Retail Pharmacy Market in Kigali

A game theoretical application on antimicrobial resistance

Agnes Durbeej-Hjalt

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Abstract

Antimicrobial resistance is an acute global health problem. Sub-Saharan Africa is particularly vulnerable, where antibiotic self-medication is one of the main causes of antimicrobial resistance. Previous research points to the role of pharmacies, where antibiotics are sometimes sold over the counter. Such behavior can be analyzed economically using game theory. This study aimed to analyze and motivate the payoffs which make up the incentives of Rwandan retail pharmacies to sell non-prescribed antibiotics and Rwandan consumers to self-medicate on non-prescribed antibiotics. The aim was fulfilled by first mapping out two hypothetical games on the strategic interaction of pharmacies and healthcare seekers with payoffs based on previous research on AMR in Rwanda. Thereafter, face-to-face semi-structured interviews were conducted with licensed retail pharmacists in Rwanda's capital city Kigali. Six themes were identified: (1) profit-prioritizing practice (2) expensive prescription (3) strong customer demand (4) retail pharmacy medical advice (5) conflict of interest (6) collaboration problem. These themes were then used to modify the games to better align them with reality. Subsequently, four policies were briefly proposed as ways of altering the payoffs to move the equilibria to the societally optimal ones: (1) enforce an over-the-counter dispensing protocol (2) introduce record-keeping of antibiotic sales (3) decrease the costs of visiting public health institutions (4) execute an awareness campaign for the general public as well as include antimicrobial resistance in retail pharmacists' continuing professional development. These policies and the illustrative games can be of great use to Rwandan regulators in their implementation of their newly adopted national action plan to combat antimicrobial resistance, as well as to fulfill Sustainable Development Goal three of good health for all.

Key words: antimicrobial resistance, over-the-counter antibiotics, retail pharmacy market, Rwanda, game theory

List of Abbreviations

AMR Antimicrobial Resistance

AMRNAP National Action Plan on Antimicrobial Resistance

CBHI Community-Based Health Insurance; *Mutuelle de Santé*

CPD Continuing Professional Development

LMIC Low-to-Middle Income Countries

MoH (Rwanda's) Ministry of Health

NAP National Action Plan

NPC (Rwanda's) National Pharmacy Council

OTC antibiotic Over-the-counter antibiotic; antibiotic without prescription

RFDA Rwanda Food and Drugs Authority

1. Introduction

Antimicrobials are medicines like antibiotics, antivirals, antiparasitics, and antifungals used to fight infections in humans, animals, and plants. *Antimicrobial resistance (AMR)* is the transmissible ability of bacteria, viruses, parasites, and fungi to fight such antimicrobials, so that they are no longer effective. Easily treatable diseases can thus once again become deadly, making AMR one of the most urgent global health problems. (World Health Organization, 2021) The World Bank (2017) has also estimated the economic costs of AMR to be severe.

In 2015, the member states of the World Health Organization were encouraged to develop their own *national action plan to fight AMR*, AMRNAP (World Health Organization, n.d.). In line with this, Rwanda adopted a four-year (2020-2024) AMRNAP (Republic of Rwanda, 2021). Since the implementation is still in its early stages, this study will help reach its different strategic objectives, one of them being to conduct more research. Additionally, following that reaching the United Nations' Agenda 2030 Sustainable Development Goals is becoming all the more pressing, this study also strives to help fulfill Sustainable Development Goal three, "to ensure healthy lives and promote well-being for all at all ages" (United Nations, 2021, n.p.).

This study will constitute a game theoretical application on the problem of AMR in Rwanda. It will focus specifically on retail pharmacies in Kigali and their relation to consumers' self-medication on antibiotics, antibiotics being the antimicrobial used as medicine for bacterial infection (World Health Organization, 2021). The aim of the study is to analyze and motivate the payoffs which make up the incentives of retail pharmacies to sell non-prescribed antibiotics and consumers to self-medicate on non-prescribed antibiotics. First, two hypothetical games will be mapped out with payoffs based on previous research on AMR in Rwanda. Thereafter, using the results from face-to-face semi-structured interviews with licensed retail pharmacists in Rwanda's capital city Kigali, these games will be modified to better correspond to reality. These altered games can help Rwandan regulators to implement appropriate policies to effectively combat AMR, in line with their AMRNAP. Four such policies will be briefly proposed at the end of the essay.

