATEs suggest that compared to the reference scenario at P_{100} where 93% of sales are made by customers previously tested for HIV, introducing a uniform price of P_{50} or P_{25} in the study area instead would both reduce the share of purchases from customers who have been tested for HIV before by about 12 percentage points (see ATE^{FT_1} and ATE^{FT_2}). The finding that knowing your HIV status increases willingness-to-pay for condoms suggests that promoting HIV testing, which is part of the HIV response of most highly affected countries, is an effective HIV prevention strategy. The shares of condom sales to behavior-related risk groups are relatively similar under FT_1 and FT_2, while the difference occurs with respect to FT_0. This is contrary to the overall price effects on condom sales, where the larger percentage decrease occurs between FT_1 and FT_2, rather than between FT_1 and FT_0.

From the perspective of health benefits, for selection effects to be a valid argument to charge higher prices, the absolute number of high-risk individuals should remain relatively unchanged at higher prices. As the results from Section 4.4.1 show, reducing condom prices leads to a substantial increase in condom demand. Given the direction and the magnitude of the selection effects, I conclude that the absolute number of condoms sold to high-risk individuals, and hence the expected health benefits, are substantially higher at lower prices. This is clear for the demographic risk groups such as widows which account for a larger share of condom sales at lower prices in addition to the overall demand increase at lower prices.

More precisely, the findings that lower prices lead to an overall increase in total condom sales as well as an increase in the share of condom sales to widows implies two positive effects of lower prices on the absolute number of condoms purchased by widows. For the behavioral risk groups, such as customers with multiple partners, I find opposing effects: the overall increase in condom demand at lower prices is accompanied by a decrease in the share of sales to high-risk groups. I estimate the change in condom sales to customers from these risk groups between the reference scenario FT_0 and FT_1 (and similarly between FT_0 and FT_2) based on the price sensitivity estimates from the previous section and the selection effects estimates:

$$\delta = \frac{g * Q_{100} * E[Y|FT_1] - Q_{100} * E[Y|FT_0]}{Q_{100} * E[Y|FT_0]}$$

where Q_{100} denotes the total number of condoms sold under full treatment with P_{100}, g is the condom sales growth rate between FT_0 and FT_1 estimated in the previous section, and $E[Y|FT_0]$ and $E[Y|FT_1]$ are the respective shares of condoms sold to high-risk individuals under each treatment scenario. Hence, $g * Q_{100} * E[Y|FT_1]$ is the total number of condoms sold to a certain high-risk group under FT_1, and $Q_{100} * E[Y|FT_0]$ is the total number of condoms sold to a certain high-risk group under FT_0. I calculate the shares at full treatment $E[Y|FT_0] = \beta_0 + \lambda_0 E[\overline{N}]$ and $E[Y|FT_1] = \beta_0 + \beta_1 + \gamma_0 E[\overline{N}]$ and $E[Y|FT_2] = \beta_0 + \beta_2 + \mu_0 E[\overline{N}]$ based on the reduced specification and $E[\overline{N}] = 0.72$. Total sales increase by 30% from FT_0 to FT_1 and by 144% from FT_0 to FT_2, so that g is 1.3 and 2.44, respectively. I find that for the behavioral risk groups, the increase in condom sales at lower prices resulting from the overall positive demand response to price reductions largely outweighs the effect of a lower proportion of high-risk customers at lower prices. More precisely, the absolute number of sales to customers with multiple partners is unchanged between FT_0 and FT_1, which would suggest an effective screening out of individuals with lower risk of illness. However, the absolute number of sales increases by 100% between FT_0 and FT_2. For the absolute number of condoms bought by customers who had previously been tested for HIV, I find that it increases by 12% between FT_0 and FT_1 and by 112% between FT_0 and FT_2.

I summarize and interpret the results on price-induced selection effects with respect to condoms as follows. First, the demographic risk groups, which account for a larger share of condom sales at lower prices, are not only associated with a higher HIV prevalence in Zambia but also with lower economic status. As discussed in Section 2.2.3, women in

Zambia generally have little control over household resources. Furthermore, in particular female widows are highly affected by extreme poverty because they are commonly forced to give their land to the relatives of the deceased husband and hence lose their livelihood. Consequently, even if these groups have a higher willingness-to-pay for condoms given their elevated risk of HIV infection or HIV transmission, it is very likely that they are constrained in their financial means. This suggests that prices crowd out important risk groups and hence, lead to counterproductive selection effects. These findings are consistent with the common negative relation between price elasticity and the proportion of the consumer's income needed to pay for the product, as well as with the relevant literature showing that prices for health products crowd out poorer and liquidity constrained populations (Spears 2014; Tarozzi et al. 2014). Second, for certain behaviors associated with an elevated HIV prevalence, in particular having multiple partners and having had a HIV test, the shares of sales decrease at lower prices. There is no reason to assume that the HIV risk groups determined on past behavior, which account for a lower share of purchases at lower prices, are disproportionately poor, which implies that a higher willingness-to-pay due to a higher risk in fact translates into actual purchases. This indicates that where health benefits are not concentrated among the poorest and willingness-to-pay is not limited by the lack of ability-to-pay, higher prices are effective at targeting condoms to those individuals with the largest health benefits. Third, while some efficiency enhancing selection effects hence exist, the absolute number of sales to high-risk individuals is considerably larger at lower prices as a result of the substantial price sensitivity of demand, suggesting that the intended selection effects are negligible from the health perspective.

TABLE 4.5: Price-Induced Selection into Purchase, by Demographic Characteristics

Share of total condom sales	Women			Divorced/separated			Widows		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Price 50 (P_{50})	0.0004	0.0199	−0.0049	−0.0069	−0.0032	−0.0088	0.0048	0.0071	0.0050
	(0.0322)	(0.0340)	(0.0323)	(0.0172)	(0.0265)	(0.0173)	(0.0039)	(0.0049)	(0.0039)
Price 25 (P_{25})	0.0160	0.0457	0.0187	−0.0036	0.0072	−0.0002	0.0171**	0.0277*	0.0187**
	(0.0376)	(0.0514)	(0.0379)	(0.0169)	(0.0264)	(0.0164)	(0.0082)	(0.0142)	(0.0094)
No. agents w. P_{100}		−0.0903	−0.0030		−0.0364	−0.0112		0.0032	−0.0054
		(0.0943)	(0.0278)		(0.0341)	(0.0138)		(0.0031)	(0.0066)
No. agents w. P_{50}		−0.0785*	−0.0622***		−0.0432**	−0.0318***		−0.0092**	−0.0088**
		(0.0430)	(0.0229)		(0.0181)	(0.0090)		(0.0046)	(0.0044)
No. agents w. P_{25}		0.0152	0.0067		−0.0286	−0.0142		−0.0020	0.0007
		(0.0463)	(0.0261)		(0.0178)	(0.0109)		(0.0194)	(0.0058)
P_{50}*(no. agents w. P_{100})		0.0823			0.0194			−0.0028	
		(0.1011)			(0.0403)			(0.0089)	
P_{25}*(no. agents w. P_{100})		0.0872			0.0306			−0.0191	
		(0.1080)			(0.0410)			(0.0135)	
P_{100}*(no. agents w. P_{50})		0.0915			0.0294			0.0057	
		(0.0782)			(0.0311)			(0.0051)	
P_{25}*(no. agents w. P_{50})		−0.0229			0.0086			−0.0052	
		(0.0531)			(0.0211)			(0.0118)	
P_{100}*(no. agents w. P_{25})		0.0037			0.0175			0.0072	
		(0.0800)			(0.0277)			(0.0203)	
P_{50}*(no. agents w. P_{25})		−0.0191			0.0213			0.0021	
		(0.0518)			(0.0252)			(0.0203)	
Constant	0.1033***	0.0991***	0.1174***	0.0560***	0.0651***	0.0693***	0.0030*	0.0021	0.0054**
	(0.0269)	(0.0245)	(0.0266)	(0.0133)	(0.0211)	(0.0158)	(0.0017)	(0.0024)	(0.0026)

TABLE 4.5 continued

Share of total condom sales	Women			Divorced/separated			Widows		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ATE^{RCT}	0.0053	0.0701	−0.0066	−0.0036	0.0119	−0.0088	0.0072**	0.0066	0.0088
	(0.0210)	(0.0683)	(0.0257)	(0.0103)	(0.0289)	(0.0144)	(0.0031)	(0.0042)	(0.0062)
ATE^{FT_1}	0.0004	0.0284	−0.0477	−0.0069	−0.0082	−0.0236	0.0048	−0.0019	0.0025
	(0.0322)	(0.0788)	(0.0451)	(0.0172)	(0.0336)	(0.0230)	(0.0039)	(0.0035)	(0.0062)
ATE^{FT_2}	0.0160	0.1220	0.0257	−0.0036	0.0128	−0.0024	0.0171**	0.0239	0.0231
	(0.0376)	(0.0821)	(0.0431)	(0.0169)	(0.0351)	(0.0221)	(0.0082)	(0.0181)	(0.0140)
F-test restr. specification	0.0065		0.6733	0.0044		0.9354	0.3416		0.6128
N	108	108	108	108	108	108	108	108	108
R^2	0.0028	0.0677	0.0449	0.0017	0.0749	0.0650	0.0525	0.0969	0.0757

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Dependent variables: (1)–(3) share of total condom sales made by women, (4)–(6) share of total condom sales made by divorced or separated individuals, and (7)–(9) share of total condom sales made by widows; aggregated from individual level purchase data (from within the study area only) to agent level. P_{100}, P_{50}, and P_{25} are binary variables indicating the assigned agent price. Spillover variables capture the number of agents with each price in 500 meters radius of the considered agent. Results are from OLS estimation; robust standard errors in parentheses. F-test for restricted specification shows p-values for joint significance of all spillover variables in Models (1), (4), and (7) and for the interaction terms only in Models (3), (6), and (9). Average treatment effects are estimated as linear combinations as summarized in Table A4.2. Indicated significance is $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

TABLE 4.6: Price-Induced Selection Into Purchase, by HIV-related Behavior

Share of total condom sales	Multiple partners			Used condom			Tested for HIV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Price 50 (P_{50})	−0.1057**	−0.0517	−0.1127**	−0.0345	0.0341	−0.0367	−0.1015**	−0.0501	−0.1063*
	(0.0515)	(0.0728)	(0.0532)	(0.0422)	(0.0581)	(0.0449)	(0.0491)	(0.0605)	(0.0540)
Price 25 (P_{25})	−0.0945	−0.0473	−0.1034	−0.0009	−0.0009	−0.0004	−0.0971**	−0.0672	−0.0938**
	(0.0575)	(0.0865)	(0.0624)	(0.0404)	(0.0642)	(0.0435)	(0.0433)	(0.0694)	(0.0452)
No. agents w. P_{100}		−0.1828	0.0399		−0.1073	0.0014		0.0587	−0.0133
		(0.1240)	(0.0596)		(0.1053)	(0.0363)		(0.0710)	(0.0527)
No. agents w. P_{50}		0.0135	−0.0148		−0.1286	−0.0230		−0.2283	−0.0456
		(0.0905)	(0.0499)		(0.1040)	(0.0368)		(0.1717)	(0.0499)
No. agents w. P_{25}		0.0924	0.0323		0.0403	0.0068		−0.0030	−0.0510
		(0.1116)	(0.0436)		(0.0648)	(0.0306)		(0.0940)	(0.0470)
P_{50}*(no. agents w. P_{100})		0.2258			0.0755			−0.0428	
		(0.1599)			(0.1196)			(0.0959)	
P_{25}*(no. agents w. P_{100})		0.2285			0.1381			−0.1699	
		(0.1465)			(0.1189)			(0.1139)	
P_{100}*(no. agents w. P_{50})		0.1289			0.1646			0.2219	
		(0.1125)			(0.1216)			(0.1788)	
P_{25}*(no. agents w. P_{50})		−0.1309			0.1371			0.2284	
		(0.1177)			(0.1145)			(0.1833)	
P_{100}*(no. agents w. P_{25})		−0.0025			0.0251			−0.0210	
		(0.1292)			(0.0768)			(0.1083)	
P_{50}*(no. agents w. P_{25})		−0.1375			−0.1053			−0.0921	
		(0.1261)			(0.0848)			(0.1291)	
Constant	0.6204***	0.5660***	0.6118***	0.8225***	0.7988***	0.8262***	0.9107***	0.9166***	0.9393***
	(0.0367)	(0.0555)	(0.0438)	(0.0273)	(0.0407)	(0.0343)	(0.0215)	(0.0316)	(0.0325)

TABLE 4.6 continued

Share of total condom sales	Multiple partners			Used condom			Tested for HIV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ATE^{RCT}	−0.0678**	0.1079	−0.0880	−0.0124	0.0780	−0.0172	−0.0672***	−0.1153**	−0.0861
	(0.0314)	(0.0983)	(0.0588)	(0.0237)	(0.0791)	(0.0426)	(0.0245)	(0.0572)	(0.0531)
ATE^{FT_1}	−0.1057**	0.0901	−0.1522*	−0.0345	0.0187	−0.0543	−0.1015**	−0.2573**	−0.1295
	(0.0515)	(0.1210)	(0.0863)	(0.0422)	(0.1110)	(0.0709)	(0.0491)	(0.1291)	(0.0990)
ATE^{FT_2}	−0.0945	0.1515	−0.1089	−0.0009	0.1057	0.0035	−0.0971**	−0.1117	−0.1211*
	(0.0575)	(0.1427)	(0.0991)	(0.0404)	(0.0974)	(0.0645)	(0.0433)	(0.0835)	(0.0705)
F-test restr. specification	0.3280		0.1394	0.4274		0.3240	0.1865		0.2500
N	108	108	108	108	108	108	108	108	108
R^2	0.0400	0.1071	0.0497	0.0084	0.0708	0.0122	0.0450	0.1418	0.0694

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Dependent variables: (1)–(3) share of total condom sales made by individuals with multiple partners, (4)–(6) share of total condom sales made by individuals who used a condom during last sexual intercourse, and (7)–(9) share of total condom sales made by individuals that have ever been tested for HIV; aggregated from individual level purchase data (from within the study area only) to agent level. P_{100}, P_{50}, and P_{25} are binary variables indicating the assigned agent price. Spillover variables capture the number of agents with each price in 500 meters radius of the considered agent. Results are from OLS estimation; robust standard errors in parentheses. F-test for restricted specification shows p-values for joint significance of all spillover variables in Models (1), (4), and (7) and for the interaction terms only in Models (3), (6), and (9). Average treatment effects are estimated as linear combinations as summarized in Table A4.2. Indicated significance is *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

4.5 Results Discussion

The magnitude of health benefits that are achieved in a population by means of different pricing strategies for preventive health products ultimately depends on the effects of price on take-up and utilization of the product, on differences in willingness-to-pay in the population based on risk of illness, and on the extent of health externalities arising from preventive behaviors. In the last decade, a growing body of experimental studies has shown that an increase in price causes substantial drops in demand for various preventive health products in developing countries, while failing to encourage actual use. In addition, existing evidence suggests that prices are not effective at allocating preventive products to the population with the highest expected health benefits, but rather on the contrary, lead to counterproductive selection effects in terms of screening out the neediest. In sum, these findings prompted the research community to recommend that preventive health products should be highly subsidized or even provided free of charge in developing countries, especially when health benefits are concentrated among the poorest populations and health externalities are large.

This study was motivated by the lack of rigorous evidence on the demand response to price of condoms, one of the most important prevention goods in the developing world. Despite several decades of condom subsidization programs and the continuing threat posed by HIV/AIDS, knowledge on how prices affect overall demand for condoms and specifically demand among HIV risk groups is scarce. We built on the missing market for condoms in rural Zambia and conducted a field experiment, in which community health volunteers served as condom agents and sold condoms at three randomly assigned prices. Based on sales data from a four-month period, I estimate price sensitivity of condom demand as well as price-induced selection effects based on HIV risk. The results are consistent with existing literature on preventive health product pricing, while adding several new insights. In line with experimental evidence on other products, I find that demand for condoms is very sensitive to price despite condoms being an effective prevention of a deadly disease, and that prices lead to worse targeting among HIV risk groups that are financially constrained.[48] In addition, the study contributes to the knowledge on the price sensitivity of products that are needed continuously in order to provide effective protection in showing that, first, estimated

[48] Experimental evidence on preventive health product pricing includes Ashraf, Berry, and Shapiro (2010), Cohen and Dupas (2010), Meredith et al. (2013), Blum, Null, and Hoffmann (2014), Dupas (2014c), Spears (2014), Tarozzi et al. (2014), and Comfort and Krezanoski (2017).

price elasticity of condom demand is high compared to longer lasting products studied in previous field experiments, and that, second, the analysis of both, the intensive and the extensive margins of demand is important to understand the effect of price on consistency of preventive behaviors. By showing that for some high-risk groups, higher prices, in fact, improve targeting, this study suggests that for products where health benefits are not concentrated among the poor, charging higher prices may be a relevant instrument to increase efficiency of public resource allocation. Price setting of preventive health products should therefore include a careful analysis of the distribution of the disease in the population according to wealth groups. In sum, the findings lead to the conclusion that high subsidization of condom prices—the lowest price of 25 ngwee is merely 2.5% of the commercial price at the time of the study—causes a substantial increase in population coverage overall, as well as among high-risk individuals. Although I cannot measure actual utilization, low prices are hence the first requirement to enable large health benefits, in particular also given the important health externalities of HIV prevention. The price elasticity estimated between the medium and the low price is close to unity and thus indicates that charging higher prices does not necessarily lead to higher revenues, undermining the argument of achieving higher sustainability by charging higher prices. Ultimately, the fact that I find only little evidence of spillover effects in the experiment, while descriptive data shows that a considerable share of customers does not purchase condoms at the nearest condom agent, may imply that spillover effects are not correlated to price. In a context where condoms are associated with disease and sex work, it is very plausible that psychological factors, in particular related to privacy and confidentiality, are important in determining where individuals purchase condoms.

As with every small-scale experimental study, external validity of the results is limited and the findings have to be considered in the context of rural Zambia or very similar contexts in Southern Africa. Condom subsidization programs exist throughout the developing world, but design and environment differ between countries or even regions. For instance, the reputation of free condoms, which constitute a substitute good to social marketing condoms, may be different in other countries with potential implications for the willingness-to-pay of the respective population. The same applies to the perceived quality of social marketing condoms themselves, also in relation to commercial brands. Brand recognition, but also general knowledge about condoms and their preventive benefits, will affect how much the population is willing to pay for condoms. In addition, price elasticity is likely to depend on the risk of contracting or transmitting HIV, that is, HIV prevalence in the general population, or more specifically in the population group from which one chooses sexual partners. Considering that HIV prevalence in Zambia, and hence the health benefits of condom use, are among the highest in the world, indicates that price sensitivity of condom demand may be higher in regions less affected by the disease. Moreover, cultural aspects may also play a role for price sensitivity. For instance, in contexts where women have a higher status in society and are more empowered to negotiate condom use than in Zambia, overall price sensitivity may be lower, as women are commonly more health-conscious, and hence willing to spend more on prevention, compared to men.

While this study provides sound evidence that demand for condoms can be increased considerably by lowering prices to a very low level, it remains unclear how such high subsidies affect condom demand in the long run. In its origin, social marketing is understood as an instrument to develop a commercial condom market over time. Most social marketing programs pursue a strategy of market segmentation that involves weaning consumers who can afford to pay from free or low-price provision, and gradually introducing them to higher and eventually commercially viable prices. Often, social marketing programs offer several brands at different prices for different groups of buyers (Armand 2003; Chapman et al. 2012). A recent body of literature has analyzed how current prices affect future willingness-to-pay. In particular for developing countries, where high subsidies and free distribution of health products are common practice, concerns exist that low prices serve as a reference point or anchor for the population, limiting the willingness to pay higher prices in the future. By negatively affecting long-term demand, low prices could hamper the development towards market conditions. However, on the other hand, it is argued that for so-called experiment goods, low prices stimulate future demand through a learning effect. If individuals learn about the benefits of a health product, they may be willing to pay more in the future. Evidence suggests that such learning effects can offset or even outweigh—for instance in the case of insecticide-treated bed nets—negative anchor effects, stimulating long-term demand (Dupas 2014c; Fischer et al. 2014). While there is great potential for positive learning in the case of condoms, given the long incubation time of HIV, the health benefits of condoms may not be visible enough to lead to a gradual increase in willingness-to-pay.

Furthermore, this study does not contribute to the debate on whether or not the population should pay for condoms at all, because the experimental design did not include a zero price. During the experiment, condoms were available free of charge at the five health clinics in the study area. Clinic level data indicates that condom distribution at the health clinics did not decrease during the four months of the experiment. The survey data collected from customers during their condom purchase visit reveals that many customers avoid collecting condoms at the clinics for various reasons, including long distances, frequent stock outs, inconvenient opening hours, lack of privacy, and poor product quality. Thus, the condom offer made by agents differs in a multitude of factors from the condom offer made at the clinics, rendering a comparison, and in particular any inference to the role of price, impossible. The isolated effect of a zero price thus remains unclear, and therewith the question whether it constitutes a special threshold, by causing either a stark increase in demand due to psychological effects of receiving a product for free or a decrease due to concerns about the quality of free products.

Charging at least a small price remains a valid argument from the perspective of improving distribution and equity in access to condoms. In urban areas, the price charged in social marketing programs facilitates the distribution of condoms through commercial logistic systems by giving wholesalers and retailers an incentive to sell condoms in their shops in terms of a profit. In rural areas, shops and functioning logistic systems usually do not exist. The condom experiment, which relied on community health volunteers to sell condoms at village level, may serve as an example for condom provision in rural areas. In many developing countries, the public health system works with community volunteers to cope with budget constraints and a lack of health staff and improve access to basic health services in rural areas. Community volunteers are intended to overcome physical distances to health clinics, but also cultural gaps by serving as a link between communities and the health system (Cotlear et al. 2015). Providing incentives to community health volunteers for selling condoms at village level could improve access to condoms considerably in rural areas. Given the lack of established logistic systems, this would require support to ensure that the health workers are supplied with condoms. While common social marketing programs are implemented by NGOs independently and rather detached from national structures, the task of organizing and supplying community health volunteers could be undertaken by the health clinics. Their involvement would have the benefit that condom programs are more closely linked to the public health system, which would be conducive to the long-term sustainability of condom provision in the time of decreasing donor funds for HIV/AIDS.