2. Background and Literature Review

There are plenty of medical research studies on the subject of AMR. Economic research on the other hand is scarce. There is thus a need for more economic applications on the AMR problem, which this study aims to fulfil. This section will first present previous research on AMR in developing countries worldwide. Then, the specific context of Rwanda and the Rwandan health system will be laid out, before going over previous research on AMR in Rwanda exclusively.

2.1 OTC Sales of Antibiotics in Pharmacies Worldwide

Generally, according to Torres et al. (2019), more research is needed on the underlying reasons for antibiotic self-medication in LMIC (low-to-middle income counties), especially in Sub-Saharan Africa. Reoccurring self-medication on antibiotics brings a high risk of developing AMR (Torres et al., 2019). The World Health Organization (2000) defines self-medication as "the use of medicinal products […] to treat self-recognized disorders or symptoms, or the intermittent or continued use of a medication prescribed by a physician for chronic or recurring diseases or symptoms." (p. 9). Much of the research conducted on self-medication of antibiotics in developing countries point to the role of pharmacies, where antibiotics are sometimes sold over the counter (henceforth OTC).

Sakeena, Bennet and McLachlan (2018) summarized findings in developing countries on OTC sales of antibiotics in community pharmacies. They concluded that should a pharmacist refuse to provide antibiotics to a demanding customer, that customer could easily obtain them from another pharmacy. Hence, there is commercial pressure on pharmacy staff, stemming from consumer demand which in turn comes from lack of knowledge on AMR among the general public, such that profits are prioritized over proper health consultation. (Sakeena, Bennet & McLachlan, 2018)

Similarly, Belachew et al. (2021) studied the drivers for sales of OTC antibiotics in LMIC community drug retail outlets, two of which have an economic character. One driver was maximizing profits in the commercial context of non-subsidized pharmacies – they lose business if they refuse to sell antibiotics OTC. Another driver was consumer demand, induced by previous satisfaction with community drug retail outlets and dissatisfaction with public health facilities. These two economic drivers are not discussed further in the study, however, which again underscores the importance of more economic research.

For African countries specifically, a 2021 systematic review by Yeika et al. drew similar conclusions on the occurrence of self-medication of antibiotics, including that because of monetary and time-wise costs of consulting a doctor, going to the community pharmacy for OTC antibiotics is a cheaper option. Equivalent findings have been made in *Ethiopia* (Ayalew, M.B., 2017; Gebrekirstos et al., 2017; Koji, Gebretekle, & Tekle, 2019; Mengistu et al., 2019; Gebretekle & Serbassa, 2, 2016; Erku & Aberra, 2018), *Cameroon* (Elong Ekambi et al., 2019), *Tanzania* (Horumpende et al., 2018; Mboya, Sanga & Ngocho, 2018; Dillip et al., 2015), *Uganda* (Mbonye et al., 2016), *Sudan* (Salim & Elgizoli, 2016), and *Kenya* (Wafula, 2013).

2.2 OTC Sales of Antibiotics in Rwandan Pharmacies

To grasp the research done so far on AMR in Rwanda, as well as the results and analysis of this study, Rwanda's health system and retail pharmacy market must first be introduced. Thereafter, previous research on AMR in Rwanda will be presented, followed by a summarizing review of a typical Rwandan healthcare seeker.

2.2.1 Rwanda's Health System

The Rwandan health system can be separated into the public, faith-based, and the private sector. The *faith-based sector* consists of health centers and hospitals run by religious organizations (Bizimana, Kayumba & Heide, 2020). In 2014 they made up about 14 percent of all health facilities in Rwanda, the private sector then constituting 19 percent, and the public sector 67 percent (Ministry of Health, 2014).

The health institutions of the Rwandan *public sector* are community health workers, health posts, health centers, district hospitals, provincial hospitals, and national referral hospitals. The main principle is that healthcare should be sought in that order. That is, the patient starts with the community health workers; if they cannot help, they are referred to a health post or health center; if they cannot help, they are referred to a district hospital, and so on. (Ministry of Health, 2019) Similarly, the dispensing authority of antimicrobials is rising, where community health workers can dispense some simpler types of antimicrobials like antimalaria, while public hospitals have the most extensive dispensing authorization (Ministry of Health, 2015).