5 The Individual Perspective: Modeling Condom Sales Location Choice

5.1 Introduction

Standard economic models of individual decision-making commonly focus on the importance of economic costs in determining demand. With respect to health care, it is widely recognized that besides the consumer price of health-related goods and fees for medical care, monetary costs for traveling and opportunity costs of time spent for accessing goods and services are crucial factors affecting demand (Mwabu 2008). In addition to these economic costs, a growing body of literature in psychology and behavioral economics emphasizes the importance of psychological costs in individual decision-making with respect to health-related behaviors. The literature distinguishes between two causes of psychological costs which can prevent individuals from seeking health care or acquiring health-related products: internal factors which are related to anxiety about the own health status and external factors such as stigma and discrimination. Internal psychological costs arise when the confrontation with the own health status or risk of disease causes discomfort to the individual. As an example, receiving information about the own health status through medical examinations and tests is valuable to the individual because it allows to make improved decisions in the future, such as taking appropriate drugs, paying special attention to nutrition and exercise, or adopting specific preventive behaviors. However, the fear of learning about a serious condition or disease may lead the individual to avoid such information and thus to neglect visiting a doctor (Caplin and Leahy 2001; Kőszegi 2003; Thornton 2008; Barigozzi and Levaggi 2010). External psychological costs, on the other hand, are the result of social stigma and anticipated discrimination. Individual demand for health care may be hampered by the fear of being observed by others. This is especially likely in the case of health conditions that are contagious, self-induced, the result of socially undesirable behaviors, or difficult to assess for others, such as mental illnesses (Philipson and Posner 1995; Thornton 2008; Corrigan, Druss, and Perlick 2014).

Both, travel costs and psychological costs of accessing health care are of particularly high relevance in rural areas of developing countries. In sparsely populated areas of developing countries, visiting the next health clinic, pharmacy, or market is associated with substantial transport and time costs for the majority of the population due to large distances. The situation is aggravated by poor road conditions and insufficient means of transport. Furthermore, rural health clinics are commonly overcrowded and plagued by absent staff, leading to long waiting times for individuals seeking medical advice. Empirical research has shown that poor physical access is a major barrier to household investment in health in developing countries. Most studies in this area investigate the relation between distance or travel time on the one hand and health facility utilization or specific health outcomes, such as child or maternal mortality, on the other hand (Tanser, Gijsbertsen, and Herbst 2006; Schoeps et al. 2011; Kumar, Dansereau, and Murray 2014; McLaren, Ardington, and Leibbrandt 2014). In the context of HIV, Thornton (2008) conducted a randomized field experiment in Malawi to analyze the impact of monetary incentives to learn one's HIV status after being tested and finds that an increasing distance to the next testing center significantly reduces the probability that an individual picks up the test result.

At the same time, psychological costs of accessing health care are high in most developing countries. In particular Sub-Saharan African countries suffer from a high burden of life-threatening infectious diseases, including HIV/AIDS (WHO 2017c). Empirical research provides support for the importance of internal psychological costs with respect to HIV/AIDS by showing that the fear of learning to be HIV-positive deters individuals from being tested or from picking up their test results (Ginwalla et al. 2002; Mugusi et al. 2002). In addition to the internal fear ob being infected, social stigma and discrimination of HIV-positive individuals persist in many countries and constitute a major barrier to health-seeking behavior because individuals are afraid to be seen by others when accessing HIV-related services. External psychological costs are increased by the basic infrastructural conditions of health clinics that offer little privacy to patients. A study conducted in Uganda, for instance, shows that a home-based testing program induced significantly higher demand to learn HIV testing results than the same service offered at the health clinic, and study participants reported fear of stigmatization as a crucial reason (Wolff et al. 2005). In a study in South Africa, Murray et al. (2013) find that diagnosis and treatment of tuberculosis, a common concomitant infection of HIV infection, is considerably impaired by low trust in patient confidentiality at the health center and anticipated HIV-related stigma.

In the context of HIV/AIDS, external psychological costs do not only exist with respect to HIV testing and treatment but are likely to be a crucial factor with respect to condom acquisition (Brent 2010). The mere fact that condoms are used during sexual intercourse may already cause individuals to be embarrassed and afraid to be seen when acquiring condoms. While this holds also for high-income countries, psychological costs are even higher in countries severely affected by HIV and other STIs. In southern African countries, where up to 25% of the population is infected with HIV (UNAIDS 2017), condoms are strongly associated with disease, not least as an unintended result of decades of intensive HIV education campaigns linking condoms to HIV and STIs. Consequently, an individual acquiring condoms is often suspected of being HIV-positive or of having other STIs. In addition, condoms are predominantly used between irregular sexual partners rather than within marriage so that condoms are related to having extramarital and risky sexual behaviors (de Walque and Kline 2011; Reynolds, Luseno, and Speizer 2013). An individual asking for a condom to be used in a regular partnership is therefore often suspected either of being unfaithful and of having multiple sexual partners her or himself, or of not trusting the partner to be faithful. Negative preconceptions exist especially with respect to women who—according to traditional gender roles—have little power to negotiate condom use within marriage (Duffy and Regan 2010). Women acquiring condoms are frequently taken for sex workers (Meekers and Rossem 2005; Brent 2010).

Building on this research, I investigate the importance of economic and psychological costs with respect to condom acquisition in rural Zambia. Rural Zambia is very sparsely populated, roads are not paved but rather gravel roads, and means of transport are commonly limited to walking. Supply of all types of goods including condoms is very limited, indicating substantial transport and time costs for the population for accessing them at distant locations. In addition, external psychological costs of acquiring condoms are likely to be large. Approximately 10% of the population in rural Zambia is HIV-positive and condoms are primarily used for and hence associated with sexual intercourse among irregular partners and sex workers (CSO, MOH, and ICF 2015). As a result of the persistent stigmatization of HIV or the wish to hide sexual relationships from others, individuals are likely to consider very carefully where to purchase condoms. One expects that they will deliberately choose sales locations they feel comfortable with and expect to find the highest level of confidentiality. Hence, I argue that when the acquisition of a good is associated with external psychological costs, individuals have preferences for certain attributes of the sales location beyond economic factors such as price and travel costs, namely attributes that convey confidentiality to the individual and as such play a crucial role for decision-making. In fact, external psychological costs may give rise to situations in which individuals accept or even value economic costs in exchange for lower psychological costs. For instance, while it is unlikely that an individual would opt for a distant location to acquire other preventive health products, such as soap or a bed net, an individual who intends to purchase condoms may prefer to buy further away from home to avoid being seen by relatives and acquaintances. Furthermore, an individual may have preferences for certain characteristics of the sales agent that suggest trustworthiness. In other words, psychological costs may induce the individual to exchange convenience for confidentiality.

I analyze the importance of convenience and confidentiality in determining individual choice of a condom sales location in rural Zambia by means of a discrete choice model derived under the assumption of individual utility-maximizing behavior. The model specifies the choice of a condom sales location to result from individual preferences for certain attributes of the sales locations, including distance from the individual's home village to the sales location as well as demographic characteristics of the sales agent. I use a unique data set that combines actual condom sales data from a randomized field experiment in Eastern Zambia with GPS coordinates of 108 condom sales locations and surrounding villages. In the field experiment, condoms were sold at three randomized prices in different villages and data was collected from every customer during a time period of four months. In addition, data is available on demographic characteristics of the condoms sales agents. By means of GPS coordinates of the condom sales locations, the home villages of the condom customers, and the connecting roads, I measure the distances the population has to travel to alternative condom sales locations. Considering that an individual chooses between alternative sales locations to realize the condom purchase and that preferences differ between individuals, I estimate a flexible mixed multinomial logit model of condom sales location choice that allows for variation in preferences for the attributes of the condom sales locations across individuals, resulting from both, observed and unobserved factors.

The results suggest that economic costs, including price and travel costs, are decisive determinants of condom sales location choice. In particular, the study reveals that individuals are very sensitive to distance. The probability of choosing a certain condom agent decreases by about 0.7 percentage points for every additional 100 meters between the individual's home village and the condom sales location. I find evidence that the negative effect of distance on location choice is weaker for individuals who report they had multiple sexual partners in the last year than for individuals with only one or no partner (-0.69 compared to -0.76 percentage points per 100 meters). This is consistent with the hypothesis that individuals who have stronger reasons to hide sexual relationships are less reluctant to travel. However, overall the negative effect of distance prevails, suggesting that individuals clearly choose convenience over confidentiality.

In addition, the results provide strong support for heterogeneous preferences of individuals for certain characteristics of condom sales agents, confirming the assumption that costs other than of economic nature influence condom sales location choice. The preference of women to purchase condoms from female condom agents is most pronounced. More precisely, for female customers, the probability of purchasing condoms at the closest sales location decreases from 71.6% to 55.2% if the condom sales agent is male, while men are indifferent with respect to the sex of the agent. Averaged over all alternatives, that is over all sales points an individual can choose from, the difference in probability between male and female agents for female customers is 7.2 percentage points. Relating this difference to the effect of distance suggests that women accept up to 900 additional meters (one way) in order to find a female condom agent. This is consistent with the literature indicating that the acquisition of condoms in Zambia is shaped by traditional gender roles and affected by prejudices towards women demanding condoms (Duffy and Regan 2010). Arguably, women expect to find higher confidentiality and less preconceptions from other women when purchasing condoms and consequently accept higher effort in terms of travel. Moreover, I find that younger customers prefer to purchase condoms from younger sales agents, indicating that they expect to find higher understanding from peers than from older condom agents who—given the small sizes of the villages in the area—may be acquaintances of their parents. This is consistent with adults having reservations towards condom education for youth, fearing that this promotes early sexual initiation (CSO, MOH, and ICF 2015).

This study makes two main contributions to the existing literature. First, it provides robust empirical evidence on the importance of different attributes of condom sales locations in individual decision-making and the willingness-to-pay for these attributes. Since the beginning of the HIV/AIDS epidemic, condom programs have been implemented in developing countries with the aim of increasing condom use by increasing demand among the population and improving accessibility to condoms. The latter involves making condoms more widely available in outlets close to the population, offering them at below market prices, and ensuring greater privacy to the customers than public health clinics (Armand 2003; Chapman et al. 2012). Thus, while costs of both, economic and psychological nature are considered in condom programs and evidence exists that condom social marketing has improved take-up of condoms (Sweat et al. 2012), there is little evidence analyzing how different types of costs jointly determine individual decision-making with respect to condom acquisition. While the results show that the strong negative effect of economic costs, including price and distance, on health-seeking behaviors in general also applies to condom acquisition, it additionally emphasizes the role of condom sales agents' attributes and their impact on customers and thus the importance of accounting for non-economic costs in condom distribution programs.[49] A lot of anecdotal evidence exists regarding the disadvantaged role of women in making decisions related to sexual health in southern Africa. By showing that men and women have heterogeneous preferences with respect to the characteristics of the condom sales agent, this study confirms that traditional gender norms play a major role in determining the effectiveness of condom distribution programs. This has direct implications for the design of condom distribution programs: since condom acquisition is associated with psychological costs, especially for women, demand for condoms will essentially depend on the characteristics of the condom sales agent. In order to target women and younger individuals, ensuring that female condom agents and younger sales agents are available to the population is essential to increase demand also among these groups.

Second, the study expands the literature on modeling demand for geographically differentiated products in a discrete choice model to the case of a market for health prevention in developing countries. The economic analysis of discrete choice, based on the seminal works of Daniel McFadden (1973), has been used to analyze spatial competition on retail markets including markets for automobiles and movie theaters (de Palma et al. 1994; Berry, Levinsohn, and Pakes 1995; Davis 2006).[50] It has also found application in health economics,

[49] See, for instance, Tanser, Gijsbertsen, and Herbst (2006), Thornton (2008), Schoeps et al. (2011), Kumar, Dansereau, and Murray (2014), and McLaren, Ardington, and Leibbrandt (2014) for the impact of distance on health behaviors and Ashraf, Berry, and Shapiro (2010), Cohen and Dupas (2010), Meredith et al. (2013), Tarozzi et al. (2014), and Comfort and Krezanoski (2017) for the impact of price on health product take-up.

[50] For an overview of developments in economic discrete choice, see also McFadden's Nobel lecture (McFadden 2001).

in particular to investigate demand for medical care and individual choice of provider or provider type (Gertler, Locay, and Sanderson 1987; Borah 2006; Sarma 2009; Varkevisser, Geest, and Schut 2012). A few studies exist on contraceptive type choice (Akin and Schwartz 1988). To the best of my knowledge, this is the first study to model demand for condoms in a discrete choice framework. The unique data of this study has the advantage that precise information on different alternatives is available, whereas previous studies often rely on imputation or incomplete information. Using data from the field experiment provides exact information on the demographic characteristics of the condom sales agents. In addition, the elaborate geocoding performed for the study area allows to measure distances on the road network utilized by the population and hence provides more accurate estimates of the distances and required effort needed to travel from the individual's home village to alternative condoms sales locations than straight-line distances.

The chapter is structured as follows. Section 5.2 derives the discrete choice model of condom sales location choice. Subsequently, Section 5.3 presents the data, focusing in particular on the individual choice sets. Section 5.4 presents the mixed multinomial logit results including robustness checks while Section 5.5 provides a discussion of the results and concludes.

5.2 A Discrete Choice Model of Condom Sales Location Choice

5.2.1 The Random Utility Maximization Model

The microeconomic analysis of choice behavior of individuals facing discrete economic alternatives gained momentum in the 1960s and evolved in particular through the seminal works of later Nobel Prize winner Daniel McFadden. Empirical research of consumer demand increasingly shifted from aggregated levels of analysis based on market level data to modeling variations in demand across individuals, made possible by the growing availability of individual and household level survey data. As illustrated below, the theoretical foundation of individual level discrete choice models are commonly random utility maximization (RUM) models. RUM-based discrete choice models have initially been used to analyze individual demand for transportation mode and subsequently found broad application in the analysis of other individual as well as firm level choices, including educational and occupational choice, demand for consumer goods, and choice of location (McFadden 2001).

Discrete choice models involve a decision-maker, for example an individual, who faces a choice and a set of alternatives to choose from, the so-called choice set. As the name implies, the defining feature of discrete choice models is that the outcome variable is discrete, meaning it takes on a countable number of values. Usually, the values are not ordinal but rather nominal in nature, that is, they do not have an order. This contrasts with standard consumption models which explain a quantity consumed and thus a continuous outcome variable. The aim of discrete choice models is to understand the behavioral process that causes the decision-maker's choice, which is determined by observable and unobservable factors. Given the unobservable factors in the behavioral process, the choice cannot be predicted exactly. Instead, the researcher estimates the probability that a decision-maker chooses a particular alternative given the set of possible alternatives, or in other words, the probability that the observable and unobservable factors result in a particular outcome given the behavioral process (Train 2009).

I follow common practice and derive a discrete choice model of condom sales location choice under the assumption of utility-maximizing behavior of the decision-maker. Individual i, the decision-maker, faces a choice of J mutually exclusive alternatives: the individual can choose one of J alternative sales locations to purchase condoms. Each of the J condom sales locations provides a certain utility U_{ij} to the individual. The fundamental assumption of RUM models is that, in line with the principle of utility-maximizing behavior, individual i chooses alternative $j = 1, ..., J$ if alternative j provides the greatest utility of all alternatives, that is, if and only if $U_{ij} > U_{ik}\ \forall k \neq j$.[51] While the individual is aware of the different utilities the alternative sales locations provide, the data only provides information on certain attributes of the alternatives from the individual's perspective, x_{ij}, termed alternative-specific attributes, as well as attributes of the individual, z_i, termed individual-specific attributes. The individual's utility from choosing j can be considered as consisting of two components:

$$U_{ij} = V_{ij} + \epsilon_{ij}$$

[51] It is commonly assumed that no two alternatives provide exactly the same utility.

where $V_{ij} = V(x_{ij}, z_i)$ is a function that relates the observed factors to the individual's utility, that is, it captures the component of utility that depends on observed individual-specific and alternative-specific factors. All factors that affect utility beyond these observed attributes are captured in ϵ_{ij}.

The condom sales locations created in the field experiment all offer the same condom brand and therewith the same product quality. Yet, I assume that the different condom sales locations provide different levels of utility to each individual, depending on the economic and psychological costs they entail and how the individual values these costs. In other words, I argue that an individual's choice of condom location is determined by the individual's preferences for certain attributes of the condom agents and that these preferences vary across individuals depending on the importance they place on economic and psychological costs, that is, the preferences are heterogeneous. Similar to other goods, when deciding where to purchase condoms, an individual considers the economic costs of acquisition incurred at different sales locations. This involves in particular the consumer price at which condoms are offered at the respective location, which was determined randomly as part of the experimental design of this study. In addition, the sales locations are located at different distances from the consumer depending on the village of residence, implying travel costs and opportunity costs of time spent for traveling and realizing the purchase. In rural Zambia, costs associated with traveling can be substantial given the combination of large distances, poor road conditions, and insufficient means of travel or lack thereof. As a result of these economic costs, including price and travel costs, the choice of an individual will be influenced by available income and time, opportunity costs of time, available transport possibilities, as well as individual capacities, among others, to walk or to ride a bike. Certain groups are more constrained with respect to these factors, for instance, women or younger people have fewer economic means; older people may be less capable of traveling.

The central argument of this study is that in addition to economic costs, an individual's choice of condom sales location is affected by agent characteristics related to confidentiality due to psychological costs associated with the acquisition of condoms. In rural Zambia, condoms are predominantly used for irregular sexual partnerships, suggesting that the population associates condoms with unfaithfulness. Furthermore, stigmatization of HIV/AIDS prevails (CSO, MOH, and ICF 2015). According to traditional gender roles, women have less decision-making power, also regarding topics related to family planning and sexual health, including condom use (Duffy and Regan 2010). Therefore, while price and travel costs are likely to play a crucial role in determining individual condom sales location choice, when an individual is afraid to be seen during condom acquisition or fears the sales agent will spread information, other attributes of sales locations are likely to gain in importance in individual decision-making. For instance, in the presence of psychological costs of condom acquisition, an individual may accept—or even value—greater distances to the sales locations and thus economic costs; be it in order to find a trusted or anonymous sales agent or simply to reduce the probability of being seen by family, friends, and other acquaintances. Hence, while some individuals prefer to purchase close to where they live for reasons of convenience, others may prefer larger distances to find higher confidentiality away from their home village. The latter is likely to be especially relevant for certain groups such as women or high-risk groups such as individuals with multiple partners. Furthermore, while demographic characteristics of a sales agent such as sex or age may only play a minor role when purchasing other goods, they may be a crucial factor for decision-making in the case of condoms in a context of high HIV prevalence and again, are likely to affect individuals differently. For instance, older men may feel comfortable purchasing condoms from a condom agent with similar characteristics; yet, younger men or women may avoid to purchase from older men due to the fear of being judged for their sexual activity or for deviating from the traditional role of women, which does not include demanding condom use in sexual relationships.

Based on these considerations, I specify utility of individual i from choosing condom sales location j as

$$U_{ij} = \beta_1 P_{50,j} + \beta_2 P_{25,j} + \beta_3 dist(L_i, L_j) + \beta_4 invill_j + \beta_5 female_j + \beta_6 age_j + \epsilon_{ij} \quad (5.1)$$

The variables $P_{50,j}$, $P_{25,j}$, $female_j$, and age_j are fixed alternative-specific attributes of condom sales locations, meaning they are identical from the perspective of all individuals. $P_{50,j}$ and $P_{25,j}$ are binary variables indicating that condom sales location j offers condoms at the price of 50 ngwee or 25 ngwee, respectively, compared to the reference price group of 100 ngwee. The binary variable $female_j$ indicates that the condom agent at location j is female. Furthermore, age_j is the age in years of the condom agent at condom sales location j. The variable $dist(L_i, L_j)$ captures the distance measured in 100 meters from the individual's village of residence, location L_i, to condom sales location j, L_j. Thus, in contrast to the other attributes, $dist(L_i, L_j)$ does not only differ across condom sales locations but also across individuals, depending on their village of residence. The binary variable $invill_j$ indicates that the condom sales location is located in the individual's home village, that is $L_i = L_j$. All other individual and alternative-specific factors that are unobserved and affect utility of condom sales location j are captured in ϵ_{ij}.

As discussed above, I assume heterogeneous preferences across individuals in the sense that attributes of the condom sales locations affect individuals' utility of choosing a certain alternative differently, not only in strength but also in direction. To analyze differences in the effects of alternative-specific factors on condom sales location choice by demographic characteristics of the individual, the basic specification given in Equation (5.1) is expanded by individual-specific attributes, which enter the model as interactions with the alternative-specific attributes:

$$\begin{aligned} U_{ij} = {} & \beta_1 P_{50,j} + \beta_2 P_{25,j} + \beta_3 invill_j + \beta_4 dist(L_i, L_j) + \beta_5 dist(L_i, L_j) * female_i \\ & + \beta_6 dist(L_i, L_j) * multpartners_i + \beta_7 female_j + \beta_8 female_j * female_i \\ & + \beta_9 age_j + \beta_{10} age_j * young_i + \epsilon_{ij} \end{aligned}$$

Accordingly, distance is interacted with the individual-specific characteristics of being a female customer ($female_i$) and having had multiple partners in the 12 months prior to the survey ($multpartners_i$). Female condom agent is interacted with female customer and the age of the agent is interacted with a binary variable indicating a young customer between the ages of 11 and 26 years ($young_i$).

While preferences for certain condom sales locations may be linked to observable characteristics of the agent as well as of the individual, they are also likely to be driven by unobserved factors such as the agent's trustworthiness as perceived by the customer, the agent's knowledge about HIV, his or her competence in providing information and advice as well as the agent's attitudes towards condom use, sexual activity, and people living with HIV/AIDS. In order to account for potential heterogeneity in preferences of the individual that are based on both, observable and unobservable factors, I estimate the effects of alternative and individual-specific attributes on the probability of choosing a condom sales location by means of a mixed multinomial logit model.