The health institutions of the Rwandan *private sector* are retail pharmacies, private clinics and polyclinics, private hospitals, and private dispensaries. *Retail pharmacies* can be opened by anyone who possesses the capital necessary. Each retail pharmacy however needs to have hired a supervising pharmacist licensed with the NPC. (Law N°12/99 Relating to the Pharmaceutical

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Art, 2013). Retail pharmacies dispense both non-prescribed medication, and medication as prescribed from any other health institution. There are currently 448 retail pharmacies in Rwanda (Ministry of Health, 2020). Private health facilities are only allowed to store emergency medicines, so when a medicine is prescribed from a private health institution, the patient must go to a retail pharmacy to retrieve it (Ministerial Instructions N°23 of 23 Sept 2020 Governing Private Health Facilities in Rwanda, 2020; Bizimana, Kayumba & Heide, 2020). Further regulation of the pharmacy profession will be covered below.

2.2.2 Regulatory Bodies

There are three regulating bodies of retail pharmacies in Rwanda: the Rwandan *Ministry of Health* (MoH), the *Rwanda Food and Drugs Authority* (RFDA), and the Rwandan *National Pharmacy Council* (NPC).

The highest decision-making body is the MoH. They are in part responsible for the Rwandan AMRNAP. MoH is also the principal of the Rwandan National List of Essential Medicines for Adults, where among other medicines the antibacterials, antivirals, antifungals, and other antimicrobials are listed for where they can be prescribed out of the different health institutions (Ministry of Health, 2015). Directly below the MoH is the newly founded (2018) government authority RFDA. They are among other things responsible for the supervision of pharmacy professionals. (Rwanda FDA, 2022)

In Rwanda, pharmacy professionals need to have a license to practice. This license is renewed each year. The licensing process is handled by NPC, founded in 2013, today working under the RFDA. (National Pharmacy Council, n.d.a.; Drame et al., 2019) In 2021, there were 769 pharmacists registered (National Pharmacy Council, 2021b). Not all work in retail pharmacies – some are in pharmaceutical wholesaling, some are in government authorities, etcetera.

2.2.3 Pharmacy Regulation

There are a few regulations of the pharmacy profession, apart from the licensing requirement, which are necessary to mention to understand the results and policy proposals of this study.

This essay will continuously mention 'malpractice' and 'unprofessional practice'. This is mainly in referral to the Ministerial Order N°20/37 of 30/10/2015 Determining the Code of Ethics for Pharmacy Profession, henceforth Code of Ethics. It says: "A pharmacy professional must make health and welfare of clients and community his/her prime concern." (Chapter II, Article 3). Further, "A pharmacy professional must (1) exercise his/her professional judgement

and act in the best interest of clients and the public. (2) ensure that his/her professional judgement is not impaired by any other commercial interests." (Chapter II, Article 6). Further, Chapter IV, Article 15 stipulates that "A client is entitled to the right of continuity of care. However, a pharmacy professional must, if considered necessary, assist and refer a client to another pharmacy professional in order to maintain continuity of service and care.". Thus, the Code of Ethics iterates that proper health consultation is to be prioritized over profit maximization. This is also repeatedly emphasized in the Good Pharmacy Practice in Rwanda compliance document from 2021 (National Pharmacy Council, 2021a).

Currently however, there is no regulation explicitly saying that antibiotics cannot be sold without prescription. Neither is there any regulation on what drugs can be sold OTC and which drugs require prescription. This is from reviewing all publications officially published by the NPC, RFDA, and MoH respectively, as well as cross-checking with Jose Edouard Munyangaju at the RFDA (personal interviews May 3 and May 17 2022). Thus, the behavior of selling antibiotics without prescription is not sanctioned explicitly at the moment. This is despite the fact that when there has been no clinical examination, there is a risk of having the customer unnecessarily consuming antibiotics, which increases their risk of developing AMR. However, it could go as malpractice in terms of prioritizing profits over patient health. An educated pharmacist ought to be aware of the dangers of consuming antibiotics when there is no clinical need. The only reason for selling antibiotics to a customer without prescription would then be to earn money from that sale. Thus, given that the pharmacist is aware of the problem of AMR, them intentionally putting an antibiotic sale above patient health could still be sanctioned if such malpractice is detected.