5.2.2 The Mixed Multinomial Logit Model

While binary outcome models are used when the dependent variable is dichotomous, multinomial models are used to analyze dependent variables that take on one of several mutually exclusive categories, as it is the case in the choice of the condom sales location. Discrete choices are most commonly analyzed by means of logit models. The most widely applied model has been McFadden's conditional logit model, also referred to as the multinomial logit (MNL) model (McFadden 2001; Hensher and Greene 2003). However, the MNL model has several limitations, two of which are relevant to the condom sales location choice problem. First, the MNL model cannot represent random variation in preferences for attributes of the alternatives across individuals. More precisely, while the model can incorporate preferences that vary systematically with observed characteristics of the decision-maker, it cannot account for variation in preferences that results from unobserved characteristics (Train 2009). As discussed above, I assume preferences for alternative-specific attributes of the condom sales points to vary across individuals due to both, observed and unobserved factors. The second limitation of the MNL model is that it implies a restrictive pattern of substitution between alternatives. The *independence from irrelevant alternatives* (IIA) assumption states that the ratio of choice probabilities for any two alternatives is the same for every choice set that includes both alternatives, meaning that this ratio does not depend on any alternative other than the two under consideration. In other words, the choice between two alternatives is simply a binary logit model (McFadden 2001; Train 2009). While such substitution patterns may be appropriate in some choice situations, they usually do not accurately reflect reality.[52]

Given these limitations of the standard MNL model, I estimate a mixed multinomial logit (MMNL) model which is more flexible and has been increasingly used since the mid 1990s (Hensher and Greene 2003). In particular, the MMNL model resolves the limitations of

[52] The restrictive nature of the IIA assumption is commonly illustrated by the 'red bus/blue bus' example. Suppose that an individual can choose between taking a car or a blue bus to commute to work. Both modes of transport provide the same utility to the individual, so that the choice probabilities are equal and their ratio is equal to one. Suppose now that a red bus is introduced which differs from the blue bus only in color. The individual is indifferent between the two buses so that the probability of taking each bus is the same and their ratio is equal to one. One would assume that the introduction of the red bus does not affect the probability of taking the car but rather that the probability of taking the bus would split between the two buses. However, the IIA assumption implies that the ratio of the probabilities of taking a car and the blue bus remains the same, that is, equal to one. The MNL model would hence predict a probability of one third for each of the three alternatives car, blue bus, and red bus, which is the only solution where the probability ratio between car and blue bus remains unchanged and the probabilities between blue and red bus are equal (Train 2009).

the standard MNL model discussed above in that it allows for random taste variation that is not related to observed characteristics as well as for unrestricted substitution patterns between alternatives. It is therefore also referred to as the multinomial logit model with unobserved heterogeneity or random parameter logit. Flexibility is achieved by allowing some or all of the coefficients of the attributes to be random and to follow any distribution specified by the researcher.[53] For a utility that is linear in its arguments, the mixed logit choice probability that individual i chooses alternative j, Pr_{ij}, is the standard logit choice probability integrated over the distribution of the parameters:

$$Pr_{ij} = \int \frac{exp(\beta' v_{ij})}{\sum_{k=0}^{J} exp(\beta' v_{ik})} f(\beta) d\beta$$

where β' is a vector of individual-specific coefficients representing the tastes for observed attributes comprised in vector v_{ij} and $f(\beta)$ is the density function of β. This means that the parameters vary over decision-makers in the population with density $f(\beta)$, accounting for different individual preferences. I specify the coefficients of all attributes to be random across individuals with an independent normal distribution and estimate means and standard deviations of the coefficients. With the normal distribution, the coefficients are not restricted to have the same sign for all individuals, which is in line with the hypothesis that individuals have opposite preferences for specific attributes. As a reminder, some individuals may value longer distances for reasons of confidentiality, which would imply a positive distance coefficient, while others are reluctant to travel and prefer convenient access, which would imply a negative distance coefficient. Due to the intractability of the likelihood function, the parameters are approximated using Maximum Simulated Likelihood (McFadden and Train 2000; Train 2009).

5.3 Data

For the empirical analysis, I use the data on condom sales locations, actual condom sales, and customers from the randomized experiment combined with the information on the geographic distribution of the condom sales locations and the customers derived from the mapping procedure (see detailed description of the data in Chapter 3). Data was collected on

[53] More precisely, whereas the standard logit is derived under the assumption that the unobserved part of utility, ϵ_{ij}, is distributed independent and identically (iid) extreme value, the mixed logit assumes that the unobserved part of utility can be decomposed into a part that follows any distribution as specified by the researcher and a part that is iid extreme value (Train 2009).

demographic characteristics of the condom agents, that is, on alternative-specific attributes, and, by means of a survey, on condom customers, that is, on individual-specific attributes. The geographic mapping of the villages additionally allows to calculate the distance from an individual's home village to every alternative condom sales location, that is, the condom sales agent's village. Therefore, I have data on the individual, the alternative condom sales locations, and the alternative actually chosen by the individual, which fulfills the data requirements for the estimation of a multinomial model. Similar to the agent level analysis in Chapter 4, I only use the data that was geo-referenced, that is, 108 agents and 259 villages. This means that the empirical analysis is based on the 82% of the purchase incidences that were mapped, meaning that both the customer's village as well as the agent's village were mapped.

The choice set—the set of alternatives from which an individual chooses—must fulfill three requirements: first, the included alternatives must be mutually exclusive for the individual in the sense that choosing one alternative necessarily implies not choosing any other alternative. Second, the alternatives must be exhaustive, meaning that all possible alternatives are included in the choice set. And third, the number of alternatives in the choice set must be finite (Train 2009). The requirements are satisfied for the condom sales location choice set as demonstrated in the following.

Exclusiveness. Although an individual can successively purchase condoms at different locations, for a single condom purchase at a specific point in time, the individual can only choose one location. Thus, exclusiveness is given for every single choice situation.

Exhaustiveness. Regarding exhaustiveness, I make the following three restrictions. First, the study is confined to analyzing condom sales location choice of individuals purchasing condoms in the study area. This means that the results do not provide a full picture of overall condom demand, for which exhaustiveness would require adding three alternatives to the individual's choice set, namely the options of i) not purchasing condoms at all, ii) collecting condoms free of charge at the health clinics, and iii) purchasing condoms outside the study area. While information about individuals acquiring condoms at the clinic is available, data on individuals choosing not to purchase condoms at all or on individuals acquiring condoms outside of the study area is missing. Following common practice, I thus analyze determinants of demand conditional on the decision to purchase condoms within the study area, which corresponds to purchasing condoms at a condom sales location created in the experiment, since no other sales options were available at the time of the study. Second, I restrict the number of choices for each individual. The data set includes 259 villages whose population can theoretically purchase condoms at 108 sales locations, resulting in 27,972 village-sales location pairs, most of which are not used. In order to make the data tractable, I restrict the choice sets for the individuals to include only agents within a radius of 5 kilometers from their home village. I argue this is reasonable as 95% of the actual purchases occurred within this distance. In addition, while individuals know about purchase options in their neighborhood, they may not be informed about condom agents many kilometers from their home, so that these cannot be considered as realistic alternatives to choose from. Nevertheless, I perform several robustness checks with different definitions of the choice sets. Note that restricting the choice set to all alternatives within a certain radius around an individual's home village means that the alternatives and the number of alternatives differ across individuals but are identical for individuals from the same village.[54] $S_i \subseteq J = 1, ..., 108$ denotes the individual's choice set of alternative condom sales locations as a subset of the 108 existing locations. Third, while 119 agents participated in the experiment, I mapped only 108 and consequently only information on distances to these agents is available. Excluding the unmapped locations means dropping potential alternatives from the choice sets of customers. However, it is unlikely that the unmapped agents would have been in the choice set of the individuals in the sample. As discussed in Chapter 3, the unmapped agents are located at the outskirts of the catchment areas. The villages surrounding these agents are also unmapped and hence dropped from the analysis. For the mapped villages, and thus for the individuals in the sample used, it is rather unlikely that the unmapped villages are within 5 kilometers distance. In fact, the unmapped agents only receive 8% of purchases from individuals from villages outside their area.

Finite number of alternatives. The number of condom sales locations is finite and thus, the last requirement for the choice set is fulfilled.

The resulting choice sets for a radius of 5 kilometers comprise between 2 and 15 condom sales locations with a mean of 7.3 and a median of 7 locations. The data set therefore includes

[54] Analyzing individual choice conditional on a positive choice as well as restricting the choice set to a certain distance or to alternatives that can be reached within a certain time is common practice (Gertler, Locay, and Sanderson 1987; Borah 2006; Varkevisser, Geest, and Schut 2012). The former is usually due to a lack of data on individuals deciding not to purchase or not to visit an alternative at all. However, some studies, for instance, Davis (2006) include an 'outside' option that captures the decision of 'no demand' of the individual.

29,238 observations, resulting from 3,983 individuals who have on average 7.3 condom sales locations in their choice set. Hence, the data set contains multiple observations for each individual, each observation representing one unique individual-alternative pair with the corresponding individual and alternative-specific attributes.[55]

Table 5.1 presents descriptive statistics on individual-specific and alternative-specific attributes as well as the individual choices sets. The upper panel presents individual-specific attributes, that is, attributes of the condom customers. Each condom acquisition is considered individually so that individuals purchasing condoms multiple times are also counted multiple times. Recall, however, that the estimated share of repeat customers is very low at 5% (Section 3.5). Accordingly, on average, an individual purchasing condoms is 26 years old, 86% of the individuals are male and 57% report they have had multiple sexual partners in the 12 months prior to the survey. The middle panel presents descriptive statistics of all $J = 1, ..., 108$ condom sales locations. Roughly a third of the agents sells condom at 100, 50, and 25 ngwee, respectively. The agents are on average 33 years old and 58% are male. Ultimately, the lower panel of the table presents descriptive statistics for the individual choice sets. More precisely, it presents the descriptive statistics of the alternative condom sales locations in an individual's choice set, $S_i \subseteq J = 1, ..., 108$, averaged over all individuals. The average alternative-specific attributes in the choice set including price, agent's sex, and agent's age are similar to the averages over all 108 alternatives, pointing to a balanced distribution of agent characteristics.[56] Most interestingly, the average distance from the individual's home village to the condom sales locations in the choice set is approximately 2.6 kilometers, which is roughly half of the distance defining the choice set of 5 kilometers. The variation, however, is substantial: the average distance from the individual's village to the sales location in the choice set varies between 500 and 4,400 meters.

[55]The estimation of MMNL models in Stata requires the data to be in long format, that is, for every individual, each alternative is one observation.

[56]For illustration, remote agents are less often represented in individual choice sets as they are less likely to be within 5 kilometers distance of individuals. If remote agents were, for illustration, predominantly female or older, the mean of these attributes in the choice sets averaged over all individuals would deviate stronger from the mean over the agents, indicating an unbalanced spatial distribution of agents according to their characteristics.

TABLE 5.1: Descriptive Statistics on Individuals and Condom Sales Locations

	Mean	Median	Min	Max	N
Individual-specific attributes					
Age of individual (in years)	26.0	25.0	11.0	70.0	3,857
Female individual (in percent)	13.8				3,974
Multiple partners (in percent)	56.6				3,665
Alternative-specific attributes					
Price P_{100} (in percent)	32.4				108
Price P_{50} (in percent)	35.2				108
Price P_{25} (in percent)	32.4				108
Age of agent (in years)	32.9	32.0	20.0	62.0	108
Female agent (in percent)	41.7				108
Individual choice sets					
Distance from individual to sales location (in 100m)	25.6	25.4	5.1	44.1	3,983
Price P_{100} (in percent)	34.2				3,983
Price P_{50} (in percent)	33.9				3,983
Price P_{25} (in percent)	31.9				3,983
Age of agent (in years)	33.3	32.5	23.0	48.0	3,983
Female agent (in percent)	45.3				3,983

Notes: Descriptive statistics of mapped individuals who purchased condoms (individual-specific attributes), mapped condom sales locations (alternative-specific attributes), and individual choice sets. All variables except *Age of individual*, *Age of agent*, and *Distance from individual to sales location* are binary variables. Individual choice sets vary by individual as they include all condom sales locations within 5 kilometers distance of the individual's home village (mean number of alternatives in choice set is 7.3 and the range is 2 to 15).

5.4 Mixed Multinomial Logit Results

5.4.1 Main Results

Table 5.2 presents the results of the MMNL model of condom sales location choice in a nested manner. Model (1) includes the agent's condom price in terms of indicator variables with P_{100} as the reference category as well as the distance measured in 100 meters from the individual's home village to the condom sales location. Model (2) replaces the continuous distance variable by distance categories of one kilometer width, where the category of 0 to 1 kilometer distance serves as the reference category. This allows to investigate a potential reverse effect of distance on location choice as distance increases: individuals may prefer a moderate distance for purchasing condoms as compared to very close to their home village to find confidentiality, but their willingness-to-travel may decrease as the distance becomes larger. Model (3) adds a binary variable indicating whether the condom agent is located in the same village as the individual, or in other words, whether the distance to the agent is zero or not. Theoretically, an agent in the same village can have a particularly strong effect on an individual's choice in both directions: on the one hand, an agent located in the home village represents the most convenient option to purchase condoms for an individual in terms of distance. On the other hand, given the small size of the villages in the area and the fact that everybody knows each other, this option may also be the least confidential. In the last step, Model (4) includes the sales agent's sex and age to investigate individual preferences for certain characteristics of a condom agent.[57] The upper panel of Table 5.2 depicts estimated mean coefficients while the lower panel depicts standard deviations of the coefficients.

The results show that economic costs including both, condom price and travel costs, are decisive determinants of condom purchase behavior. Throughout the different model specifications, the mean coefficients of the price indicator variables suggest a statistically significant positive effect of lower prices on purchase probability, while the distance variables indicate a statistically significant negative effect of larger distances on purchase probability. Accordingly, individuals are significantly less likely to choose sales locations that offer condoms at higher prices as well as sales locations that are located further away from their home village. Models (2) to (4), which include the distance categories instead of the continuous distance variables, emphasize the highly significant negative effect of distance on purchase probability. Compared to the reference category of 0 to 1 kilometer distance, the negative effect of distance on the probability of choosing a condom sales location becomes larger for further distances, highlighting the clear preferences of individuals to purchase condoms in close proximity and therewith the preference for convenience rather than the search for confidentiality further from home. Models (3) and (4) additionally show that living in the same village as a condom agent has a significant positive effect on the probability of choosing this location to purchase condoms. While economic costs thus clearly affect the probability of an individual choosing a sales location, other than expected, demographic characteristics of the condom agents do not seem to influence individual choice given that the mean coefficients of agent's sex and age are not statistically different from zero in Model (4).

[57]The model is estimated using the *mixlogit* command in Stata described in Hole (2007). 400 Halton draws are made for the simulation of the choice probabilities.

TABLE 5.2: Mixed MNL - Condom Sales Location Choice

	(1)	(2)	(3)	(4)
Mean				
Price 50 (P_{50})	0.4716**	0.3861*	0.3569**	0.3429**
	(0.1828)	(0.2132)	(0.1557)	(0.1499)
Price 25 (P_{25})	0.6071***	0.6640***	0.4927**	0.4889**
	(0.1853)	(0.2188)	(0.1949)	(0.1935)
Distance in 100 meters	−0.2206***			
	(0.0312)			
Distance 1-2 kilometers		−2.3546***	−1.7891***	−1.7727***
		(0.4432)	(0.3060)	(0.2986)
Distance 2-3 kilometers		−3.7336***	−2.6435***	−2.6316***
		(0.9328)	(0.3215)	(0.3238)
Distance 3-4 kilometers		−5.8152***	−4.5236***	−4.5286***
		(1.4663)	(1.2842)	(1.3404)
Distance 4-5 kilometers		−6.6109***	−4.4409***	−4.3615***
		(1.7039)	(1.5497)	(1.5889)
Agent in village			3.7833**	3.7402**
			(1.5658)	(1.6190)
Female agent				0.1003
				(0.1214)
Agent's age				0.0014
				(0.0095)
Std. deviation				
Price 50 (P_{50})	0.5974	1.3545*	0.0187	0.0180
	(0.9889)	(0.7276)	(0.0303)	(0.0302)
Price 25 (P_{25})	0.4135	1.0868*	0.6969	0.6653
	(1.0130)	(0.5662)	(0.6674)	(0.6868)
Distance	0.1367***			
	(0.0266)			
Distance 1-2 kilometers		0.0270	0.0054	0.0105
		(0.0384)	(0.0785)	(0.1155)
Distance 2-3 kilometers		1.6381	0.0528	0.0557
		(1.0075)	(0.1555)	(0.1845)
Distance 3-4 kilometers		2.4429**	1.9002*	1.9200*
		(1.0079)	(1.0976)	(1.1488)
Distance 4-5 kilometers		2.7914**	1.2164	1.1310
		(1.1907)	(1.5564)	(1.6922)
Agent in village			5.9192**	5.8413**
			(2.4098)	(2.5003)
Female agent				0.0735
				(0.0910)
Agent's age				0.0008
				(0.0013)
N	29,238	29,238	29,238	29,238

Notes: Observations include all condom sales locations within 5 kilometers distance (each observation is a unique individual-alternative pair). Binary dependent variable equals 1 for chosen alternative and 0 otherwise for each individual. Binary variables P_{50} and P_{25} indicate condom price at respective location (reference category: P_{100}). Binary variables *Agent in village* and *Female agent* indicate that the agent sells in the customer's home village and that the agent is female. Distance is measured in 100 meters or in 1,000 meters distance categories (reference category: *Distance 0-1 kilometer*). Standard errors in parentheses are clustered at the level of the customer's village. Indicated significance is $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

The standard deviations of the coefficients depicted in the lower panel of Table 5.2 provide information on whether preferences for attributes of the sales locations vary across individuals. With respect to price, preferences do not vary significantly throughout the different specifications. For distance, the standard deviation is significant for the continuous variable in Model (1) as well as for the distance category of 3 to 4 kilometer width in Models (2) to (4). Based on the estimated mean and standard deviation of the random distance coefficient estimated in Model (1) and the assumption that they are normally distributed, I calculate the shares of the population that place a positive and negative value, respectively, on distance.[58] I calculate that 95% of the individuals have a negative distance coefficient and thus place a negative value on distance. The significant mean and standard deviation of the variable indicating whether the agent lives in the same village as the customer in Model (4) suggest that 74% of the individuals have a positive coefficient on this variable. This means that for a fourth of the individuals, the probability of choosing an agent decreases if this agent lives in the same village. In sum, while these results suggest that some individuals do, in fact, prefer to purchase condoms outside their home village, overall, the standard deviations confirm the interpretation above that potential preferences for purchasing further from home in a more anonymous location are largely outweighed by preferences for proximity and convenience. The significant standard deviation of the distance variables may thus indicate that preferences differ across individuals in strength but rather not in direction.

To assess the magnitude of the effects found to be statistically significant in Table 5.2, I calculate marginal effects. More precisely, based on the coefficient estimates from Model (4), I estimate own marginal effects that capture the change in the predicted probability of choosing alternative j that results from changing one attribute of alternative j while holding the other attributes of alternative j as well as all attributes of the other alternatives constant.[59] This means a change from zero to one for indicator variables and a one unit increase for continuous variables. For example, for P_{50}, I consider the change in the predicted probability of choosing an agent when the price of this agent decreases from 100 ngwee (the reference category) to 50 ngwee. Note that a change in an attribute of alternative j does

[58]The share is given by $\Phi(z)$ where Φ is the standard normal cumulative distribution function and $z = mean/standard\,deviation$.

[59]The term 'own' marginal effect shall emphasize that the marginal effect under consideration is the change in the predicted probability of choosing alternative j when changing one attribute of *this* alternative j as opposed to the change in the predicted probability of choosing alternative j when changing one attribute of *another* alternative k with $\forall k \neq j$.

not only change the predicted probability of choosing alternative j but also the predicted probabilities of choosing any other alternative in the choice set as for every individual, the predicted probabilities of the alternatives in the choice set add up to one. Marginal effects are depicted in Table 5.3. The upper panel of the table presents the marginal effects averaged over the closest alternative only, that is, it indicates how the probability of choosing the closest sales agent changes when the attributes of this location change. I thereby focus on the price variables only and do not present results for the distance variables. This is because a change in distance by at least one category of one kilometer width of the closest alternative is likely to change the distance ranking of the alternatives, rendering an interpretation of the effects on the (previously) closest alternative misleading. The lower panel presents the own marginal effects averaged over all alternatives for both, price and distance indicator variables. Note that for the closest alternatives, changing the distance category from the reference category *Distance 0-1 kilometer* to more distant categories also implies that the variable *Agent in village* is set to zero when calculating marginal effects.

The marginal effects highlight the economic significance of condom price and travel costs in choosing sales locations. The predicted probability of purchasing condoms at the closest location, which is on average 310 meters away from the individual's home, is 63.2%. It decreases rapidly with increasing distance rank: 19.4% for rank 2, 8.9% for rank 3, 3.7% for rank 4, and 2.4% for rank 5 (not shown), indicating a strong preference for proximity. Regarding the marginal effects, the upper panel of the table shows that the predicted probability of purchasing at the closest agent increases from 57.7% when this agent sells at 100 ngwee (reference category) by 3.9 percentage points when the price decreases to 50 ngwee and by 5.5 percentage points when the price decreases to 25 ngwee. The lower panel shows that averaged over all alternatives, the probability of purchasing at an agent increases from 12.1% at 100 ngwee by 1.7 percentage points for a decrease to 50 ngwee and by 2.5 percentage points for a decrease to 25 ngwee. In relative terms, the changes in probability due to price changes are larger when averaged across all alternatives than when averaged over the closest alternative only: the probability of choosing the closest agent increases by 6.8% when the price decreases from 100 to 50 ngwee and by 9.6% when the price decreases from 100 to 25 ngwee, while the respective figures are 13.9% and 21.0% when averaged over all alternatives. This indicates the role of distance in choosing a sales location: individuals are willing to pay more to purchase close to home. In this regard, the results indicate a

TABLE 5.3: Marginal Effects on Condom Sales Location Choice

	Mean	Std. dev.	Min	Max	N	Mean ref. cat.
Effects averaged over the closest alternative						
Price 50 (P_{50})	0.0393	0.0249	0.0056	0.0851	3,983	0.5766
Price 25 (P_{25})	0.0551	0.0355	0.0045	0.1218	3,983	
Effects averaged over all alternatives						
Price 50 (P_{50})	0.0168	0.0203	0.0006	0.0851	29,238	0.1212
Price 25 (P_{25})	0.0254	0.0295	0.0006	0.1221	29,238	
Distance 1-2 km	−0.1976	0.1409	−0.6255	0.0158	29,238	0.3078
Distance 2-3 km	−0.2459	0.1724	−0.6734	−0.0518	29,238	
Distance 3-4 km	−0.2775	0.1997	−0.7467	−0.0536	29,238	
Distance 4-5 km	−0.2857	0.2053	−0.7700	−0.0551	29,238	

Notes: Own marginal effects: effects on choice probability of choosing condom sales location j when respective attribute of j changes (holding other attributes fixed). Changes are from zero to one as all variables are binary. Upper panel depicts average results for the closest alternative. Lower panel depicts effects averaged over all alternatives. Last column indicates the mean predicted probability for the reference categories *Price* 100 and *Distance 0-1 kilometer*, respectively. 400 Halton draws were used for the simulation.

substantial negative effect of distance on location choice: the predicted probability of choosing a sales location decreases continuously with increasing distance from the individual's home. Compared to the reference category of 0 to 1 kilometers and a predicted probability of 30.8%, the probability of purchasing at a location decreases by 19.8 percentage points for 1 to 2 kilometers, by 24.6 percentage points for 2 to 3 kilometers, by 27.8 percentage points for 3 to 4 kilometers, and by 28.6 percentage points for 4 to 5 kilometers.