To detect malpractice, the RFDA regularly inspect pharmacies. They conduct both general inspections, often annually, as well as specific inspections. Such specific inspections can occur for example when a supervising pharmacist has submitted a letter of resignation to the RFDA, informing them that they are leaving a certain pharmacy. Then the RFDA will inform the pharmacy owner that they need to close their pharmacy until they have hired a new supervising pharmacist. During that time, the RFDA can come to do a specific inspection. Both general and specific inspections can be conducted without prior announcement. (Law N°12/99 Relating to the Regulation and Inspection of Food and Pharmaceutical Products, 2013)

Another important regulation of the pharmacy profession was put into place in 2013. Before then, only pharmacists were allowed to open pharmacies (Karuhanga, 2012). However, now

anyone with sufficient capital can start their own pharmacy business. The reason for this change was according to Jose Edouard Munyangaju at the RFDA (personal interviews May 3 and May 17 2022) a downturn in the pharmaceutical business in general – newly graduated pharmacists generally lack the startup capital required to open a pharmacy – and although all retail pharmacies were owned by a pharmacist on paper, it was often someone else who was the business owner in practice. Thus, it was decided in 2013 that anyone can open a retail pharmacy. They still have to hire a responsible pharmacist though (Regulations N° CBD/TRG/001 Rev. N°0 "Regulations governing licensing to manufacture pharmaceutical products or to operate as wholesale or retailer seller of pharmaceutical products", 2020).

If a pharmacist does not comply to these regulations, they will face disciplinary measures upon detection. For "Failure to exercise professional judgment and act in the interest of the public due to personal interest or any other reason behind it" (p.22), which is the malpractice most applicable to selling antibiotics without prescription, the sanction can range from a warning letter to temporary suspension of maximum three months, depending on the NPC's judgement of the gravity of the malpractice. They can also be prohibited to be elected as chairmen for the NPC. (National Pharmacy Council, 2022).

2.2.4 Previous Research on AMR in Rwanda

Now that some background information has been laid out, a literature review of OTC sales of antibiotics in Rwanda will be presented. The research studies mainly illustrate Rwandans' incentives to self-medicate and seek different types of healthcare.

For Rwanda, a 2020 study by Nisabwe et al. found that undergraduate health students at the University of Rwanda, including pharmacy students, self-medicate on antibiotics without consulting a health provider, despite them having good knowledge on the problem of AMR. That said, Rwandan healthcare students can practice directly after graduating, for example in a pharmacy. (Nisabwe et al., 2020) A similar study examined undergraduate students at all colleges of the University of Rwanda (except the College of Education). It concluded that not only is self-medication of antibiotics a common health-seeking behavior among university students, but also their main source was community pharmacies – a whopping 72 percent. They authors identified the main reason for such antibiotic self-medication as consulting a doctor being considered too burdensome for the sickness at hand. (Tuyishimire et al., 2019) Correspondingly, 78 percent of Rwandan parents sought self-medication for their children, in a

study by Ukwishaka et al. (2020). Among those, 93 percent had a pharmacy as their source for OTC drugs.

Additionally, Bizimana, Kayumba and Heide (2020) investigated price and availability of common medication, including antibiotics, in Rwanda's private pharmacies, faith-based health centers, public health centers, and district hospitals respectively. They found that prices on generic medicine were 103 percent higher in private pharmacies compared to public facilities. However, the antibiotics included in the study were available to a degree of 93.3 percent in private pharmacies compared to only about 60 percent in both the public and faith-based sector. Although many Rwandans are covered by health insurances that apply to purchases at public health centers, the drug availability there is as said low, making Rwandans turn to the private sector where they are not reimbursed. (Bizimana, Kayumba & Heide, 2020) This will be further discussed below.

2.2.5 The Rwandan Healthcare Seeker

Lastly, the conditions for a Rwandan to seek healthcare will be summarized, mainly in terms of health insurance. These conditions will make up the incentives for Rwandans to self-medicate on non-prescribed antibiotics in the games presented in the next chapter.