To analyze variations in preferences that are linked to observable characteristics of the individual, I expand the model by individual-specific characteristics. Results are presented in Table 5.4. Following common procedure, I include the individual-specific characteristics as interactions with alternative-specific attributes. In addition to the variables analyzed in Table 5.2, Model (1) includes an interaction term of the continuous distance variable and a binary variable indicating a female customer, and an interaction term of the distance variable and a binary variable indicating a customer with multiple sexual partners. The coefficients of these interaction terms reveal whether the effects and thus preferences for distance differ for individuals who have stronger reasons to hide condom purchase and thus are likely to seek more privacy: women and individuals with risky sexual behaviors as proxied by having multiple partners. To investigate differences in preferences for the sex of the condom agent between men and women, Model (2) includes an interaction term of female agent and female customer. Ultimately, Model (3) additionally interacts the age of the condom agent with a binary variable indicating a young customer between the age of 11 and 26 years to analyze individual preferences for the age of the condom agent by own age.

The regression results confirm that individuals are significantly less likely to choose condom sales locations with higher prices and further away from home as the mean coefficient estimates of the price and distance variables are highly significant in all specifications. In addition, the results provide evidence that preferences for distance differ across individuals: the significant positive coefficient estimate of the interaction term between distance and having multiple sexual partners in all model specifications indicates that the negative effect of distance on condom sales location choice is smaller in magnitude for individuals with multiple partners, suggesting that they are somewhat less reluctant to travel than individuals with only one or no partner. While the effect of distance remains negative also for those with multiple partners, indicating that overall, they also prefer proximity when purchasing condoms, this finding is in line with the hypothesis that they are somewhat more willing to travel in order to find confidentiality. As indicated by the insignificant coefficient estimate of the interaction term *Distance*female customer*, the effect of distance does not differ by sex, indicating that the preferences for proximity are not different between men and women.

Furthermore, whereas the basic specification suggested that demographic characteristics of the condom sales agents do not affect sales location choice of individuals, the inclusion of interaction terms provides strong evidence that heterogeneous preferences for agent characteristics do exist. Most striking are the heterogeneous preferences with respect to the agent's sex between male and female customers. Overall, the agent's sex does not significantly affect condom sales location choice as indicated by the insignificant coefficient estimate of the binary variable *Female agent* in Model (1). However, the positive coefficient estimate of the interaction term *Female agent*female customer* is highly significant and of substantial magnitude in Models (2) and (3). This indicates that women have a clear and strong preference to purchase condoms from female agents while men are indifferent regarding the sex of the agent. Moreover, while the age of the condom agent does not significantly affect condom sales location choice overall (see Models (1) and (2)), there is a significant negative effect of the interaction term *Agent's age*young customer* in Model (3). This indicates that for young individuals between 11 and 26 years of age, the probability of choosing a location decreases with increasing age of sales agent at the respective location.

TABLE 5.4: Mixed MNL - Condom Sales Location Choice, Individual Attributes

	(1)	(2)	(3)
Mean			
Price 50 (P_{50})	0.4364**	0.4255**	0.3949**
	(0.1765)	(0.1860)	(0.1722)
Price 25 (P_{25})	0.6094***	0.5920***	0.6041***
	(0.1996)	(0.2104)	(0.2071)
Agent in village	2.0031	1.7109	1.5073
	(1.3878)	(1.1382)	(1.1136)
Distance in 100 meters	−0.1992***	−0.2070***	−0.2013***
	(0.0337)	(0.0370)	(0.0338)
Distance*female customer	−0.0324	−0.0318	−0.0240
	(0.0215)	(0.0207)	(0.0257)
Distance*multiple partners	0.0223*	0.0214*	0.0256**
	(0.0114)	(0.0123)	(0.0129)
Female agent	0.0619	−0.1198	−0.1952
	(0.1351)	(0.1321)	(0.1280)
Female agent*female customer		1.7331***	1.7274***
		(0.3418)	(0.3338)
Agent's age	−0.0055	−0.0058	0.0124
	(0.0079)	(0.0079)	(0.0090)
Agent's age*young customer			−0.0387***
			(0.0126)
Std. deviation			
Price 50 (P_{50})	0.0015	0.0001	0.0345
	(0.0412)	(0.0426)	(0.0515)
Price 25 (P_{25})	0.3390	0.4901	0.5129
	(1.2655)	(0.9127)	(0.8831)
Agent in village	4.8807*	4.5026**	3.8780*
	(2.5289)	(2.1885)	(2.2602)
Distance in 100 meters	0.1205***	0.1258***	0.1133***
	(0.0308)	(0.0331)	(0.0254)
Distance*female customer	0.0083	0.0049	0.0268
	(0.0233)	(0.0160)	(0.0418)
Distance*multiple partners	0.0147	0.0212	0.0014
	(0.0120)	(0.0140)	(0.0077)
Female agent	0.0959	0.3448	0.2395
	(0.2446)	(0.5565)	(0.7319)
Female agent*female customer		0.0480	0.0195
		(0.1915)	(0.1953)
Agent's age	0.0014	0.0024	0.0021
	(0.0021)	(0.0036)	(0.0038)
Agent's age*young customer			0.0007
			(0.0039)
N	26,749	26,749	26,039

Notes: Observations include all condom sales locations within 5 kilometers distance (each observation is a unique individual-alternative pair). Binary dependent variable equals 1 for chosen alternative and 0 otherwise for each individual. Binary variables P_{50} and P_{25} indicate condom price at respective location (reference category: P_{100}). Binary variables *Agent in village* and *Female agent* indicate that the agent sells in the customer's home village and that the agent is female. Distance is measured in 100 meters. Alternative-specific attributes are interacted with the individual-specific attributes female, having multiple partners, and being young (11 to 26 years). Standard errors in parentheses are clustered at the level of the customer's village. Indicated significance is *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Again, I calculate marginal effects to assess the magnitude of the statistically significant coefficients in Model (3) of Table 5.4. I calculate own marginal effects that capture the change in the predicted probability of choosing alternative j that results from changing one attribute of alternative j while holding the other attributes of alternative j as well as all attributes of the other alternatives constant. For the indicator variables, this means a change from zero to one. For instance, the marginal effect of *Female agent* captures the difference in choice probability between female agents compared to male agents. For continuous variables, the considered change is a one unit increase, for instance, an additional 100 meters distance between individual and agent or an additional year of age of the condom agent. While for the alternative-specific attributes, the change is only for alternative j and the attributes are held constant for all other alternatives (as in Table 5.3 based on the simple specification), the interaction terms with the individual-specific attributes change for all attributes. For illustration, the interaction term *Female agent * female customer* changes from male customer to female customer for all alternatives in a choice set because the sex of the individual is the same for all alternatives.

Marginal effects are set out in Table 5.5. Similar to above, the upper panel of the table presents the average effects for the closest agent only, while the lower panel presents the effects averaged over all alternatives. Accordingly, the probability of choosing the closest agent increases by 4.4 percentage points (from 59.4% to 63.8%) when the price of the closest location decreases from 100 ngwee to 50 ngwee, and by 6.7 percentage points (from 59.4% to 66.1%) when the price of the closest location decreases from 100 ngwee to 25 ngwee. These effects are similar in magnitude to the marginal effects derived from the basic specification. The marginal effects for the distance variables are interpreted as follows: for individuals with only one or no sexual partner in the last 12 months, the probability of purchasing condoms at the closest agent is 64.6%. It decreases by 2.1 percentage points for every 100 meters increase. For individuals with multiple sexual partners in the past year, the probability of choosing the closest agent is slightly smaller at 62.1% (not shown) and as indicated by the calculated marginal effect on the interaction term *Distance*multiple partners*, it decreases slightly less compared to individuals with only one or no partner, that is, by 1.9 percentage points for every additional 100 meters distance ($-0.0214 + 0.0023 = -0.0191$). As already indicated by the regression results, the largest differences by individual characteristics are found with respect to preferences for the condom agent's sex between male and female customers. The marginal effects calculated for *Female agent* in combination with the interaction effect *Female agent*female customer* indicate the following. For men, the predicted probability of choosing the closest condom agent if this agent is male is 64.1%. The effect of a female agent on choice probability for male customers in not statistically significant (see Table 5.4). For female customers, the probability of choosing the closest condom agent given that this agent is male is 55.2% (not shown). It increases by considerable 16.4 percentage points when the closest agent is female, that is, to 71.6% ($-0.0221+0.1865 = 0.1644$). With respect to the agent's age, I find a small effect on young customers. For individuals between 11 and 26 years, the probability of choosing the closest agent decreases by 0.3 percentage points for every year of age of the condom agent ($0.0014 - 0.0043 = -0.0029$).

The effects averaged over all alternatives are presented in the lower panel of the table. Starting from a predicted probability of 12.0 % at 100 ngwee, changing the condom price to 50 ngwee increases the probability that an individual chooses this agent by 1.8 percentage points. For a price reduction from 100 ngwee to 25 ngwee, the probability increases by 2.9 percentage points. Again, these figures are very similar to those calculated based on the simple specification. Regarding the marginal effects of distance, a 100 meters increase in the distance between an individual and the condom agent reduces the probability of choosing this agent by 0.8 percentage points for individuals with one or no sexual partner and by 0.7 percentage points for individuals with multiple partners ($-0.0076 + 0.0007 = -0.0069$), confirming that the latter are slightly less sensitive to distance changes. For women, the probability of choosing a sales location increases by 7.2 percentage points if the agent is female instead of male ($-0.0095 + 0.0811 = 0.0716$) while men are not affected by the condom agents' sex. Relating the 7.2 percentage points increase for women for a female agent instead of a male agent to the decrease in probability for every additional 100 meters distance (assuming a linear relation) suggests that women would accept up to 900 meters additional distance in order to find a female condom agent. For young individuals between 11 and 26, the probability of choosing an agent decreases by 0.1 percentage points for every year of age of the condom agent ($0.0006 - 0.0019 = -0.0013$).

In sum, the results show that individuals are very sensitive to distance and prefer convenience rather than confidentiality. However, condom sales agent's characteristics also play a crucial role, in particular, women have a very strong preference to purchase condoms from female agents.

TABLE 5.5: Marginal Effects on Condom Sales Location Choice, Individual Attributes

	Mean	Std. dev.	Min	Max	N	Mean ref. cat.
Effects averaged over the closest alternative						
Price 50 (P_{50})	0.0442	0.0250	0.0026	0.0963	3,546	0.5941
Price 25 (P_{25})	0.0668	0.0388	0.0030	0.1406	3,546	
Distance in 100 meters	−0.0214	0.0153	−0.0502	0.0002	3,546	0.6460
Distance*multiple partners	0.0023	0.0022	−0.0009	0.0064	3,546	
Female agent	−0.0221	0.0130	−0.0487	−0.0018	3,546	0.6408
Female agent*female cust.	0.1865	0.1021	0.0141	0.3906	3,546	
Agent's age	0.0014	0.0008	0.0001	0.0031	3,546	0.6329
Agent's age*young cust.	−0.0043	0.0025	−0.0092	−0.0002	3,546	
Effects averaged over all alternatives						
Price 50 (P_{50})	0.0182	0.0220	0.0004	0.0963	26,039	0.1196
Price 25 (P_{25})	0.0293	0.0341	0.0007	0.1464	26,039	
Distance in 100 meters	−0.0076	0.0125	−0.0507	0.0004	26,039	0.1362
Distance*mult. partners	0.0007	0.0015	−0.0009	0.0064	26,039	
Female agent	−0.0095	0.0113	−0.0497	−0.0002	26,039	0.1404
Female agent*female cust.	0.0811	0.0942	0.0023	0.3940	26,039	
Agent's age	0.0006	0.0007	0.0000	0.0031	26,039	0.1362
Agent's age*young cust.	−0.0019	0.0022	−0.0093	0.0000	26,039	

Notes: Own marginal effects: effects on choice probability of choosing condom sales location j when respective attribute of j changes (holding other attributes fixed). Changes are from zero to one for binary variables and a one unit change for continuous variables. Changes of individual-specific attributes apply to all observations. Upper panel depicts average results for the closest alternative. Lower panel depicts effects averaged over all alternatives. Last column indicates the mean predicted probability for the category *Price 100*, for the category *No or one sexual partner* (at the mean distance), for the category *Male agent*male customer*, and for the category *older customers* (at the mean agent's age). 400 Halton draws were used for the simulation.

5.4.2 Robustness Check

In the following, I perform two robustness checks that concern the definition of the individuals' choice sets. The design of the randomized experiment made use of the preexisting system of community health volunteers by assigning them the task of selling condoms from their homes at community level. Consistent with their scope of responsibility as community health volunteers, they were initially assigned to cover the few villages located around their home village. Before the condom sales activities started, the individuals in the study area were officially informed by the village head men during a village meeting about the one condom agent serving their village. The fact that individuals also purchase condoms at other agents confirms that they were aware of other options besides the one agent responsible for their village. Nevertheless, a concern may be that not all individuals were aware of other sales locations, and hence, did not consider them as alternatives in their choice sets. The restriction made for the analysis, namely that the choice sets are limited to the sales locations within 5 kilometers distance of the individual's home village, increases the probability that the individuals were aware of the alternatives. Nevertheless, I investigate in how far the empirical results are sensitive to the definition of the individual choice sets by means of the following to robustness checks. First, I repeat the MMNL regression for a reduced number of individuals who, as explained below, are more likely to know about alternative sales locations and second, I reduce the choice set to include only alternatives all individuals are more likely to know about, that is, all alternatives within a 3 kilometers distance of the individual's home village instead of 5 kilometers.

Table A5.1 in the Appendix shows the MMNL regression results for a reduced sample of individuals. More precisely, I exclude the purchase incidences that were made in the first month of the experiment, which reduces the number of individuals by approximately 18%. I argue that while information about other condom sales locations may not have been available immediately after sales activities started, the word of community health volunteers selling condoms in the area spread over time and individuals became increasingly informed. Results are virtually unchanged, both, in statistical significance as well as in magnitude.

Table A5.2 in the Appendix presents the results for the reduced choice sets. Restricting the individual choice sets to sales alternatives that are located within 3 kilometers instead of 5 kilometers distance of the individual's home village reduces the range of condom sales locations to 1 to 9 as compared to 2 to 15. For 258 individuals, the reduction of distance leads to the situation of having only one alternative in the defined choice set. Yet, choice sets that consist of only one alternative do not provide information on determinants of individual choice behavior and therefore do not enter the MMNL estimation.[60] Overall, the reduction of the choice set and the exclusion of individuals facing a single choice reduces the number of observations in the estimation by approximately 50%. The results are very similar to those provided by the regression based on 5 kilometers distance choice sets. With the exception of the coefficients on price 50 and the interaction effect of distance and multiple partners, which are not statistically different from zero with the reduced choice sets, direction and significance of the coefficient estimates are unchanged. Overall, the magnitude of the

[60] Individuals facing a single choice are automatically dropped with the mixlogit command in Stata.

coefficients is also very similar; however, some coefficients are slightly larger when choice sets are limited to 3 kilometers radius, suggesting that the size of the coefficients is, in fact, somewhat sensitive to the definition of the choice sets. In particular, the negative effect of distance is stronger with 3 kilometer radius choice sets. This is plausible as restricting the choice set to 3 kilometers distance excludes purchases conducted at distances beyond 3 kilometers distance and hence those individuals that exhibit a preference to purchase further from home. The predicted probability of purchasing condoms at the closest agent is 68% compared to 63% estimated for 5 kilometer radius and the decrease in probability for every 100 meters is 2.7 compared to 2.1. However, given that 10% of the purchase incidences are excluded from the analysis, the 5 kilometers distance analysis is preferred.

5.5 Results Discussion

The provision of health goods and services to poor and sparsely populated areas has been an ongoing challenge for governments of developing countries. Visiting dispersed health clinics, pharmacies, and markets is associated with substantial monetary and opportunity costs of travel for the population in remote areas, often aggravated by insufficient means of transport and poor road conditions. A large body of research has shown that geographical distance is a major barrier for accessing health care in rural areas of developing countries with adverse effects on the population's health (Tanser, Gijsbertsen, and Herbst 2006; Thornton 2008; Schoeps et al. 2011; Kumar, Dansereau, and Murray 2014; McLaren, Ardington, and Leibbrandt 2014).

While economic costs of acquisition are the prime focus of the analysis of demand for standard goods and services, this study argues that due to the psychological costs associated with the acquisition of condoms, attributes of condom sales locations related to confidentiality are crucial factors in individual decision-making regarding where to purchase condoms. In particular in Sub-Saharan African contexts with high HIV prevalence rates, where condoms are associated with disease and traditional gender roles discriminate against women acquiring condoms or demanding their use, individuals may have heterogeneous preferences for certain characteristics that seem conducive to their wish to hide their purchase and avoid rumors about their sexual behavior. In particular, while the distance between a consumer and the place of acquisition of a good or service is commonly only considered a cost for the consumer, the particularity of condoms as a good being used during sexual intercourse may give rise to the situation in which a consumer values greater distances in exchange for confidentiality.

In this study, I investigate the importance of economic and psychological costs in choosing condom sales location in rural Zambia by means of a discrete choice model derived under the assumption of utility-maximizing behavior of the individual. The model specifies condom sales location choice to be determined by a combination of alternative-specific and individual-specific attributes. I use a unique data set that combines data on condom sales and customers from a randomized field experiment and GPS data on the distribution of the sales locations and the customers. More precisely, the data from the experiment provides demographic characteristics of the condom agents, that is, on alternative-specific attributes, and on the condom customers, that is, on individual-specific attributes. The geographic positioning of the villages additionally allows to calculate the distance from an individual's home village to every alternative condom sales location. To account for potential heterogeneity in preferences of the individuals that are based on observed and unobserved factors, I estimate the effects of alternative and individual-specific attributes on the probability of choosing a condom sales location by means of a mixed multinomial logit model.

I find that overall, economic costs, including price and distance between the consumer and the condom agent, have a substantial negative effect on the probability of choosing a condom sales location. Individuals are significantly less likely to choose agents selling condoms at higher prices as well as agents located further away from the individuals' home village. More precisely, the predicted probability of purchasing condoms at the closest agent when this agent sells at 100 ngwee is 59.4%. It increases by 4.4 percentage points and 6.7 percentage points when the price decreases to 50 ngwee or 25 ngwee, respectively. Regarding the effect of costs associated with travel, the probability of choosing the closest agent decreases by about 2.1 percentage points for every additional 100 meters. While I find some evidence that preferences with respect to distance vary across individuals—customers with multiple sexual partners, for instance, are somewhat less sensitive to distance—overall, individuals purchasing condoms have a very pronounced preference for close proximity.

Nevertheless, the results provide strong support for heterogeneous preferences of certain attributes of the condom sales agents, indicating that costs other than of economic nature are of crucial importance in condom sales location choice. In particular, I find that women have a clear and strong preference to purchase condoms from other women. The probability that a woman purchases condoms at the closest agent increases by 16.4 percentage points if this agent is female instead of male. Averaged over all alternatives, the increase is 7.2 percentage points. Relating this estimate to the distance effect suggests that a woman would accept up to 900 additional meters in order to find a female condom agent. This is consistent with the hypothesis that traditional gender roles which associate women acquiring condoms with being ill, unfaithful, or sex workers, hinders women from purchasing condoms and suggests that they expect to find greater understanding and higher confidentiality from other women. In addition, I find that younger individuals have a preference for younger agents, indicating that they feel more comfortable to purchase from peers.

The study provides valuable policy-relevant information. The results confirm the need to provide condoms close to where the population lives and at affordable prices in order to increase condom coverage and therewith health benefits among the population. Besides geographical access to condoms, this study provides rigorous evidence on the role of the seller's characteristics in affecting demand among specific population groups, especially when stigmatization of HIV and traditional gender roles persist. It emphasizes the importance to evaluate which population groups are supposed to be targeted by condom programs. The finding that female customers are strongly influenced by the sex of the condom agent, whereas men are indifferent, suggests that special focus should be placed on integrating female sellers in condom distribution programs as this would be conducive to reduce the gender discrepancy among customers and reach important risk groups such as widows.

A limitation of the study is that due to its design, which only provides data of condom customers, it only analyzes determinants of condom sales location choice of those actually purchasing condoms and thus does not provide information on the decision of whether or not to purchase condoms at all. It remains unclear, for instance, which attributes of condom sales locations keep individuals from purchasing condoms altogether. The findings that distance is a crucial factor determining condom sales location choice and that women have a strong preference to purchase from other women suggest, for instance, that women who do not have access to a female condom agent within a certain proximity of their home village may not purchase condoms at all. However, sound evidence in this regard would require survey data that also includes non-buyers. Further research based on a representative sample, which also includes the 'outside option' of not purchasing condoms at all in the choice sets would provide a more complete picture of factors influencing individual condom demand.

6 Conclusion

For the past three decades, the HIV/AIDS epidemic has characterized the disease burden in Sub-Saharan Africa, with devastating impacts in terms of human suffering and severe economic implications for affected individuals and their families. The international community has invested unprecedented resources in measures to reduce the spread of HIV and mitigate the impacts of the epidemic. In the area of HIV prevention, condom distribution programs have been a crucial component since the onset of the epidemic. With the aim of encouraging condom use by reducing the costs of acquisition for the population, substantial resources have been devoted to making condoms available at subsidized prices in outlets which are closer to the population and offer more privacy than public health clinics. However, progress has only been moderate: while condom use has increased among casual sexual partners, it remains a persistent challenge among regular sexual partners, among youths, and in rural areas.

Despite the long history of condom programs and the essential importance they are given in the international response to the HIV/AIDS epidemic, robust evidence on the effects of price, travel costs, and psychological costs on demand for condoms which could inform policy decisions and feed into the design of condom distribution programs is very limited. Motivated by the striking lack of research, this dissertation analyzes demand for condoms in rural Zambia by means of two main empirical studies, focusing on the importance of different types of costs in affecting condom purchase behavior. While the first study analyzes the effect of price on condom demand at the sales level, the second study examines the importance of travel costs and psychological costs in determining condom sales location choice on the individual level by means of a discrete choice model. The empirical analyzes of both studies are based on a unique data set which combines condom sales data from a field experiment with randomized prices and geospatial data of the study area in rural Zambia.

The main results can be briefly summarized as follows. The dissertation provides strong empirical evidence on the crucial importance of costs in determining demand for condoms. Despite large benefits of preventing an incurable disease, which are even more striking given the absence of sufficient HIV/AIDS treatment options, even small economic costs for price and travel lead to a substantial decline in condom demand among the population in rural

Zambia. In addition, psychological costs of condom acquisition have a significant influence on individual purchase behavior.

More precisely, in line with recent experimental evidence on other preventive health products, the first study of the dissertation finds that demand for condoms is highly sensitive to price even at very low prices. In comparison with recent evidence, the estimated price elasticity suggests that demand for condoms is even more sensitive to price than demand for most other preventive health products. Furthermore, the increase in the number of customers at lower prices is substantially larger than the increase in the number of condoms bought per customer, indicating that lowering prices is more effective at attracting new customers than at encouraging existing customers to purchase more condoms. With respect to price-induced selection into purchasing based on HIV risk, the effects are ambiguous. On the one hand, the share of condoms purchased by population groups with an above-average HIV prevalence increases at lower prices for groups which are known to be financially constrained, such as widows. This suggests that higher prices induce a counterproductive selection effect by screening out certain HIV risk groups. On the other hand, the share of condom sales to HIV risk groups decreases at lower prices for HIV risk groups which are not associated with being disproportionately financially constrained, including individuals with multiple sexual partners.

The second study of the dissertation confirms that economic costs are decisive determinants of condom sales location choice. In particular, the study adds strong support for the importance of distance in individual decision-making, as the probability of choosing a certain condom agent decreases significantly with increasing distance between the individual's home village and the respective condom sales location. In addition, the results reveal that individuals have heterogeneous preferences for certain characteristics of the condom agents and thus point to the significance of psychological costs in affecting demand for condoms. The preference of women to purchase condoms from female condom agents is most pronounced, which indicates that the acquisition of condoms in Zambia is shaped by traditional gender roles and affected by prejudices towards women demanding condoms. Moreover, the study finds that the negative effect of distance on sales location choice is weaker for individuals who have multiple sexual partners, which is consistent with the hypothesis that individuals with stronger reasons to hide sexual relationships are less reluctant to travel to find more privacy. Ultimately, I find that younger customers prefer to purchase condoms from younger sales agents, indicating that they expect to find higher understanding or confidentiality from peers than from older condom agents.

Beyond the evidence on the causal effects of price on condom demand obtained by means of the empirical analyses, descriptive data collected by means of the survey during the experiment provides additional indications concerning the underlying reasons for the individual purchase behavior. The finding that the number of condoms purchased per customer only increases moderately at lower prices although the demanded quantity falls short of what is needed to protect all acts of sexual intercourse during the experiment indicates that individuals have a low level of saturation with condoms. Information collected from the customers at the sales points suggests that common reasons for not using condoms are associated with the type of partnerships or more precisely, that condoms are not used if the sexual partner is the spouse or the relationship involves trust and love. This finding supports existing evidence that condom use in Sub-Saharan Africa is not consistent and mostly limited to irregular partnerships, indicating a lack of information and risk awareness regarding the fact that the majority of new HIV infections in Zambia occurs in regular partnerships. Imperfect information as well as gender roles which prevent women from acquiring condoms may also be responsible for the fact that a large part of the population does not purchase condoms at all during the experiment.

The results have several important policy implications. First, and most importantly, this dissertation reveals that the recommendation made in recent experimental studies—that preventive health products should be highly subsidized—also applies to condoms. The finding that introducing condom prices below the prevailing social marketing price leads to a substantial increase in demand for condoms, while price-induced selection effects are of minor economic importance, clearly shows that lowering prices is a highly effective instrument to increase take-up of condoms and therewith to increase health benefits. The increase in demand is especially important given the positive externalities of HIV prevention for sexual partners and, in the case of women, for unborn children. Robust evidence on the demand response to price is particularly necessary in light of the vision of many social marketing programs to create conditions closer to commercial markets by increasing prices and—not least due to fading donor support—to promote financial sustainability. The substantial size of the estimated price elasticity of demand for condoms indicates that charging higher prices does not only lead to a large decrease in demand but also does not necessarily result in higher revenues, undermining the argument of achieving higher financial sustainability by increasing prices.

Second, condoms should be provided close to where the population lives. As a result of HIV stigma and discrimination, one could assume that individuals prefer to purchase condoms further away from their home to avoid being seen by acquaintances and, as a consequence, are not particularly sensitive to distance. This dissertation provides evidence that individuals assumed to have higher psychological costs, namely individuals with multiple sexual partners, are, in fact, less reluctant to travel further to purchase condoms. This is in line with the hypothesis that they accept larger economic costs in order to reduce psychological costs. However, overall, individuals have a clear preference for geographic proximity, that is, they choose convenience over confidentiality. This emphasizes the need to reduce travel costs for the population as much as possible in order to increase take-up of condoms and the corresponding health impacts.

Third, while geographic proximity is essential to increase condom demand, as a result of psychological costs of condom acquisition, special attention has to be given to the characteristics of condom sellers as well as to the composition of the target groups of condom programs. The finding that female customers are strongly influenced by the sex of the condom agent, whereas men are indifferent, suggests that special focus should be placed on integrating female sellers in condom distribution programs as this would be conducive to reduce the gender discrepancy among condom customers. The related impact on HIV prevention is of particular significance, since female agents are especially effective at targeting widows and potentially also female sex workers, two groups with an extremely high HIV prevalence and hence risk of onward transmission. Yet, in particular with respect to psychological costs, the local context has to be taken into account in the design of condom distribution programs: depending on the prevalent gender roles and the corresponding status of women, on the level of HIV stigma and discrimination, as well as on the distribution of HIV prevalence in certain risk groups, psychological costs and, consequently, attributes of the sellers will play a different role in affecting demand for condoms in different settings.

Taking a broader perspective, the dissertation provides additional impulses for the provision of health care in developing countries in general. As the price sensitivity of demand for condoms is high, and in fact, even higher than for other preventive health products, the results emphasize the need to consider price as a barrier to acquisition also for items that do not require a large initial investment but, on the contrary, are quite inexpensive. This is especially relevant for products which have to be acquired frequently in order to be effective, as a low price may lead to the tendency to neglect that the costs multiply and, as a whole, may constitute a burden to the individual. What is more, frequently needed products also involve higher travel costs for the individual. While in other contexts, individuals could adapt to long distances by purchasing a higher quantity per visit to contain travel costs, this is difficult in low-income countries due to widespread liquidity constraints. In this regard, the distinction between the extensive and intensive margins of demand are relevant and provide valuable information about individual purchase behavior and the consistency of use. With respect to the targeting of health products to certain risk groups, by showing that the share of sales to some high-risk who are not financially constrained is higher at higher prices, this dissertation suggests that for products where health benefits are not concentrated among the poorest, charging higher prices may be, in fact, a reasonable instrument to increase the efficiency of public resource allocation. This could be relevant for some non-communicable diseases, which—although increasingly widespread also in developing countries—are not especially pronounced among the poorest. Precise information on the disease prevalence by wealth groups is of crucial importance here, however, to avoid screening out the neediest.

Ultimately, from the perspective of ensuring equity in access to condoms, the field experiment constitutes a practical example of how access to condoms can be improved for the commonly underserved populations in rural areas of developing countries by making use of the existing system of community health volunteers. Prior to the experiment, lack of access to condoms in the study area was stated as the main reason for not using condoms among those who purchased in the experiment. In the presence of tight health budgets and a lack of health staff to cover rural areas, many developing countries, including Zambia, increasingly rely on community health volunteers to provide basic health services at village level to make progress towards universal health coverage. The condom experiment led to a considerable increase in the amount of condoms acquired in the study area, providing evidence for the effectiveness of community health volunteers in improving access to and promoting take-up of condoms in rural areas. Thus, the integration of community health volunteers in condom distribution programs to create condom sales points at village level and the provision of incentives to motivate the sales activities as in the field experiment has potential to considerably contribute to the prevention of HIV/AIDS.

The strengths of the empirical analyses of this dissertation mostly originate from the rich data set used. The implementation of a field experiment allows to observe actual purchase decisions of the population and thereby avoids biases associated with simple stated preferences or willingness-to-pay surveys. Furthermore, within the scope of the field experiment, comprehensive data was collected on demographic characteristics of both, condom sales agents as well as individuals purchasing condoms. By means of an elaborate mapping procedure, geospatial data was obtained which allows to estimate distances on the road network actually used by the population. Especially in landscapes with hills, forests, and streams, this provides more accurate estimates of the opportunity costs of purchasing condoms than straight line distances. These feature of the data set lead to the following advantages. First, it allows a comprehensive descriptive analysis of the condom customers by demographic characteristics and their condom purchase behavior. With respect to the first study, which analyzes the effects of price on condom demand at agent level, the experimental data allows to identify causal effects of price on demand by creating exogenous variation in the condom price offered at the sales agents. Moreover, the exogenous variation in the price treatment of neighboring sales agents combined with the distance measures allows to control for potential spillover effects in sales between agents. The second study, which models condom sales location choice at the individual level, benefits in particular from the fact that precise and comprehensive data is available on different alternatives from the individual's point of view. More precisely, information such as distance and condom agent characteristics is available for both, the alternative the individual in fact chose but also for the other alternatives in the individual's choice set. Considering that previous studies relied on incomplete information or imputation, this is a clear asset for discrete choice models.

Nevertheless, the empirical analyses are not without limitations. First, as with every small-scale experiment, external validity of the findings is limited. While condom distribution programs exist throughout the developing world with similar challenges and research gaps, their design and the environment they operate in differ between countries or even regions. For instance, the availability and reputation of free condoms on the one hand and commercial condoms on the other hand is likely to have implications for the willingness-to-pay or willingness-to-travel. General knowledge about condoms and their preventive benefits as well as the risk of contracting HIV will further affect the willingness to bear the costs of acquiring condoms. Considering that HIV prevalence in Zambia—and hence the health benefits of condom use—is among the highest in the world, sensitivity to costs may be even larger in regions less affected by the disease. Moreover, cultural aspects and the extent of HIV-related stigma and discrimination determines the level of psychological costs and influences the impact of price and travel costs. While many countries in Sub-Saharan Africa suffer from similar challenges regarding widespread poverty, imperfect markets, poor access to services, as well as HIV-related stigma, indicating that the findings would be similar, the results should be considered keeping in mind the context of rural Zambia.

The second limitation concerns the impossibility to measure actual condom use and therewith to assess the magnitude of health benefits in terms of averted HIV infections. While this dissertation has the advantage of using actual purchase decisions rather than willingness-to-pay data, it is not observed whether the purchased condom is actually used for the intended purpose of safe sexual behavior. Studies on other preventive health products have observed actual utilization during home visits; however, this is not feasible in the case of condoms. It has been argued in the context of condoms that as soon as individuals pay for them, either in terms of a monetary price or in terms of travel costs, it can be assumed that they actually use the product due to a psychological effect. In fact, this sunk cost effect has been the primary argument against free condom distribution in order to reduce wastage of condoms. However, against the background that experimental studies on other preventive products do not find an effect of price on likelihood of utilization, this argument seems not justifiable. In particular in the case of condoms, it cannot be completely ruled out that a purchased condom is not available at the right time in the right place, or that the refusal of the partner may lead to it not being used. Hence, one has to acknowledge that a certain share of the condoms purchased will not be used. However, put differently, the lack of evidence on sunk cost effects suggests that this share of wastage will not increase at lower prices, indicating that there is a linear increase in condoms used at lower prices.

This dissertation provides valuable evidence on determinants of condom demand and therewith addresses an urgent research gap; however, unanswered questions remain, leaving room for further research. First, as regards the lack of data on actual condom use, future studies could integrate a follow-up survey into the research design in order to investigate whether the purchased condoms are actually used. While survey responses to sexual behavior have to be taken with caution given potential biases of over or underreporting, this could, nevertheless, provide valuable insights into potential barriers to condom use after acquisition.

Second, from a policy perspective, the costs per averted HIV infection at different pricing strategies would be of great interest. Such a cost-effectiveness analysis requires an assessment of the health benefits at different price levels, which, in turn, must take into account positive health externalities of HIV prevention. Further research could therefore model averted HIV infections and relate them to the costs of different pricing strategies. Third, while the dissertation contributes to the debate on health product pricing, it does not contribute to the question of whether or not the population in developing countries should pay for condoms at all. A recommendation in this respect would require to conduct an experiment which includes a zero price under otherwise the same conditions, for instance, with respect to access and privacy. In doing so, one could isolate the effect of a zero price and therewith analyze the question whether it constitutes a special threshold, by causing either a stark increase in demand due to psychological effects of receiving a product for free or a decrease due to concerns about the quality of free products. Fourth, the study provides rigorous evidence that demand for condoms can be considerably increased by lowering prices to a very low level; yet, it remains unclear how such high subsidies affect condom demand in the long run. In particular in developing countries where high subsidies and free distribution of health products are common practice, concerns exist that low prices serve as a reference point or anchor for the population, limiting their willingness to pay higher prices in the future and consequently hampering the development towards market conditions. However, on the contrary, recent evidence has shown that learning about the benefits of a health product at low prices may increase willingness-to-pay in the future, so that low prices can be used to stimulate long-term demand. The question of long-term demand is highly relevant for condoms. On the one hand, there is great potential for learning about benefits of condoms and becoming familiar with their use. On the other hand, given the long incubation time of HIV, the health benefits of condom use may not be visible enough to lead to a gradual increase in willingness-to-pay. Future research should therefore analyze condom demand over a longer period in order to generate evidence on the development of demand over time which can inform long-term strategies for condom distribution programs in developing countries. Ultimately, due to the design of the experiment, the empirical analyses are based on data of individuals who select into purchase. As a result, the determinants of condom sales location choice identified by means of the individual level analysis must be interpreted as conditional on the decision to purchase at all. From a policy perspective, it is of great interest to identify key factors which keep individuals from purchasing condoms altogether. A data set which includes non-purchasers, for instance, a representative sample, would provide a more complete picture of individual condom demand and therewith of barriers that prevent individuals from purchasing condoms.

Appendix

TABLE A2.1: Condom Use in Countries Most Heavily Affected by HIV/AIDS

Country	HIV prevalence	DHS survey	Condom use at last sex with any partner		Condom use at last sex with a non-marital, non-cohabitating partner (higher risk)		Condom use at last sex among those who had multiple partners in the last year (higher risk)	
			Female	Male	Female	Male	Female	Male
Swaziland	28.8	2006/07	36.6	48.3	53.9	67.3	55.0	55.8
Lesotho	22.7	2014	*n.a.*	*n.a.*	76.0	76.6	53.9	65.3
Botswana	22.2	*No recent data available*						
South Africa	19.2	*No recent data available*						
Zimbabwe	14.7	2010/11	14.5	26.4	57.6	77.4	48.0	33.0
Namibia	13.3	2013	*n.a.*	*n.a.*	65.5	79.7	68.1	72.2
Zambia	12.9	2013/14	14.6	24.8	41.2	55.5	29.7	29.0
Mozambique	10.5	2011	9.7	17.7	34.2	40.9	30.6	25.5
Malawi	9.1	2010	9.1	19.1	46.8	57.2	27.3	24.6
Uganda	7.1	2011	12.1	19.1	45.5	60.0	30.6	19.0

Notes: Table includes the ten countries that are most heavily affected by the HIV/AIDS epidemic worldwide in terms of adult prevalence (15 to 49 years). HIV prevalence data are UNAIDS 2015 estimates. Condom use data is from the Demographic and Health Surveys conducted in the respective countries in the indicated survey years. It was compiled in July 2016 using the STAT-compiler (http://www.statcompiler.com). *Condom use at last sexual intercourse with any partner* is not available for all countries.

FIGURE A3.1: Impressions of the Study Area in Katete, Zambia

Pictures taken by the author.

FIGURE A3.2: Survey Instrument

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Introduction and consent (read out to customer)
Organizations that help provide these condoms would like to learn about condom distribution so that they can improve access to people like you who want to acquire them. I would like to ask you some background questions and why you acquired condoms here. You do not need to talk to me if you do not want to. And you do not have to answer any question that you do not want to. I will not ask your name or write it down. This information will be kept anonymous so that no one will be able to link it to you. Also, you do not have to answer these questions to purchase condoms and your refusal will not affect your future purchases. Will you please answer these questions? Thank you.

(fill out yourself)	
1	**Condom agent's NAME**: **CODE**: |__|__|
2	**Today's date (DD – MM – YY) and time** DATE|__|__| - |__|__| - |__|__| TIME: |__|__|
3	**Sex of respondent** MALE ☐ 1 FEMALE ☐ 2
4	**Number of condoms distributed** **4a Packs**|__|__| or **4b Individual**|__|__|

(ask customer)	
5	**How old are you?** *(Record exact age in completed years)* |__|__|
6	**What is your current marital status?** NEVER MARRIED ☐ 1 SEPARATED ☐ 3 WIDOWED ☐ 5 MARRIED ☐ 2 DIVORCED ☐ 4 LIVING TOGETHER ☐ 6
7	**How many children do you have?** |__|__|
8	**What is the highest grade you completed in school thus far?** |__|__|
9	**What village do you currently live in?** *(Record name)* ________________________
10	**How long did you travel to get here? (***Record exact time in minutes)* |__|__|
11	**By what means of transport did you get here?** WALKING ☐ 1 SCOTCH CART ☐ 4 BICYCLE TAXI ☐ 7 BICYCLE ☐ 2 PUBLIC TRANSPORT ☐ 5 OTHER (SPECIFY): ☐ 8 MOTORBIKE ☐ 3 PERSONAL CAR ☐ 6 ____________________
12	**What is the main type of energy that your household uses for cooking?** COLLECTED FIREWOOD ☐ 1 COAL ☐ 5 ELECTRICITY ☐ 8 PURCHASED FIREWOOD ☐ 2 KEROSENE/ SOLAR ☐ 9 CHARCOAL OWN PRODUCED ☐ 3 PARAFFIN ☐ 6 CROP/LIVESTOCK ☐ 10 CHARCOAL PURCHASED ☐ 4 GAS ☐ 7 OTHER (specify) ☐ 11 _ ____________________

13	**What is the main type of energy used for lighting in your household?** KEROSENE/PARAFFIN ☐ 1 CANDLE ☐ 4 TORCH ☐ 7 ELECTRICITY ☐ 2 DIESEL ☐ 5 NONE ☐ 8 SOLAR PANEL ☐ 3 OPEN FIRE ☐ 6 OTHER (specify): ☐ 9 ______________________
14	**Have you acquired condoms here before?** YES ☐ 1 (→ *question 15*) NO ☐ 2 (→ *question 16*)
15	**When was the last time you acquired condoms here?** LESS THAN A WEEK AGO ☐ 1 3 – 4 WEEKS AGO ☐ 3 1 – 2 WEEKS AGO ☐ 2 MORE THAN 4 WEEKS AGO ☐ 4
16	**We will not raise your price. What is the most you are willing to pay for 1 packet of three condoms?** Price in Ngwee |__|__|
17	**What is the main reason for buying condoms?** PREVENTION OF HIV/AIDS ☐ 1 BOTH ☐ 3 PREVENTION OF PREGNANCY ☐ 2 OTHER (SPECIFY): ☐ 4 ____________________
18	**Can people reduce their chances of getting HIV by having only one uninfected sex partner who has no other sex partners?** YES ☐ 1 NO ☐ 2 DON'T KNOW ☐ 3
19	**If used every time a person has sexual intercourse, how effective do you believe condoms are for preventing HIV and AIDS?** VERY EFFECTIVE ☐ 1 NOT AT ALL EFFECTIVE ☐ 3 SOMEWHAT EFFECTIVE ☐ 2 DON'T KNOW ☐ 4
20	**How many sexual partners have you had in the last 12 months?** |__|__|
21	**The last time you had sexual intercourse, was a condom used?** YES ☐ 1 (→ *question 23*) NO ☐ 2 (→ *question 22*)
22	**If no, what was the main reason for not using a condom?**___________________________________
23	**I don't want to know the results but were you ever tested for HIV and received the results?** YES ☐ 1 NO ☐ 2
24	**What is the main reason that you buy condoms here instead of receiving free condoms at the clinic? (Condom agents only ask this question)** NOT AWARE OF FREE CONDOMS ☐ 1 NOT ENOUGH PRIVACY AT CLINIC ☐ 5 CLINIC IS TOO FAR / AGENT IS CLOSER ☐ 2 CONDOMS AT CLINIC ARE BAD QUALITY ☐ 6 CLINIC IS CLOSED WHEN I WANT CONDOMS ☐ 3 OTHER (SPECIFY): ☐ 7 NO CONDOMS AVAILABLE AT CLINIC ☐ 4 _______________________________
25	**What is the main reason that you are buying condoms here instead of buying them at a different location?** THESE CONDOMS ARE THE CHEAPEST ☐ 1 THIS LOCATION IS THE CLOSEST TO MY HOME ☐ 2 THIS LOCATION IS MORE PRIVATE THAN OTHERS ☐ 3 I AM VISITING THIS AREA ☐ 4 I DO NOT KNOW OF ANYWHERE ELSE I CAN BUY CONDOMS ☐ 5 I LIKE THE PERSON SELLING THE CONDOMS HERE ☐ 6

TABLE A3.1: Properties of Condom Sales Points and Randomization Test, Full Sample

	Total sample $N = 119$		Price 100 $N = 39$	Price 50 $N = 40$	Price 25 $N = 40$	
	mean	median	mean	mean	mean	p-value
Population in agent's village cluster	566.3	496.0	598.8	565.6	535.2	0.7915
Agent characteristics:						
Male (%)	58.8	*male*	59.0	57.5	60.0	0.9749
Age in years	33.2	33.0	32.4	34.6	32.7	0.4731
Married (%)	68.1	*married*	64.1	72.5	67.5	0.7280
Years of schooling completed	9.1	9.0	9.2	9.0	9.0	0.8389
Spatial attributes						
Travel time to clinic with bicycle (min.)	45.0	35.0	39.1	52.6	43.3	0.2888

Notes: Sample includes 119 condom sales points (agents) that existed in the field experiment. *Population in agent's village cluster* indicates the number of people living in the village cluster served by the respective condom agent. *Male* and *Married* are binary variables indicating a male and a married condom agent, respectively. *Travel time to clinic with bicycle* is for a one-way trip from the respective condom sales point (agent home) and measured by the respective agent. p-values are for the joint test of equality of means across price groups.