According to the latest Demographic and Health Survey, about 85 percent of the Kigali population are covered by some health insurance (National Institute of Statistics of Rwanda, 2022). The biggest is *Mutuelle de Santé*, or Community Based Health Insurance, henceforth CBHI, which applies only to public health institutions (Rwanda Social Security Board, n.d.a.). CBHI covers about 70 percent of the Kigali population (National Institute of Statistics of Rwanda, 2021). Retail pharmacies can collaborate with health insurance companies to gain access to their customers, but they cannot partner with CBHI, because CBHI only covers health consultation and drug purchases in public health institutions.

Thus, the main part of the Rwandan population is not reimbursed for purchases in retail pharmacies. Still, the literature review of AMR in Rwanda pointed out that going to retail pharmacies is a very common health-seeking behavior among Rwandans. Since a part of the aim of this study is to analyze and motivate the payoffs which make up the incentives of consumers to self-medicate on non-prescribed antibiotics, a part of the aim of this essay is to examine why uninsured and CBHI patients still have incentives to self-medicate from OTC purchases in retail pharmacies, where neither have cost coverage. While the medicine is more

expensive, the availability is much higher, so customers can be sure that they get the medicine they want. There are also substantial costs associated with visiting public health institutions, which will be summarized in Table 1 below. For example, CBHI patients are only covered for health consultation if they follow a certain channel of transfer: they must visit a health post or health center first, and can then be referred to a public hospital, meaning they cannot visit for example a district hospital directly (Rwanda Social Security Board, n.d.a.).

For the other insurances to cover retail pharmacy purchases, customers need to have obtained a prescription. The second most common insurance type, after CBHI, is to have health insurance through one's employer. This makes up about 10 percent of the Kigali population, including health insurance from the Rwandan Social Security Board (RSSB) for employees in the public sector and the Military Medical Insurance (MMI) for employees in the military. There are also private insurance companies, but less than three percent of the Kigali population use them. (National Institute of Statistics of Rwanda, 2021)

Table 1 provides an overview of the associated costs and benefits of a Kigali-based healthcare seeker, contingent on health insurance situation and the health institution they visit. Medicines can be obtained from both public and private health institutions, but the drug availability is vastly different, as described in 2.2.4. These costs and benefits will make up the incentives for a Rwandan to self-medicate on non-prescribed antibiotics in the games presented further below.

Table 1. The associated costs and benefits of seeking healthcare at different health institutions for an average Kigali citizen contingent on different types of health insurances.[1]

	Retail pharmacy	Public health institution	Private health institution[2]
Insured: CBHI **(~70%)**	*Costs*: No cost coverage for medicine purchase. Expensive medicine. Transportation costs, mainly if in rural area. *Benefits*: Quick service. High drug availability.	*Costs*: Long waiting time, constituting opportunity costs[3]. Low drug availability. Transportation costs. Have to follow channel of transfer for cost coverage for health consultation. *Benefits*: Cost coverage for health consultation (co-payment 200 RWF[4] at health posts and health centers, 90% at hospitals)[5]. Cheap medicine.	*Costs*: No cost coverage for health consultation. Drugs are obtained from retail pharmacies, see first column. Transportation costs, mainly if in rural area. *Benefits*: Quick service. High drug availability.

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[1] This table has been cross-checked with Jose Edouard Munyangaju at the RFDA (personal interviews May 3 and May 17 2022)
[2] Private health institution that is not a retail pharmacy
[3] in terms of spending an entire day waiting to reach a doctor which could instead have been spent on work.
[4] Rwandan francs
[5] Rwanda Social Security Board, n.d.a.