TABLE A3.2: Main Reason for not Using a Condom During Last Sex

Category	Frequency	Percent
Availability of condoms	(437)	(56.1)
No condoms available	266	34.2
No condom at hand	78	10.0
Clinic is too far away	49	6.3
Clinic was out of stock	21	2.7
Distance in general	12	1.5
Clinic is closed/opening hours	11	1.4
Type of partnership	(152)	(19.6)
Love, trust in partner	111	14.3
Sexual partner was wife/partner	35	4.5
Only one sexual partner	6	0.8
Information	(44)	(5.6)
No knowledge about where to find condoms	25	3.2
No knowledge/experience about how to use condoms	12	1.5
No knowledge about availability of free condoms	7	0.9
Preference for sex without condom	(39)	(5.0)
Dislike condoms/no joy with condoms	35	4.5
Partner refused to use condom	4	0.5
Time costs for condom acquisition	(28)	(3.6)
In a hurry/too busy	26	3.3
Waste of time/fear partner leaves	2	0.3
Monetary costs	(25)	(3.2)
No money/ price too high	25	3.2
Other reasons	(53)	(6.9)
Pregnancy wish	12	1.5
Too shy, afraid	11	1.4
Never had sex before	3	0.4
Other contraceptives used	2	0.3
Sex was unexpected	2	0.3
Girl was very beautiful	2	0.3
Age of woman	2	0.3
Other	19	2.4
Total	778	100.0

Notes: Main reasons for not using a condom during the last sexual intercourse among individuals acquiring condoms and reporting not to have used a condom during last sexual intercourse. Sample includes both agent customers (88.3%) and clinic clients (11.7%). Question was asked as an open question and answers were categorized afterwards.

TABLE A3.3: Main Reason for Buying Instead of Collecting Free Condoms

Main reason	Frequency	Percent
Clinic is too far / agent is closer	2705	55.17
Clinic is closed when condoms wanted	774	15.79
Not aware of free condoms	508	10.36
Not enough privacy at clinic/stigma	436	8.89
No condoms available at clinic	249	5.08
Condoms at clinic are bad/worse quality	226	4.61
Other	5	0.10
Total	4903	100.0

Notes: Sample includes individuals purchasing condoms at a condom agent during the four months of the experiment.

TABLE A4.1: Bias in the Naïve Estimator

In the following, I derive the bias in the naïve estimator that results from neglecting spillover effects. I follow Wooldridge (2002) in his demonstration of the omitted variable problem. In the data-generating process of agent condom sales in the experiment, the spillovers have additive effects on the outcome

$$Y_i = \beta_0 + \beta_1 T_{1,i} + \gamma_0 \overline{T_{1,i}} + \gamma_1 T_{0,i}\overline{T_{1,i}} + \lambda_0 \overline{T_{0,i}} + \lambda_1 T_{1,i}\overline{T_{0,i}} + u_i \tag{A4.1}$$

The naïve specification omits the spillover terms, reducing the equation to

$$Y_i = \alpha_0 + \alpha_1 T_{1,i} + v_i$$

In order to derive the probability limit of α_1, I first notate the linear projections of each omitted spillover term onto the one explanatory variable $T_{1,i}$:

$$\overline{T_{1,i}} = b_0 + b_1 T_{1,i} + q_i \tag{A4.2}$$

$$T_{0,i}\overline{T_{1,i}} = c_0 + c_1 T_{1,i} + r_i \tag{A4.3}$$

$$\overline{T_{0,i}} = d_0 + d_1 T_{1,i} + s_i \tag{A4.4}$$

$$T_{1,i}\overline{T_{0,i}} = e_0 + e_1 T_{1,i} + w_i \tag{A4.5}$$

Plugging Equations (A4.2) – (A4.5) into Equation (A4.1) yields

$$\begin{aligned} Y_i &= \beta_0 + \beta_1 T_{1,i} + \gamma_0(b_0 + b_1 T_{1,i} + q_i) + \gamma_1(c_0 + c_1 T_{1,i} + r_i) \\ &\quad + \lambda_0(d_0 + d_1 T_{1,i} + s_i) + \lambda_1(e_0 + e_1 T_{1,i} + w_i) + u_i \\ &= (\beta_0 + \gamma_0 b_0 + \gamma_1 c_0 + \lambda_0 d_0 + \lambda_1 e_0) \\ &\quad + (\beta_1 + \gamma_0 b_1 + \gamma_1 c_1 + \lambda_0 d_1 + \lambda_1 e_1) T_{1,i} \\ &\quad + (u_i + q_i + r_i + s_i + w_i) \end{aligned}$$

and the probability limit for the OLS estimator can be read off as

$$plim\ \hat{\alpha}_1 = \beta_1 + \gamma_0 b_1 + \gamma_1 c_1 + \lambda_0 d_1 + \lambda_1 e_1 \tag{A4.6}$$

The linear regression model in general matrix notation is given by $\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u}$, where $\mathbf{y}$ is the $N \times 1$ data vector of observations on the dependent variable and $\mathbf{X}$ the $N \times K$ data matrix of observations on the explanatory variables. Minimizing the sum of squared residuals provides the OLS estimator $\hat{\boldsymbol{\beta}} = (\mathbf{X'X})^{-1}\mathbf{X'y}$. In order to estimate the probability limits of the parameters $\hat{b_1}$, $\hat{c_1}$, $\hat{d_1}$, and $\hat{e_1}$, I write Equations (A4.2) – (A4.5) in the general form $q = \delta_0 + \delta_1 T_{1,i} + z$, where q is the omitted factor and $\delta = \begin{pmatrix} \delta_0 \\ \delta_1 \end{pmatrix}$. Then[61]

$$\begin{aligned}
plim\ \hat{\delta}^{RCT} &= \left(E\left[\begin{pmatrix} 1 \\ T_1^{RCT} \end{pmatrix} \begin{pmatrix} 1 & T_1^{RCT} \end{pmatrix} \right] \right)^{-1} E\left[\begin{pmatrix} 1 \\ T_1^{RCT} \end{pmatrix} q^{RCT} \right] \\
&= \begin{pmatrix} 1 & E[T_1] \\ E[T_1] & E[T_1^2] \end{pmatrix}^{-1} \begin{pmatrix} E[q] \\ E[T_1 q] \end{pmatrix} \\
&= \begin{pmatrix} \frac{E[T_1^2]}{-E[T_1]E[T_1]+E[T_1^2]} & \frac{-E[T_1]}{-E[T_1]E[T_1]+E[T_1^2]} \\ \frac{-E[T_1]}{-E[T_1]E[T_1]+E[T_1^2]} & \frac{1}{-E[T_1]E[T_1]+E[T_1^2]} \end{pmatrix} \begin{pmatrix} E[q] \\ E[T_1 q] \end{pmatrix} \\
&= \begin{pmatrix} \frac{E[T_1^2]E[q]-E[T_1]E[T_1 q]}{-E[T_1]E[T_1]+E[T_1^2]} \\ \frac{-E[T_1]E[q]+E[T_1 q]}{-E[T_1]E[T_1]+E[T_1^2]} \end{pmatrix}
\end{aligned}$$

and

$$plim\ \hat{\delta_1}^{RCT} = \frac{Cov(T_1^{RCT}, q^{RCT})}{Var(T_1^{RCT})} \tag{A4.7}$$

Using (A4.7) for Equations (A4.2) – (A4.5) allows to estimate the probability limits of the parameters $\hat{b_1}$, $\hat{c_1}$, $\hat{d_1}$, and $\hat{e_1}$:

For $q = \overline{T_1}$ (compare Equation (A4.2))

$$plim\ \hat{b_1}^{RCT} = \frac{Cov(T_1^{RCT}, \overline{T_1}^{RCT})}{Var(T_1^{RCT})} = 0 \tag{A4.8}$$

because $Cov(T_1^{RCT}, \overline{T_1}^{RCT}) = 0$ due to randomization.

[61] I neglect the superscript 'RCT' in the intermediate steps of the calculation for better readability.

For $q = T_0\overline{T_1}$ (compare Equation (A4.3))

$$
\begin{aligned}
plim\ \hat{c_1}^{RCT} &= \frac{Cov(T_1^{RCT}, T_0^{RCT}\overline{T_1}^{RCT})}{Var(T_1^{RCT})} \\
&= \frac{E[T_1^{RCT}T_0^{RCT}\overline{T_1}^{RCT}] - E[T_1^{RCT}]E[T_0^{RCT}\overline{T_1}^{RCT}]}{Var(T_1^{RCT})} \\
&= \frac{E[T_1(1-T_1)\overline{T_1}] - E[T_1]E[(1-T_1)\overline{T_1}]}{Var(T_1)} \\
&= \frac{E[\overline{T_1}](E[T_1] - E[T_1^2]) - E[T_1]E[\overline{T_1}]E[1-T_1]}{Var(T_1)} \\
&= \frac{E[\overline{T_1}](E[T_1] - E[T_1^2] - E[T_1] + E[T_1]^2)}{Var(T_1)} \\
&= -E[\overline{T_1}^{RCT}]
\end{aligned}
\tag{A4.9}
$$

For $q = \overline{T_0}$ (compare Equation (A4.4))

$$
plim\ \hat{d_1}^{RCT} = \frac{Cov(T_1^{RCT}, \overline{T_0}^{RCT})}{Var(T_1^{RCT})} = 0 \tag{A4.10}
$$

because $Cov(T_1^{RCT}, \overline{T_0}^{RCT}) = 0$ due to randomization.

For $q = T_0\overline{T_0}$ (compare Equation (A4.5))

$$
\begin{aligned}
plim\ \hat{e_1}^{RCT} &= \frac{Cov(T_1^{RCT}, T_1^{RCT}\overline{T_0}^{RCT})}{Var(T_1^{RCT})} \\
&= \frac{E[T_1^{RCT}T_1^{RCT}\overline{T_0}^{RCT}] - E[T_1^{RCT}]E[T_1^{RCT}\overline{T_0}^{RCT}]}{Var(T_1)^{RCT}} \\
&= \frac{E[\overline{T_{0,i}}]E[T_1^2] - E[T_1]E[T_1]E[\overline{T_0}]}{Var(T_1)} \\
&= \frac{E[\overline{T_{0,i}}](E[T_1^2] - E[T_1]^2)}{Var(T_1)} \\
&= E[\overline{T_0}^{RCT}]
\end{aligned}
\tag{A4.11}
$$

Plugging the results from Equations (A4.8) – (A4.11) into Equation (A4.6) provides the probability limit of $\hat{\alpha}$

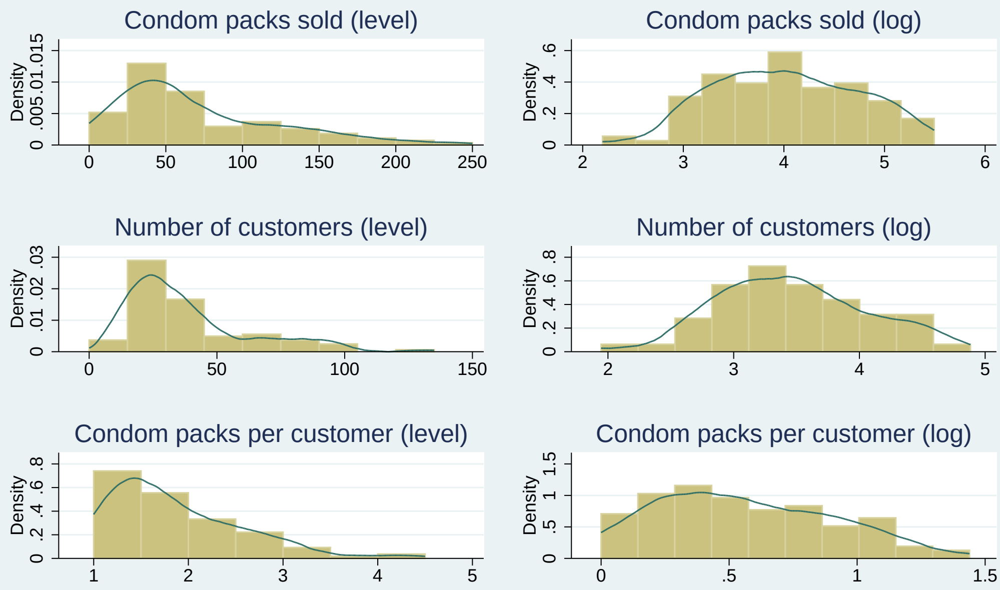
$$
plim\ \hat{\alpha_1} = \beta_1 - \gamma_1 E[\overline{T_1}^{RCT}] + \lambda_1 E[\overline{T_0}^{RCT}]
$$

TABLE A4.2: Average Treatment Effects

Data-generating process:	
$Y_i = \beta_0 + \beta_1 T_{1,i} + \beta_2 T_{2,i} + \lambda_0 \overline{T_{0,i}} + \lambda_1 T_{1,i}\overline{T_{0,i}} + \lambda_2 T_{2,i}\overline{T_{0,i}} + \gamma_0 \overline{T_{1,i}} + \gamma_1 T_{0,i}\overline{T_{1,i}} + \gamma_2 T_{2,i}\overline{T_{1,i}} + \mu_0 \overline{T_{2,i}} + \mu_1 T_{1,i}\overline{T_{2,i}} + \mu_2 T_{0,i}\overline{T_{2,i}} + u_i$	
$\boldsymbol{ATE^{RCT} = E[Y\|RCT] - E[Y\|FT_0]}$ (ATE of the RCT compared to the reference scenario FT_0)	
Naïve specification	$\beta_1 E[T_1^{RCT}] + \beta_2 E[T_2^{RCT}]$
Full specification	$\beta_1 E[T_1^{RCT}] + \beta_2 E[T_2^{RCT}]$ $+\lambda_0 E[\overline{T_0}^{RCT}] + \lambda_1 E[T_1^{RCT}]E[\overline{T_0}^{RCT}] + \lambda_2 E[T_2^{RCT}]E[\overline{T_0}^{RCT}]$ $+\gamma_0 E[\overline{T_1}^{RCT}] + \gamma_1 E[T_0^{RCT}]E[\overline{T_1}^{RCT}] + \gamma_2 E[T_2^{RCT}]E[\overline{T_1}^{RCT}]$ $+\mu_0 E[\overline{T_2}^{RCT}] + \mu_1 E[T_1^{RCT}]E[\overline{T_2}^{RCT}] + \mu_2 E[T_0^{RCT}]E[\overline{T_2}^{RCT}] - \lambda_0 E[\overline{N}]$
Reduced specification	$\beta_1 E[T_1^{RCT}] + \beta_2 E[T_2^{RCT}]$ $+\lambda_0 E[\overline{T_0}^{RCT}] + \gamma_0 E[\overline{T_1}^{RCT}] + \mu_0 E[\overline{T_2}^{RCT}] - \lambda_0 E[\overline{N}]$
$\boldsymbol{ATE^{FT_1} = E[Y\|FT_1] - E[Y\|FT_0]}$ (ATE of full treatment with T_1 compared to the reference scenario FT_0)	
Naïve specification	β_1
Full specification	$\beta_1 + (\gamma_0 - \lambda_0)E[\overline{N}]$
Reduced specification	$\beta_1 + (\gamma_0 - \lambda_0)E[\overline{N}]$
$\boldsymbol{ATE^{FT_2} = E[Y\|FT_2] - E[Y\|FT_0]}$ (ATE of full treatment with T_2 compared to the reference scenario FT_0)	
Naïve specification	β_2
Full specification	$\beta_2 + (\mu_0 - \lambda_0)E[\overline{N}]$
Reduced specification	$\beta_2 + (\mu_0 - \lambda_0)E[\overline{N}]$

Notes: In the regression models, the naïve specification is always presented in Models (1), (4), and (7); the full specification in Models (2), (5), and (7); and the reduced specification in Models (3), (6), and (9).

FIGURE A4.1: Distribution of Dependent Variables



Notes: Figures show density and kernel density for the variables condom packs sold, number of customers, and condom packs per customer for 108 agents in level form and logarithmic transformation. Based on the Shapiro-Wilk and Shapiro-Francia test, the null hypothesis that the variable is normally distributed is rejected for all variables in level form as well as for condom packs sold per customer in the logarithmic transformation, while it cannot be rejected for condoms sold nor for number of customers in the logarithmic transformation.

TABLE A4.3: Effect of Price on Condom Demand at Agent Level, Spillovers in 1 km

	Total Condom Packs			Customers			Condom Packs per Customer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Price 50 (P_{50})	0.326***	0.479***	0.350***	0.192*	0.385***	0.217*	0.134**	0.094	0.134**
	(0.122)	(0.170)	(0.129)	(0.108)	(0.144)	(0.112)	(0.062)	(0.087)	(0.061)
Price 25 (P_{25})	0.930***	1.133***	0.982***	0.521***	0.665***	0.575***	0.409***	0.468***	0.406***
	(0.116)	(0.169)	(0.116)	(0.100)	(0.158)	(0.105)	(0.066)	(0.097)	(0.071)
No. agents w. P_{100}		−0.360	−0.145		−0.088	−0.136		−0.272	−0.009
		(0.434)	(0.120)		(0.315)	(0.098)		(0.231)	(0.075)
No. agents w. P_{50}		−0.239	−0.134		−0.279	−0.127		0.040	−0.006
		(0.241)	(0.121)		(0.190)	(0.099)		(0.129)	(0.051)
No. agents w. P_{25}		0.050	−0.099		0.043	−0.038		0.007	−0.061
		(0.115)	(0.081)		(0.126)	(0.068)		(0.079)	(0.043)
P_{50}*(no. agents w. P_{100})		0.215			−0.142			0.358	
		(0.470)			(0.353)			(0.256)	
P_{25}*(no. agents w. P_{100})		0.145			0.010			0.135	
		(0.460)			(0.346)			(0.251)	
P_{100}*(no. agents w. P_{50})		0.431			0.389			0.042	
		(0.332)			(0.258)			(0.156)	
P_{25}*(no. agents w. P_{50})		−0.087			0.010			−0.097	
		(0.287)			(0.237)			(0.140)	
P_{100}*(no. agents w. P_{25})		−0.289**			−0.165			−0.124	
		(0.143)			(0.147)			(0.090)	
P_{50}*(no. agents w. P_{25})		−0.183			−0.081			−0.102	
		(0.167)			(0.159)			(0.109)	
Constant	4.068***	3.957***	4.073***	3.465***	3.376***	3.468***	0.603***	0.580***	0.605***
	(0.157)	(0.165)	(0.161)	(0.169)	(0.166)	(0.174)	(0.077)	(0.085)	(0.077)

TABLE A4.3 continued

	Total Condom Packs			Customers			Condom Packs per Customer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ATE^{RCT}	0.416***	0.792	0.467***	0.236***	0.331	0.311**	0.180***	0.462	0.156*
	(0.067)	(0.533)	(0.161)	(0.059)	(0.389)	(0.130)	(0.036)	(0.272)	(0.090)
ATE^{FT_1}	0.326***	0.628	0.364	0.192*	0.151	0.227	0.134**	0.476	0.137
	(0.122)	(0.631)	(0.268)	(0.108)	(0.461)	(0.212)	(0.062)	(0.320)	(0.136)
ATE^{FT_2}	0.930***	1.634***	1.038***	0.521***	0.825*	0.695***	0.409***	0.809**	0.343**
	(0.116)	(0.587)	(0.228)	(0.100)	(0.438)	(0.199)	(0.066)	(0.309)	(0.143)
F-Test restr. specification	0.1260		0.1229	0.0281		0.1011	0.2522		0.4445
N	108	108	108	108	108	108	108	108	108
R^2	0.495	0.567	0.520	0.450	0.525	0.477	0.371	0.423	0.383

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Dependent variables: (1)–(3) total number of condom packs sold, (4)–(6) total number of customers, and (7)–(9) mean number of condom packs sold per customer; all in the logarithmic transformation and aggregated from individual level purchase data (from within the study area only) to agent level. P_{100}, P_{50}, and P_{25} are binary variables indicating the assigned agent price. Spillover variables capture the number of agents with each price in 1,000 meters radius of the considered agent. All models control for the five clinic catchment areas. Results are from OLS estimations; robust standard errors in parentheses. F-test for restricted specification shows p-values for joint significance of all spillover variables in models (1), (4), and (7) and for the interaction terms only in models (3), (6), and (9). Average treatment effects are estimated as linear combinations as summarized in Table A4.2. Indicated significance is $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE A4.4: Effect of Price on Condom Demand at Agent Level with Controls

	Total Condom Packs		Customers		Condom Packs per Customer	
	(1)	(2)	(3)	(4)	(5)	(6)
Price 50 (P_{50})	0.324**	0.317**	0.203*	0.204*	0.121*	0.113*
	(0.124)	(0.129)	(0.110)	(0.117)	(0.062)	(0.060)
Price 25 (P_{25})	0.957***	0.961***	0.537***	0.553***	0.421***	0.408***
	(0.120)	(0.129)	(0.101)	(0.114)	(0.071)	(0.072)
Population	0.063	0.044	0.065	0.045	−0.001	−0.001
	(0.068)	(0.078)	(0.056)	(0.064)	(0.037)	(0.039)
Distance	0.007	−0.006	0.016	−0.003	−0.009	−0.003
	(0.071)	(0.081)	(0.055)	(0.069)	(0.037)	(0.036)
Male	−0.031	−0.041	−0.044	−0.044	0.013	0.003
	(0.103)	(0.106)	(0.097)	(0.097)	(0.061)	(0.065)
Age	0.008	0.007	−0.001	−0.002	0.009**	0.009**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)
Married	−0.136	−0.116	−0.097	−0.088	−0.039	−0.028
	(0.120)	(0.122)	(0.110)	(0.110)	(0.071)	(0.072)
No. agents w. (P_{100})		−0.047		−0.085		0.038
		(0.162)		(0.121)		(0.096)
No. agents w. (P_{50})		−0.084		−0.117		0.033
		(0.142)		(0.112)		(0.062)
No. agents w. (P_{25})		−0.103		−0.057		−0.045
		(0.095)		(0.082)		(0.051)
Constant	3.492***	3.658***	3.139***	3.341***	0.353	0.317
	(0.573)	(0.654)	(0.484)	(0.566)	(0.276)	(0.298)