Insured: private health insurance[6] (~3%)	*Costs*: For cost coverage a prescription must be obtained from public or private health institution, see the next two columns. Expensive medicine. Transportation costs, mainly if in rural area. *Benefits*: Cost coverage in designated pharmacies for medicine purchase if obtained prescription (90%). Quick service. High drug availability.	*Costs*: Long waiting time, constituting opportunity costs. Low drug availability. Transportation costs. *Benefits*: Cost coverage for health consultation (85% at King Faisal Hospital, 90% elsewhere). Cheap medicine.	*Costs*: Drugs are obtained from retail pharmacies, see first column. Transportation costs, mainly if in rural area. *Benefits*: Cost coverage for health consultation in designated facilities (90%). Quick service. High drug availability.
Insured: employer[7] (~10%)	*Costs*: For cost coverage a prescription must be obtained from public or private health institution, see the next two columns. Expensive medicine. Transportation costs, mainly if in rural area. *Benefits*: Cost coverage in designated pharmacies for medicine purchase if obtained prescription (85%). Quick service. High drug availability.	Costs: Long waiting time, constituting opportunity costs. Low drug availability. Transportation costs. Benefits: Cost coverage for health consultation (85%). Cheap medicine.	*Costs*: Drugs are obtained from retail pharmacies, see first column. Transportation costs, mainly if in rural area. Cost coverage for health consultation only in designated facilities. *Benefits*: Cost coverage for health consultation in designated facilities (85%). Quick service. High drug availability.
Uninsured (~17%)	*Costs*: No cost coverage for medicine purchase. Expensive medicine. Transportation costs, mainly if in rural area. *Benefits*: Quick service. High drug availability.	*Costs*: Paying for health consultation out of pocket. Long waiting time, constituting opportunity costs. Low drug availability. Transportation costs. *Benefits*: Cheaper out-of-pocket payment for health consultation than private health institutions. Cheap medicine.	*Costs*: Paying for health consultation out of pocket, which is more expensive than in public health institutions. Drugs are obtained from retail pharmacies, see first column. Transportation costs, mainly if in rural area. *Benefits*: Quick service. High drug availability.

As can be seen in Table 1, the associated costs and benefits of visiting a retail pharmacy as well any other private health institution are exactly the same for an uninsured patient and a patient with CBHI. They are similar also in their incentives to visit a public health institution, the only difference is that while uninsured pay for health consultation out of pocket, CBHI patients have cost coverage but only if they follow the channel of transfer. This difference will be brought up

[6] Co-payment rates based on Soras Assurances Generales (Soras Assurances Generales, n.d.)
[7] Including RSSB and MMI. Co-payment rates based on RSSB (Rwanda Social Security Board, n.d.b.)

further in the essay. Nevertheless, uninsured and CBHI patients together make up the majority of the Kigali population, and they are next to identical in their incentives to seek healthcare, which is why they will together be one of the players in the games presented below. Their monetary and non-monetary costs and benefits of visiting these health institutions will constitute their payoffs.

3. Game Theory: Two Hypothetical Games

The aim of this study is to analyze and motivate the payoffs which make up the incentives of retail pharmacies to sell non-prescribed antibiotics and consumers to self-medicate on non-prescribed antibiotics. The strategic interaction of Rwandan pharmacies selling OTC antibiotics will thus be analyzed using a game theoretical approach. Two hypothetical games will be presented, with payoffs chosen to illustrate the behaviors found in the literature review. They will later be modified following the interview results.

Game 1 focuses on the strategic interaction of a retail pharmacy and a local patient. The local patient is uninsured or only carries CBHI, meaning retail pharmacy purchases have to be paid 100 percent out of pocket. Game 2 displays the horizontal competition between two retail pharmacies, assuming there are only two retail pharmacies to choose from in a free market. For both games it is assumed that consumers follow the utility maximization principle, that pharmacies follow the profit maximizing principle, that both players are rational and reason strategically, and that a pharmacy professional will act as if (s)he is responsible for the pharmacy's survival on the pharmacy market. The games are also static and non-cooperative. (Pepall, Richards & Norman, 2008; Varian, 2014) Finally, it is assumed that pharmacists are highly aware of the problem of AMR and how it is caused by misuse of antibiotics. This is to define the only reason for them to sell antibiotics without prescription being to earn money, meaning intentionally putting an antibiotic sale above patient health, which would go as malpractice according to current regulation.

3.1 Game 1
In Game 1, the two players are a local patient and a retail pharmacy. The retail pharmacy's two possible strategies are either strategy S or N. *Strategy S* means that the local pharmacy chooses to *sell OTC antibiotics*, and that other pharmacies do the same. *Strategy N* means the local pharmacy *does not sell OTC antibiotics*, while other pharmacies do, but would sell antibiotics when the customer brings a prescription. Thus, for both strategies of the retail pharmacy, it is assumed that its surrounding competing pharmacies do sell OTC antibiotics.

For the other player, the local patient with CBHI or no health insurance, the two possible strategies are S and P. In this case, *strategy S* means that the local patient chooses to *self-medicate on OTC antibiotics*. *Strategy P* means that the local patient instead chooses to *go to a prescriber* to gain a nurse's, general practitioner's, or doctor's opinion, depending on which level of health institution they choose to visit (uninsured patients can choose whichever, while CBHI patients must follow the channel of transfer in public health institutions to have cost coverage for health consultation), on their health situation and potentially get a prescription for the appropriate antibiotic or another more suitable medicine. The payoffs of the local patient are constructed such that (s)he perceives the utility of receiving a prescriber's opinion as relatively low compared to its monetary and time-wise costs as displayed in Table 1. That is, the payoffs of strategy P are relatively low to strategy S.

Game 1: The game between a local patient and a retail pharmacy.

Game 1	Player 2: Retail Pharmacy	
Player 1: Local Patient	S = Sell OTC antibiotics	N = Do not sell OTC antibiotics
S = Self-medicate on OTC antibiotics	5, 10	4, 2
P = Go to prescriber	3, 4	3, 4

In the upper left cell, the local patient chooses to self-medicate on OTC antibiotics and the retail pharmacy chooses to sell them, both receiving their highest payoff of 5 and 10 respectively. In the upper right cell, the patient still chooses to self-medicate, but now the retail pharmacy refuses to sell them OTC antibiotics. The payoffs are then lower, 4<5 and 2<10 respectively. Note that in the upper right cell the local patient goes to another competing pharmacy to obtain OTC antibiotics. So, in the upper right cell the patient still self-medicates, but they have to go to another pharmacy to do so, meaning their payoff is slightly lower than that of the upper left cell because of the transportation costs (4<5), while the retail pharmacy player loses a sale to another pharmacy resulting in a much larger relative payoff decrease (2<10).

In the lower cells, the local patient instead chooses to go to a prescriber. The payoffs for both players are then the same regardless of whether or not the retail pharmacy would have sold OTC antibiotics. For the retail pharmacy, this is because when their customer has consulted a prescriber already, none of the strategies is preferred over the other, since strategy N also entailed selling antibiotics once the customer presents a prescription. So, they might still get to

sell, compared to the outcome in the upper right cell when the customers goes to a competing pharmacy (4>2), but the payoff is still lower than in the upper left cell (4<10) because they might have to wait for some time before the customer returns with a prescription and, more importantly, the patient might not get a prescription at all and not come back. For the local patient in turn, it does not matter if the pharmacy would refuse to sell antibiotics without prescription or not, because it is assumed they trust the prescriber's opinion on how they should treat the ailment at hand, regardless of whether that entails going to the retail pharmacy to retrieve a prescribed antibiotic or for example let the sickness have its course by resting at home (3=3). Still, the payoffs in the bottom cells are lower than those in the upper (3<4<5), because of the costs associated with consulting a prescriber presented in Table 1.

In Game 1, (S, S) marked with downward sloping lines is an equilibrium in dominant strategies, where the local patient is better of self-medicating independent of what the local retail pharmacy chooses to do, and the local retail pharmacy is better off selling OTC antibiotics independent of what the local patient chooses to do. Hence, the dominant equilibrium illustrates the current Rwandan situation described in the literature review. However, it can be assumed that (P, N), marked with upward sloping lines, is the efficient outcome for society as a whole: the retail pharmacy sells antibiotics only if even uninsured customers and customers of CBHI bring a prescription, and the local patient chooses to go to a prescriber rather than to self-medicate. That would eliminate the risk of patients overusing antibiotics, which increases AMR.

3.2 Game 2

In Game 2, the players are instead two different retail pharmacies, Pharmacy A and Pharmacy B. The strategies S and N are the same here as for the retail pharmacy in Game 1. Again, it is assumed they are the only retail pharmacies competing on a free market. It is also assumed that when neither of the pharmacies sell antibiotics without prescription, the market will shrink, so that the payoffs for both pharmacies decrease.

Game 2: The game between retail pharmacies on the local retail pharmacy market.