TABLE A4.4 continued

	Total Condom Packs		Customers		Condom Packs per Customer	
	(1)	(2)	(3)	(4)	(5)	(6)
ATE^{RCT}	0.424***	0.399***	0.245***	0.251**	0.179***	0.147**
	(0.069)	(0.130)	(0.060)	(0.022)	(0.038)	(0.071)
ATE^{FT_1}	0.324**	0.290	0.203*	0.181	0.121*	0.109
	(0.124)	(0.224)	(0.110)	(0.181)	(0.0615)	(0.111)
ATE^{FT_2}	0.957***	0.921***	0.537***	0.573***	0.421***	0.348***
	(0.120)	(0.197)	(0.101)	(0.170)	(0.0712)	(0.114)
N	108	108	108	108	108	108
R^2	0.511	0.517	0.466	0.476	0.410	0.418

Notes: Sample includes 108 condom sales agents who sold condoms during a four-month period in 2013. Dependent variables: (1)–(2) total number of condom packs sold, (3)–(4) total number of customers, and (5)–(6) mean number of condom packs sold per customer; all in the logarithmic transformation and aggregated from individual level purchase data (from within the study area only) to agent level. P_{100}, P_{50}, and P_{25} are binary variables indicating the assigned agent price. *Population* is the population in the villages assigned to the respective agent (in log form). *Distance* is the travel time in minutes from the agent to the clinic with the bicycle (in log form). *Male* indicates a male agent. *Age* is the agent's age in years. *Married* indicates a married agent. Spillover variables capture the number of agents with each price in 500 meters radius of the considered agent. All models control for the five clinic catchment areas. Results are from OLS estimations; robust standard errors in parentheses. Average treatment effects are estimated as linear combinations as summarized in Table A4.2. Indicated significance is $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE A5.1: Mixed MNL - Condom Sales Location Choice, Reduced Sample

	(1)	(2)	(3)
Mean			
Price 50 (P_{50})	0.4567**	0.4322**	0.3956**
	(0.1895)	(0.1977)	(0.1817)
Price 25 (P_{25})	0.6779***	0.6400***	0.6583***
	(0.2000)	(0.2093)	(0.2266)
Agent in village	1.3433	1.0969	0.9993
	(1.0084)	(0.8640)	(0.7665)
Distance in 100 meters	−0.1946***	−0.2003***	−0.1962***
	(0.0315)	(0.0354)	(0.0365)
Distance*female customer	−0.0284	−0.0296	−0.0159
	(0.0178)	(0.0209)	(0.0205)
Distance*multiple partners	0.0234**	0.0224*	0.0271**
	(0.0113)	(0.0116)	(0.0136)
Female agent	0.0513	−0.1477	−0.2245
	(0.1383)	(0.1344)	(0.1474)
Female agent*female customer		1.7815***	1.7712***
		(0.3511)	(0.3905)
Agent's age	−0.0100	−0.0106	0.0068
	(0.0082)	(0.0082)	(0.0096)
Agent's age*young customer			−0.0375***
			(0.0137)
Std. deviation			
Price 50 (P_{50})	0.0153	0.0259	0.0103
	(0.0354)	(0.0928)	(0.0515)
Price 25 (P_{25})	0.1345	0.4230	0.3866
	(0.5689)	(0.9786)	(1.2200)
Agent in village	4.0060*	3.6543**	3.2302*
	(2.0630)	(1.8404)	(1.7861)
Distance in 100 meters	0.1184***	0.1227***	0.1091***
	(0.0303)	(0.0331)	(0.0264)
Distance*female customer	0.0059	0.0174	0.0020
	(0.0094)	(0.0216)	(0.0345)
Distance*multiple partners	0.0014	0.0049	0.0053
	(0.0087)	(0.0117)	(0.0209)
Female agent	0.3139	0.2654	0.1231
	(0.5468)	(0.9788)	(4.8132)
Female agent*female customer		0.0604	0.0662
		(0.1885)	(0.1677)
Agent's age	0.0023	0.0024	0.0091
	(0.0040)	(0.0039)	(0.0076)
Agent's age*young customer			0.0001
			(0.0147)
N	22,036	22,036	21,531

Notes: Observations include all condom sales locations within 5 kilometers distance (each observation is a unique individual-alternative pair). Purchases made in the first 4 weeks of the experiment are excluded. Binary dependent variable equals 1 for chosen alternative and 0 otherwise for each individual. Binary variables P_{50} and P_{25} indicate condom price at respective location (reference category: P_{100}). Binary variables *Agent in village* and *Female agent* indicate that the agent sells in the customer's home village and that the agent is female. Distance is measured in 100 meters. Alternative-specific attributes are interacted with the individual-specific attributes female, having multiple partners, and being young (11 to 26 years). Standard errors in parentheses are clustered at the level of the customer's village. Indicated significance is *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

TABLE A5.2: Mixed MNL - Condom Sales Location Choice, Reduced Choice Sets

	(1)	(2)	(3)
Mean			
Price 50 (P_{50})	0.3587	0.3519	0.3449
	(0.2354)	(0.2463)	(0.2373)
Price 25 (P_{25})	0.7872**	0.7919**	0.7777**
	(0.3197)	(0.3456)	(0.3315)
Agent in village	0.5584	0.7984	0.3719
	(1.2327)	(2.1874)	(0.6695)
Distance in 100 meters	−0.3300***	−0.3522**	−0.3784***
	(0.0743)	(0.1740)	(0.0929)
Distance*female customer	0.0074	−0.0245	−0.0117
	(0.1068)	(0.0686)	(0.0929)
Distance*multiple partners	0.0107	0.0137	0.0490
	(0.0624)	(0.2634)	(0.0305)
Female agent	0.1480	−0.1789	−0.2722
	(0.1993)	(0.2634)	(0.2161)
Female agent*female customer		2.9113***	2.7787***
		(1.0587)	(0.8295)
Agent's age	−0.0048	−0.0046	0.0154
	(0.0109)	(0.0144)	(0.0146)
Agent's age*young customer			−0.0446**
			(0.0179)
Std. deviation			
Price 50 (P_{50})	0.0837	0.3454	0.3955
	(0.4959)	(1.1577)	(1.3374)
Price 25 (P_{25})	0.5286	0.8372	0.9208
	(1.3648)	(1.0141)	(0.9498)
Agent in village	2.1910	2.9659	1.8635
	(3.5088)	(5.2998)	(2.0797)
Distance in 100 meters	0.2079***	0.2241	0.2413***
	(0.0491)	(0.1661)	(0.0650)
Distance*female customer	0.0718	0.1608*	−0.1586
	(0.2829)	(0.0966)	(0.1344)
Distance*multiple partners	0.1325	0.1272	0.0199
	(0.1119)	(0.4938)	(0.0475)
Female agent	1.4192**	1.6839*	1.6156**
	(0.7089)	(0.9325)	(0.7500)
Female agent*female customer		0.2107	0.0130
		(0.8730)	(0.4225)
Agent's age	0.0030	0.0129	0.0047
	(0.0296)	(0.0314)	(0.0194)
Agent's age*young customer			0.0049
			(0.0139)
N	12,553	12,553	12,259

Notes: Observations include all condom sales locations within 3 kilometers distance (each observation is a unique individual-alternative pair). Binary dependent variable equals 1 for chosen alternative and 0 otherwise for each individual. Binary variables P_{50} and P_{25} indicate condom price at respective location (reference category: P_{100}). Binary variables *Agent in village* and *Female agent* indicate that the agent sells in the customer's home village and that the agent is female. Distance is measured in 100 meters. Alternative-specific attributes are interacted with the individual-specific attributes female, having multiple partners, and being young (11 to 26 years). Standard errors in parentheses are clustered at the level of the customer's village. Indicated significance is $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Bibliography

Agha, Sohail and John Davies (1998). *Contraceptive Social Marketing in Pakistan: Assessing the Impact of the 1991 Condom Price Increases on Sales and Consumption.* PSI Research Divison Working Paper No. 14. Washington, DC: Population Services International (PSI).

Agha, Sohail, Paul Hutchinson, and Thankian Kusanthan (2006). The Effects of Religious Affiliation on Sexual Initiation and Condom Use in Zambia. *Journal of Adolescent Health* 38 (5), 550–555.

Agha, Sohail and Thankian Kusanthan (2003). Equity in Access to Condoms in Urban Zambia. *Health Policy and Planning* 18 (3), 299–305.

Agha, Sohail et al. (2002). *Reasons for Non-Use of Condoms in Eight Countries in Sub-Saharan Africa.* PSI Research Divison Working Paper No. 49. Washington, DC: Population Services International (PSI).

Akin, John S. and J. Brad Schwartz (1988). The Effect of Economic Factors on Contraceptive Choice in Jamaica and Thailand: A Comparison of Mixed Multinomial Logit Results. *Economic Development and Cultural Change* 36 (3), 503–527.

Angelucci, Manuela and Giacomo De Giorgi (2009). Indirect Effects of an Aid Program: How Do Cash Transfers Affect Ineligibles' Consumption? *American Economic Review* 99 (1), 486–508.

Angelucci, Manuela and Vincenzo Di Maro (2015). *Program Evaluation and Spillover Effects.* IZA Discussion Paper No. 9033. Bonn: Institute for the Study of Labor (IZA).

Angrist, Joshua D., Guido W. Imbens, and Donald B. Rubin (1996). Identification of Causal Effects Using Instrumental Variables. *Journal of the American Statistical Association* 91 (434), 444–455.

Angrist, Joshua D. and Jörn-Steffen Pischke (2009). *Mostly Harmless Econometrics: An Empiricist's Companion.* Princeton: Princeton University Press.

Aral, Sinan (2016). Networked Experiments. *Oxford Handbook of the Economics of Networks.* Ed. by Yann Bramoullé, Andrea Galeotti, and Brian Rogers. Oxford: Oxford University Press, 376–411.

Armand, Françoise (2003). *Social Marketing Models for Product-Based Reproductive Health Programs: A Comparative Analysis.* Occasional Paper Series. Washington, DC: USAID/ Commercial Market Strategies Project.

Arrow, Kenneth J. (1963). Uncertainty and the Welfare Economics of Medical Care. *American Economic Review* 53 (5), 941–973.

Ashraf, Nava, James Berry, and Jesse M. Shapiro (2010). Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia. *American Economic Review* 100 (5), 2383–2413.

Auvert, Bertran et al. (2005). Randomized, Controlled Intervention Trial of Male Circumcision for Reduction of HIV Infection Risk: The ANRS 1265 Trial. *PLoS Medicine* 2 (11), 1112–1122.

AVERT (2016). *The Science of HIV and AIDS - Overview.* URL: `https://www.avert.org/professionals/hiv-science/overview` (visited on 08/02/2016).

— (2017). *History of HIV and AIDS Overview.* URL: `http://www.avert.org/professionals/history-hiv-aids/overview` (visited on 10/09/2017).

Baeten, Jared M. et al. (2012). Antiretroviral Prophylaxis for HIV Prevention in Heterosexual Men and Women. *New England Journal of Medicine* 367 (5), 399–410.

Bailey, Robert C. et al. (2007). Male Circumcision for HIV Prevention in Young Men in Kisumu, Kenya: A Randomised Controlled Trial. *Lancet* 369 (9562), 643–656.

Baird, Sarah, Aislinn Bohren, Craig McIntosh, and Berk Özler (2014). *Designing Experiments to Measure Spillover Effects.* Policy Research Working Paper No. 6824. Washington, DC: World Bank.

Banerjee, Abhijit V. and Esther Duflo (2009). The Experimental Approach to Development Economics. *Annual Review of Economics* 1, 151–178.

Banerjee, Abhijit V., Esther Duflo, Rachel Glennerster, and Dhruva Kothari (2010). Improving Immunisation Coverage in Rural India: Clustered Randomised Controlled Evaluation of Immunisation Campaigns With and Without Incentives. *British Medical Journal* 340 (c2220), 1–9.

Barigozzi, Francesca and Rosella Levaggi (2010). Emotional Decision-Makers and Anomalous Attitudes Towards Information. *Journal of Risk and Uncertainty* 40 (3), 255–280.

Berry, James, Greg Fischer, and Raymond P. Guiteras (2015). *Eliciting and Utilizing Willingness to Pay: Evidence from Field Trials in Northern Ghana.* CEPR Discussion Paper No. 10703. London: Centre for Economic Policy Research.

Berry, Steven, James Levinsohn, and Ariel Pakes (1995). Automobile Prices in Market Equilibrium. *Econometrica* 63 (4), 841–890.

Blum, Annalise G., Clair Null, and Vivian Hoffmann (2014). Marketing Household Water Treatment: Willingness to Pay Results from an Experiment in Rural Kenya. *Water* 6 (7), 1873–1886.

Bobba, Matteo and Jérémie Gignoux (2014). *Neighborhood Effects and Take-Up of Transfers in Integrated Social Policies: Evidence from Progresa.* PSE Working Papers No. 2011-37. Paris: Paris School of Economics.

Boily, Marie-Claude et al. (2009). Heterosexual Risk of HIV-1 Infection per Sexual Act: Systematic Review and Meta-Analysis of Observational Studies. *Lancet Infectious Diseases* 9 (2), 118–129.

Bor, Jacob, Abraham J. Herbst, Marie-Louise Newell, and Till Bärnighausen (2013). Increases in Adult Life Expectancy in Rural South Africa: Valuing the Scale-Up of HIV Treatment. *Science* 339 (6122), 961–965.

Borah, Bijan J. (2006). A Mixed Logit Model of Health Care Provider Choice: Analysis of NSS Data for Rural India. *Health Economics* 15 (9), 915–932.

Brent, Robert J. (2010). Why Countries Have both Subsidized and Free Condoms to Prevent HIV/AIDS: The Role of Stigma Mitigation. *Journal of African Development* 12 (2), 61–71.

Caplin, Andrew and John Leahy (2001). Psychological Expected Utility Theory and Anticipatory Feelings. *Quarterly Journal of Economics* 116 (1), 55–79.

Cardo, Denise M. et al. (1997). A Case-Control Study of HIV Seroconversion in Health Care Workers After Percutaneous Exposure. *New England Journal of Medicine* 337 (21), 1485–1490.

Central Statistical Office Zambia [CSO] (2011). *Zambia 2010 Census of Population and Housing: Preliminary Population Figures*. Lusaka.

— (2012). *Living Conditions Monitoring Survey Report 2006 and 2010*. Lusaka.

Central Statistical Office Zambia [CSO], Central Board of Health [CBH], and ORC Macro [ORC] (2003). *Zambia Demographic and Health Survey 2001-2002*. Calverton, Maryland.

Central Statistical Office Zambia [CSO], Ministry of Health Zambia [MOH], and ICF International [ICF] (2015). *Zambia Demographic and Health Survey 2013-14*. Rockville, Maryland.

Central Statistical Office Zambia [CSO] et al. (2009). *Zambia Demographic and Health Survey 2007*. Calverton, Maryland.

Chapman, Steven et al. (2012). Condom Social Marketing in Sub-Saharan Africa and the Total Market Approach. *Sexual Health* 9 (1), 44–50.

Choopanya, Kachit et al. (2013). Antiretroviral Prophylaxis for HIV Infection in Injecting Drug Users in Bangkok, Thailand (the Bangkok Tenofovir Study): A Randomised, Double-Blind, Placebo-Controlled Phase 3 Trial. *Lancet* 381 (9883), 2083–2090.

Ciszewski, Robert L. and Philip D. Harvey (1995). Contraceptive Price Changes: The Impact on Sales in Bangladesh. *International Family Planning Perspectives* 21 (4), 150–154.

Cohen, Jessica and Pascaline Dupas (2010). Free Distribution or Cost-Sharing? Evidence from a Randomized Malaria Prevention Experiment. *Quarterly Journal of Economics* 125 (1), 1–45.

Cohen, Myron S. et al. (2011). Prevention of HIV-1 Infection with Early Antiretroviral Therapy. *New England Journal of Medicine* 365 (6), 493–505.

Comfort, Alison B. and Paul J. Krezanoski (2017). The Effect of Price on Demand for and Use of Bednets: Evidence from a Randomized Experiment in Madagascar. *Health Policy and Planning* 32 (2), 178–193.

Corrigan, Patrick W., Benjamin G. Druss, and Deborah A. Perlick (2014). The Impact of Mental Illness Stigma on Seeking and Participating in Mental Health Care. *Psychological Science in the Public Interest* 15 (2), 37–70.

Cotlear, Daniel et al. (2015). *Going Universal: How 24 Developing Countries are Implementing Universal Health Coverage Reforms from the Bottom Up.* Washington, DC: World Bank.

Culyer, Anthony J. and Joseph P. Newhouse (2000). Introduction: The State and Scope of Health Economics. *Handbook of Health Economics.* Ed. by Anthony J. Culyer and Joseph P. Newhouse. 1st Edition. Vol. 1A. Amsterdam: North Holland, 1–8.

Culyer, Anthony J. and Adam Wagstaff (1993). Equity and Equality in Health and Health Care. *Journal of Health Economics* 12 (4), 431–457.

Davis, Peter (2006). Spatial Competition in Retail Markets: Movie Theaters. *RAND Journal of Economics* 37 (4), 964–982.

de Palma, André, Robin Lindsey, Balder von Hohenbalken, and Douglas S. West (1994). Spatial Price and Variety Competition in an Urban Retail Market: A Nested Logit Analysis. *International Journal of Industrial Organization* 12 (3), 331–357.

de Walque, Damien, Harounan Kazianga, and Mead Over (2012). Antiretroviral Therapy Perceived Efficacy and Risky Sexual Behaviors: Evidence from Mozambique. *Economic Development and Cultural Change* 61 (1), 97–126.

de Walque, Damien and Rachel Kline (2011). Variations in Condom Use by Type of Partner in 13 Sub-Saharan African Countries. *Studies in Family Planning* 42 (1), 1–10.

Denison, Julie A. et al. (2008). HIV Voluntary Counseling and Testing and Behavioral Risk Reduction in Developing Countries: A Meta-Analysis, 1990–2005. *AIDS and Behavior* 12 (3), 363–373.

DHS Program (2017). *Using Biomarkers to Collect Health Data.* URL: `https://dhsprogram.com/What-We-Do/Biomarkers.cfm` (visited on 02/08/2016).

DKT International (2015). *2014 Contraceptive Social Marketing Statistics.* Washington, DC.

Duffy, Valerie and Ciara Regan (2010). *This is What Has Happened: HIV and AIDS, Women and Vulnerability in Zambia.* Wicklow: 80:20 Educating and Acting for a Better World.

Duflo, Esther, Rachel Glennerster, and Michael Kremer (2008). Using Randomization in Development Economics Research: A Toolkit. *Handbook of Development Economics.* Ed.

by T. Paul Schultz and John Strauss. 1st Edition. Vol. 4. Amsterdam: North Holland, 3895–3962.

Dunkle, Kristin L. et al. (2008). New Heterosexually Transmitted HIV Infections in Married or Cohabiting Couples in Urban Zambia and Rwanda: An Analysis of Survey and Clinical Data. *Lancet* 371 (9631), 2183–2191.

Dupas, Pascaline (2011). Health Behavior in Developing Countries. *Annual Review of Economics* 3, 425–449.

— (2014a). Getting Essential Health Products to Their End Users: Subsidize, but how Much? *Science* 345 (6202), 1279–1281.

— (2014b). Pricing and User Fees. *Encyclopedia of Health Economics.* Ed. by Anthony J. Culyer. 1st Edition. Amsterdam: Elsevier, 136–141.

— (2014c). Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence from a Field Experiment. *Econometrica* 82 (1), 197–228.

Embassy of Sweden (2008). *Sida Gender Country Profile - Zambia.* Stockholm: Swedish International Development Cooperation Agency (SIDA).

Epstein, Helen and Martina Morris (2011). Concurrent Partnerships and HIV: An Inconvenient Truth. *Journal of the International AIDS Society* 14 (13), 1–11.

ESRI (2017). *ArcGIS Network Analyst.* URL: `http://www.esri.com/software/arcgis/extensions/networkanalyst` (visited on 01/01/2017).

Evans, W. Douglas, Noah Taruberekera, Kim Longfield, and Jeremy Snider (2011). Brand Equity and Willingness to Pay for Condoms in Zimbabwe. *Reproductive Health* 8 (1), 1–8.

Fawzi, Wafaie W. et al. (2004). A Randomized Trial of Multivitamin Supplements and HIV Disease Progression and Mortality. *New England Journal of Medicine* 351 (1), 23–32.

Fischer, Greg, Dean Karlan, Margaret McConnell, and Pia Raffler (2014). *To Charge or Not to Charge: Evidence from a Health Products Experiment in Uganda.* NBER Working Paper No. 20170. Cambridge: National Bureau of Economic Research (NBER).

Fishel, Joy D., Ladys Ortiz, and Bernard Barrère (2012). *Measuring Concurrent Sexual Partnerships: Experience of the MEASURE DHS Project to Date.* DHS Methodological Reports No. 7. Calverton, Maryland: ICF International.

Fortson, Jane G. (2011). Mortality Risk and Human Capital Investment: The Impact of HIV/AIDS in Sub-Saharan Africa. *Review of Economics and Statistics* 93 (1), 1–15.

Foss, Anna M., M. Hossain, Peter T. Vickerman, and Charlotte H. Watts (2007). A Systematic Review of Published Evidence on Intervention Impact on Condom Use in Sub-Saharan Africa and Asia. *Sexually Transmitted Infections* 83 (7), 510–516.

Fox, Matthew P. et al. (2004). The Impact of HIV/AIDS on Labour Productivity in Kenya. *Tropical Medicine and International Health* 9 (3), 318–324.

Gallo, Robert C. and Luc Montagnier (2003). Retrospective: The Discovery of HIV as the Cause of AIDS. *New England Journal of Medicine* 349 (24), 2283–2285.

Gertler, Paul, Luis Locay, and Warren Sanderson (1987). Are User Fees Regressive? The Welfare Implications of Health Care Financing Proposals in Peru. *Journal of Econometrics* 36 (1-2), 67–88.

Ginwalla, Sara K. et al. (2002). Use of UNAIDS Tools to Evaluate HIV Voluntary Counselling and Testing Services for Mineworkers in South Africa. *AIDS Care* 14 (5), 707–726.

Goldsmith-Pinkham, Paul and Guido W. Imbens (2013). Social Networks and the Identification of Peer Effects. *Journal of Business and Economic Statistics* 31 (3), 253–264.

Goodreau, Steven M. (2011). A Decade of Modelling Research Yields Considerable Evidence for the Importance of Concurrency: A Response to Sawers and Stillwaggon. *Journal of the International AIDS Society* 14 (12), 1–7.

Government of the Republic of Zambia [GRZ] (2014). *National AIDS Strategic Framework 2014-2016*. Lusaka: National HIV/AIDS/STI/TB Council Zambia.

— (2015). *Zambia Country Report: Monitoring the Declaration of Commitment on HIV and AIDS and the Universal Access*. Lusaka: National HIV/AIDS/STI/TB Council Zambia.

Grant, Robert M. et al. (2010). Preexposure Chemoprophylaxis for HIV Prevention in Men who Have Sex with Men. *New England Journal of Medicine* 363 (27), 2587–2599.

Gray, Ronald H. et al. (2007). Male Circumcision for HIV Prevention in Men in Rakai, Uganda: A Randomised Trial. *Lancet* 369 (9562), 657–666.

Grossman, Michael (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy* 80 (2), 223–255.

Habyarimana, James, Bekezela Mbakile, and Cristian Pop-Eleches (2010). The Impact of HIV/AIDS and ARV Treatment on Worker Absenteeism: Implications for African Firms. *Journal of Human Resources* 45 (4), 809–839.

Harvey, Philip D. (1994). The Impact of Condom Prices on Sales in Social Marketing Programs. *Studies in Family Planning* 25 (1), 52–58.

Hensher, David A. and William H. Greene (2003). The Mixed Logit Model: The State of Practice. *Transportation* 30 (2), 133–176.

Hole, Arne R. (2007). Fitting Mixed Logit Models by Using Maximum Simulated Likelihood. *Stata Journal* 7 (3), 388–401.

Holland, Paul W. (1986). Statistics and Causal Inference. *Journal of the American Statistical Association* 81 (396), 945–960.

Hollingsworth, T. Déirdre, Roy M. Anderson, and Christophe Fraser (2008). HIV-1 Transmission, by Stage of Infection. *Journal of Infectious Diseases* 198 (5), 687–693.

Hudgens, Michael G. and M. Elizabeth Halloran (2008). Toward Causal Inference with Interference. *Journal of the American Statistical Association* 103 (482), 832–842.

Ichino, Nahomi and Matthias Schündeln (2012). Deterring or Displacing Electoral Irregularities? Spillover Effects of Observers in a Randomized Field Experiment in Ghana. *Journal of Politics* 74 (1), 292–307.

Institute for Health Metrics and Evaluation [IHME] (2014). *Health Service Provision in Zambia: Assessing Facility Capacity, Costs of Care, and Patient Perspectives.* Seattle, Washington.

— (2015). *Financing Global Health 2014: Shifts in Funding as the MDG Era Closes.* Seattle, Washington.

Jalan, Jyotsna and E. Somanathan (2008). The Importance of Being Informed: Experimental Evidence on Demand for Environmental Quality. *Journal of Development Economics* 87 (1), 14–28.

Jamison, Dean T. et al. (2013). Global Health 2035: A World Converging Within a Generation. *Lancet* 382 (9908), 1898–1955.

Janowitz, Barbara and John H. Bratt (1996). What Do We Really Know About the Impact of Price Changes on Contraceptive Use? *International Family Planning Perspectives* 22 (1), 38–40.

Japan International Development Agency [JICA] and Ministry of Health Zambia [MOH] (2006). *Zambia Health Facility Census 2005-2006.* Primary Data.

Jiang, Junjun et al. (2014). Pre-Exposure Prophylaxis for the Prevention of HIV Infection in High Risk Populations: A Meta-Analysis of Randomized Controlled Trials. *PLoS One* 9 (2), 1–8.

Johnson, Leigh F. et al. (2009). Sexual Behaviour Patterns in South Africa and Their Association with the Spread of HIV: Insights from a Mathematical Model. *Demographic Research* 21 (11), 289–340.

Johnson, Leigh F. et al. (2013). Life Expectancies of South African Adults Starting Antiretroviral Treatment: Collaborative Analysis of Cohort Studies. *PLoS Medicine* 10 (4), 1–11.

Karlan, Dean and Jonathan Zinman (2009). Observing Unobservables: Identifying Information Asymmetries with a Consumer Credit Field Experiment. *Econometrica* 77 (6), 1993–2008.

Kennedy, Caitlin E., Kevin R. O'Reilly, Amy M. Medley, and Michael D. Sweat (2007). The Impact of HIV Treatment on Risk Behaviour in Developing Countries: A Systematic Review. *AIDS Care* 19 (6), 707–720.

Kőszegi, Botond (2003). Health Anxiety and Patient Behavior. *Journal of Health Economics* 22 (6), 1073–1084.

Kim, Byung-Do and Peter E. Rossi (1994). Purchase Frequency, Sample Selection, and Price Sensitivity: The Heavy-User Bias. *Marketing Letters* 5 (1), 57–67.

Korachais, Catherine, Elodie Macouillard, and Bruno Meessen (2016). How User Fees Influence Contraception in Low and Middle Income Countries: A Systematic Review. *Studies in Family Planning* 47 (4), 341–356.

Kremer, Michael, Amrita Ahuja, and Alix Peterson-Zwane (2010). *Providing Safe Water: Evidence from Randomized Evaluations*. Discussion Paper No. 10–23. Cambridge: Harvard Environmental Economics Program.

Kremer, Michael and Edward Miguel (2007). The Illusion of Sustainability. *Quarterly Journal of Economics* 122 (3), 1007–1065.

Kumar, Santosh, Emily A. Dansereau, and Christopher J. L. Murray (2014). Does Distance Matter for Institutional Delivery in Rural India? *Applied Economics* 46 (33), 4091–4103.

Lalive, Rafael and M. Alejandra Cattaneo (2009). Social Interactions and Schooling Decisions. *Review of Economics and Statistics* 91 (3), 457–477.

Langford, Simone E., Jintanat Ananworanich, and David A. Cooper (2007). Predictors of Disease Progression in HIV Infection: A Review. *AIDS Research and Therapy* 4 (11), 1–14.

Larson, Bruce A. et al. (2008). Early Effects of Antiretroviral Therapy on Work Performance: Preliminary Results from a Cohort Study of Kenyan Agricultural Workers. *AIDS* 22 (3), 421–425.

Levinsohn, James, Zoë M. McLaren, Olive Shisana, and Khangelani Zuma (2013). HIV Status and Labor Market Participation in South Africa. *Review of Economics and Statistics* 95 (1), 98–108.

Lewis, Maureen A. (1986). Do Contraceptive Prices Affect Demand? *Studies in Family Planning* 17 (3), 126–135.

Lurie, Mark N. and Samantha Rosenthal (2010). Concurrent Partnerships as a Driver of the HIV Epidemic in Sub-Saharan Africa? The Evidence is Limited. *AIDS and Behavior* 14 (1), 17–24.

Madajewicz, Malgosia et al. (2007). Can Information Alone Change Behavior? Response to Arsenic Contamination of Groundwater in Bangladesh. *Journal of Development Economics* 84 (2), 731–754.

Maharaj, Pranitha and John Cleland (2004). Condom Use Within Marital and Cohabiting Partnerships in KwaZulu-Natal, South Africa. *Studies in Family Planning* 35 (2), 116–124.

Mbikusita-Lewanika, Mbololwa, Hart Stephen, and Jane Thomas (2009). The Prevalence of the Use of 'Dry Sex' Traditional Medicine, Among Zambian Women, and the Profile of the Users. *Psychology, Health and Medicine* 14 (2), 227–238.

McFadden, Daniel (1973). Conditional Logit Analysis of Qualitative Choice Behavior. *Frontiers in Econometrics*. Ed. by Paul Zarembka. New York: Academic Press, 105–142.

— (2001). Economic Choices. *American Economic Review* 91 (3), 351–378.

McFadden, Daniel and Kenneth Train (2000). Mixed MNL Models for Discrete Response. *Journal of Applied Econometrics* 15 (5), 447–470.

McLaren, Zoë M., Cally Ardington, and Murray Leibbrandt (2014). Distance Decay and Persistent Health Care Disparities in South Africa. *BMC Health Services Research* 14 (541), 1–9.

Meekers, Dominique (1997). *The Implications of Free and Commercial Distribution for Condom Use: Evidence from Cameroon*. PSI Research Division Working Paper No. 9. Washington, DC: Population Services International (PSI).

Meekers, Dominique and Ronan Van Rossem (2005). Explaining Inconsistencies Between Data on Condom Use and Condom Sales. *BMC Health Services Research* 5 (5), 1–14.

Meredith, Jennifer, Jonathan Robinson, Sarah Walker, and Bruce Wydick (2013). Keeping the Doctor Away: Experimental Evidence on Investment in Preventative Health Products. *Journal of Development Economics* 105, 196–210.

Miguel, Edward and Michael Kremer (2004). Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. *Econometrica* 72 (1), 159–217.

Mills, Edward J. et al. (2006). Adherence to HAART: A Systematic Review of Developed and Developing Nation Patient-Reported Barriers and Facilitators. *PLoS Medicine* 3 (11), 2039–2064.

Mills, Edward J. et al. (2011). Life Expectancy of Persons Receiving Combination Antiretroviral Therapy in Low-Income Countries: A Cohort Analysis From Uganda. *Annals of Internal Medicine* 155 (4), 209–216.

Ministry of Health Zambia [MOH] (2010). *National Community Health Worker Strategy in Zambia*. Lusaka.

— (2011). *List of Health Facilities in Zambia 2010*. Lusaka.

— (2013). *The 2012 List of Health Facilities in Zambia. Preliminary Report*. Lusaka.

Mishra, Vinod et al. (2007). HIV Infection Does Not Disproportionately Affect the Poorer in Sub-Saharan Africa. *AIDS* 21 (Suppl. 7), S17–S28.

Morgan, Stephen L. and Christopher Winship (2007). *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. Cambridge: Cambridge University Press.

Mugusi, Ferdinand et al. (2002). Dropouts in a Long-Term Follow-Up Study Involving Voluntary Counseling and HIV Testing: Experience from a Cohort of Police Officers in Dar Es Salaam, Tanzania. *Journal of Acquired Immune Deficiency Syndrome* 30 (1), 119–123.

Mulenga, Osward et al. (2009). *Zambia HIV Prevention Response and Modes of Transmission Analysis*. Zambia National HIV/AIDS/STI/TB Council, World Bank, Joint United Nations Programme on HIV/AIDS [UNAIDS].

Murray, Emma J. et al. (2013). High Levels of Vulnerability and Anticipated Stigma Reduce the Impetus for Tuberculosis Diagnosis in Cape Town, South Africa. *Health Policy and Planning* 28 (4), 410–418.

Mwabu, Germano (2008). Health Economics for Low-Income Countries. *Handbook of Development Economics*. Ed. by T. Paul Schultz and John Strauss. 1st Edition. Vol. 4. Amsterdam: North Holland, 3305–3374.

Nations Online Project (2017). *Political Map of Zambia*. URL: `http://www.nationsonline.org/oneworld/map/zambia-political-map.htm` (visited on 11/09/2017).

Ndulo, Muna (2011). African Customary Law, Customs, and Women's Rights. *Indiana Journal of Global Legal Studies* 18 (1), 87–120.

Nsanzimana, Sabin et al. (2015). Life Expectancy Among HIV-Positive Patients in Rwanda: A Retrospective Observational Cohort Study. *Lancet Global Health* 3 (3), 169–177.

Nyamweya, Samuel et al. (2013). Comparing HIV-1 and HIV-2 Infection: Lessons for Viral Immunopathogenesis. *Reviews in Medical Virology* 23 (4), 221–240.

Ochako, Rhoune et al. (2015). Barriers to Modern Contraceptive Methods Uptake Among Young Women in Kenya: A Qualitative Study. *BMC Public Health* 15 (118), 1–9.

O'Reilly, Kevin R., Virginia A. Fonner, Caitlin E. Kennedy, and Michael D. Sweat (2014). Free Condom Distribution: What We Don't Know May Hurt Us. *AIDS and Behavior* 18 (11), 2169–2171.

Ortego, Carmen et al. (2011). Adherence to Highly Active Antiretroviral Therapy (HAART): A Meta-Analysis. *AIDS and Behavior* 15 (7), 1381–1396.

Patel, Pragna et al. (2014). Estimating Per-Act HIV Transmission Risk: A Systematic Review. *AIDS* 28 (10), 1509–1519.

Philipson, Tomas J. and Richard A. Posner (1995). A Theoretical and Empirical Investigation of the Effects of Public Health Subsidies for STD Testing. *Quarterly Journal of Economics* 110 (2), 445–474.

Potts, Malcom et al. (2008). Reassessing HIV Prevention. *Science* 320 (5877), 749–750.

Reniers, Georges and Jeffrey Eaton (2009). Refusal Bias in HIV Prevalence Estimates from Nationally Representative Seroprevalence Surveys. *AIDS* 23 (5), 621–629.

Resch, Stephen et al. (2011). Economic Returns to Investment in AIDS Treatment in Low and Middle Income Countries. *PLoS One* 6 (10), 1–9.

Reynolds, Heidi W., Winnie K. Luseno, and Ilene S. Speizer (2013). Consistent Condom Use Among Men with Non-Marital Partners in Four Sub-Saharan African Countries. *AIDS Care* 25 (5), 592–600.

Rosenbaum, Paul R. (2007). Interference Between Units in Randomized Experiments. *Journal of the American Statistical Association* 102 (477), 191–200.

Rubin, Donald B. (1974). Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies. *Journal of Educational Psychology* 66 (5), 688–701.

— (1980). Randomization Analysis of Experimental Data: The Fisher Randomization Test Comment. *Journal of the American Statistical Association* 75 (371), 591–593.

Sarma, Sisira (2009). Demand for Outpatient Healthcare: Empirical Findings from Rural India. *Applied Health Economics and Health Policy* 7 (4), 265–277.

Sasaki, Yuri et al. (2012). Adherence to Antiretroviral Therapy (ART) During the Early Months of Treatment in Rural Zambia: Influence of Demographic Characteristics and Social Surroundings of Patients. *Annals of Clinical Microbiology and Antimicrobials* 11 (34), 1–11.

Sawers, Larry and Eileen Stillwaggon (2010). Concurrent Sexual Partnerships Do Not Explain the HIV Epidemics in Africa: A Systematic Review of the Evidence. *Journal of the International AIDS Society* 13 (34), 1–23.

Schoeps, Anja et al. (2011). The Effect of Distance to Health-Care Facilities on Childhood Mortality in Rural Burkina Faso. *American Journal of Epidemiology* 173 (5), 492–498.

Schultz, T. Paul (2004). Health Economics and Applications in Developing Countries. *Journal of Health Economics* 23 (4), 637–641.

Seidenfeld, David (2014). An Intervention to Increase the Condom Supply in Rural Zambia. *Studies in Family Planning* 45 (3), 379–387.

Shampanier, Kristina, Nina Mazar, and Dan Ariely (2007). Zero as a Special Price: The True Value of Free Products. *Marketing Science* 26 (6), 742–757.

Spears, Dean (2014). Decision Costs and Price Sensitivity: Field Experimental Evidence from India. *Journal of Economic Behavior and Organization* 97, 169–184.

Stringer, Jeffrey S. A. et al. (2006). Rapid Scale-Up of Antiretroviral Therapy at Primary Care Sites in Zambia: Feasibility and Early Outcomes. *Journal of the American Medical Association* 296 (7), 782–793.

Sultan, Binta, Paul Benn, and Laura Waters (2014). Current Perspectives in HIV Post-Exposure Prophylaxis. *HIV/AIDS - Research and Palliative Care* 6, 147–158.

Sweat, Michael D. et al. (2012). Effects of Condom Social Marketing on Condom Use in Developing Countries: A Systematic Review and Meta-Analysis, 1990–2010. *Bulletin of the World Health Organization* 90 (8), 613–622.

Tanser, Frank, Brice Gijsbertsen, and Kobus Herbst (2006). Modelling and Understanding Primary Health Care Accessibility and Utilization in Rural South Africa: An Exploration Using a Geographical Information System. *Social Science and Medicine* 63 (3), 691–705.

Tanser, Frank et al. (2011). Effect of Concurrent Sexual Partnerships on Rate of New HIV Infections in a High-Prevalence, Rural South African Population: A Cohort Study. *Lancet* 378 (9787), 247–255.

Tanser, Frank et al. (2013). High Coverage of ART Associated with Decline in Risk of HIV Acquisition in Rural KwaZulu-Natal, South Africa. *Science* 339 (6122), 966–971.

Tarozzi, Alessandro et al. (2014). Micro-Loans, Insecticide-Treated Bednets, and Malaria: Evidence from a Randomized Controlled Trial in Orissa, India. *American Economic Review* 104 (7), 1909–1941.

Terris-Prestholt, Fern and Frank Windmeijer (2016). How to Sell a Condom? The Impact of Demand Creation Tools on Male and Female Condom Sales in Resource Limited Settings. *Journal of Health Economics* 48, 107–120.

Thirumurthy, Harsha, Joshua Graff Zivin, and Markus Goldstein (2008). The Economic Impact of AIDS Treatment: Labor Supply in Western Kenya. *Journal of Human Resources* 43 (3), 511–552.

Thornton, Rebecca L. (2008). The Demand for, and Impact of, Learning HIV Status. *American Economic Review* 98 (5), 1829–1863.

— (2012). HIV Testing, Subjective Beliefs and Economic Behavior. *Journal of Development Economics* 99 (2), 300–313.

Todd, Jim et al. (2007). Time from HIV Seroconversion to Death: A Collaborative Analysis of Eight Studies in Six Low and Middle-Income Countries Before Highly Active Antiretroviral Therapy. *AIDS* 21 (Suppl. 6), S55–S63.

Train, Kenneth (2009). *Discrete Choice Methods with Simulation.* 2nd Edition. Cambridge: Cambridge University Press.

UNAIDS Reference Group on Estimates, Modelling, and Projections: Working Group on Measuring Concurrent Sexual Partnerships [UNAIDS Reference Group] (2010). HIV: Consensus Indicators are Needed for Concurrency. *Lancet* 375 (9715), 621–622.

United Nations Development Programme [UNDP] (2016). *Industrialisation and Human Development: Poverty Reduction Through Wealth and Employment Creation.* Zambia Human Development Report 2016. Lusaka.

United Nations International Children's Emergency Fund [UNICEF] and World Health Organization [WHO] (2015). *Progress on Sanitation and Drinking Water. 2015 Update and MDG Assessment*. Geneva.

United Nations Joint Programme on HIV/AIDS [UNAIDS] (2011). *UNAIDS Terminology Guidelines*. Geneva.

— (2012). *Global Report: UNAIDS Report on the Global AIDS Epidemic 2012*. Geneva.

— (2013). *Global Report: UNAIDS Report on the Global AIDS Epidemic 2013*. Geneva.

— (2016a). *Fact Sheet 2016*. URL: http://www.unaids.org/en/resources/fact-sheet (visited on 02/08/2016).

— (2016b). *Prevention Gap Report*. Geneva.

— (2017). *AIDSinfo*. URL: www.aidsinfo.unaids.org (visited on 02/07/2017).

United Nations Population Fund [UNFPA] (2011). *Donor Support for Contraceptives and Condoms for Family Planning and STI/HIV Prevention 2010*. New York.

United Nations Population Fund [UNFPA], World Health Organization [WHO], and United Nations Joint Programme on HIV/AIDS [UNAIDS] (2015). *Position Statement on Condoms and the Prevention of HIV, Other Sexually Transmitted Infections and Unintended Pregnancy*. URL: http://www.unaids.org/en/resources/presscentre/featurestories/2015/july/20150702_condoms_prevention (visited on 09/10/2017).

Varkevisser, Marco, Stéphanie A. van der Geest, and Frederik T. Schut (2012). Do Patients Choose Hospitals with High Quality Ratings? Empirical Evidence from the Market for Angioplasty in the Netherlands. *Journal of Health Economics* 31 (2), 371–378.

Wagstaff, Adam and Eddy van Doorslaer (2000). Equity in Health Care Finance and Delivery. *Handbook of Health Economics*. Ed. by Anthony J. Culyer and Joseph P. Newhouse. 1st Edition. Vol. 1A. Amsterdam: North Holland, 1803–1862.

Wandel, Simon et al. (2008). Duration from Seroconversion to Eligibility for Antiretroviral Therapy and from ART Eligibility to Death in Adult HIV-Infected Patients from Low and Middle-Income Countries: Collaborative Analysis of Prospective Studies. *Sexually Transmitted Infections* 84 (Suppl. 1), i31–i36.

Weinhardt, Lance S., Michael P. Carey, Blair T. Johnson, and Nicole L. Bickham (1999). Effects of HIV Counseling and Testing on Sexual Risk Behavior: A Meta-Analytic Review of Published Research, 1985-1997. *American Journal of Public Health* 89 (9), 1397–1405.

Weller, Susan C. and Karen Davis-Beaty (2002). Condom Effectiveness in Reducing Heterosexual HIV Transmission. *Cochrane Database of Systematic Reviews* 2002 (1), 1–25.

Westercamp, Nelli et al. (2010). Determinants of Consistent Condom Use Vary by Partner Type Among Young Men in Kisumu, Kenya: A Multi-Level Data Analysis. *AIDS and Behavior* 14 (4), 949–959.

Winfrey, William (2003). *Willingness to Pay Increased Prices for Reproductive Health Products and Services in Ghana*. Country Research Series No. 12. Washington, DC: USAID/Commercial Market Strategies Project.

Wolff, Brent et al. (2005). Evaluation of a Home-Based Voluntary Counselling and Testing Intervention in Rural Uganda. *Health Policy and Planning* 20 (2), 109–116.

Wooldridge, Jeffrey M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge: MIT Press.

World Bank (2015). *6th Zambia Economic Brief: Powering the Zambian Economy*. Washington, DC.

— (2017). *World Development Indicators*. URL: `https://data.worldbank.org/data-catalog/world-development-indicators` (visited on 08/02/2017).

World Health Organization [WHO] (2016a). *Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Recommendations for a Public Health Approach*. 2nd Edition. Geneva.

— (2016b). *HIV/AIDS*. URL: `http://www.who.int/features/qa/71/en` (visited on 08/02/2016).

— (2017a). *HIV/AIDS Fact sheet*. URL: `http://www.who.int/mediacentre/factsheets/fs360/en` (visited on 08/09/2017).

— (2017b). *Mother-to-Child Transmission of HIV*. URL: `http://www.who.int/hiv/topics/mtct/about/en/` (visited on 08/09/2017).

— (2017c). *The Top 10 Causes of Death*. URL: `http://www.who.int/mediacentre/factsheets/fs310/en/` (visited on 08/09/2017).

Zivin, Joshua Graff, Harsha Thirumurthy, and Markus Goldstein (2009). AIDS Treatment and Intrahousehold Resource Allocation: Children's Nutrition and Schooling in Kenya. *Journal of Public Economics* 93 (7-8), 1008–1015.