Game 2	Player 2: Pharmacy B	
Player 1: Pharmacy A	S = Sell OTC antibiotics	N = Do not sell OTC antibiotics
S = Sell OTC antibiotics	10, 10	14, 5
N = Do not sell OTC antibiotics	5, 14	8, 8

In the upper left cell, both retail pharmacies choose to sell OTC antibiotics when customers ask for it (meaning it is not a matter of the retail pharmacy recommending the customer to buy an antibiotic without them demanding it first). They receive equal payoff from this (10 each). In the upper right cell, only Pharmacy A chooses to sell OTC antibiotics, while Pharmacy B refuses customers wanting OTC antibiotics. Thus, Pharmacy A gains those demanding customers from Pharmacy B (14 versus 5 in payoff). The market does shrink with -1 compared to when both pharmacies sell, because only one retail pharmacy on the market is making those sales. In the lower left cell, the situation is reversed such that it is instead Pharmacy B who gains customers from Pharmacy A (14 versus 5 in payoff). Again, the market shrinks with -1. In the lower right cell, neither retail pharmacy chooses to sell OTC antibiotics, meaning they once again receive equal, but lower, payoffs of 8 each, and the market now shrinks with -2 because neither pharmacy is making sales of OTC antibiotics.

In Game 2, (S, S) marked with downward sloping lines is also an equilibrium of dominant strategies, meaning both Pharmacy A and B are better off selling OTC antibiotics independent of what the other retail pharmacy chooses to do. Note that this is not a standard prisoner's dilemma as (N, N) is not the Pareto efficient outcome for the players, since it was assumed that the market shrinks with -2 when none of the pharmacies sell OTC antibiotics. However, it can again be presumed that (N, N), marked with upward sloping lines, is the efficient outcome for society as a whole, where no retail pharmacy would sell antibiotics to customers without prescription (but would sell antibiotics to customers with prescription) such that the spread of AMR is decreased.

The payoffs and prerequisites for Game 1 and Game 2 will now be examined by interviewing retail pharmacists. The research methods will be presented below.

4. Research Methods

4.1 Research Design
This was a deductive qualitative interview study, with its aim to analyze two hypothetical games constructed from a literature review, subsequently to reformulate them using the results (Clark et al., 2021). Fourteen semi-structured interviews were conducted with NPC licensed pharmacists during April and May 2022 on-site in Rwanda through purposive sampling. First, a pilot interview was conducted according to a pre-defined interview schedule, drafted from the

hypothetical games. The schedule consisted of open-ended questions divided into the four themes (1) Retail Pharmacy Market (2) Customers' Health-Seeking Behavior (3) RFDA Regulation (4) Policy. There were also probing, specifying, interpreting and other direct or indirect follow-up questions. After the pilot, the specific questions within these retained themes were slightly revised (see Appendix C) to conduct thirteen more interviews using snowball sampling and maximum variation sampling. The focus of the interviews was to gain retail pharmacists' experiences on their practice in relation to AMR, and to understand the intricate interaction of retail pharmacies with their customers and other health institutions. All interviews were audio-recorded and transcribed verbatim. Then followed theme analysis.

The initial idea was to also collect complementary data using a self-completion questionnaire, distributed digitally to all registered retail pharmacists in Rwanda, to gain quantitative data from a geographically broader range of respondents also including pharmacies in both big and small cities as well as in rural areas. However, this ended up infeasible because of the time required to obtain the required approvals of the MoH, the RFDA, and the NPC. Nonetheless, there are some quantitative data on the Rwandan retail pharmacy market accessed through the RFDA's Pharmaceutical Database 2020-2021 which will contextualize the data sample (see 4.3). Special access to this datafile was granted by the Directorate General of the RFDA (Ref. No: DAR/2230/FDA/2022, Appendix B).

Also, since this study aimed to analyze the strategic interaction of retail pharmacies and their customers in the Rwandan health system, it can be argued that a qualitative approach is actually the most appropriate to thoroughly examine their incentives and the nuances of those. This is argued by for example Obermann, Scheppe and Glazinski (2013). They claim that in the field of health economics, qualitative research methods are applied to a suboptimal extent, given the characterization of a national healthcare system as a "highly complex and diverse set of institutions that differ markedly across time and space" (p. 256). Thus, interviews would have needed to be conducted before execution of a survey regardless, to properly understand the features of the Rwandan health institutions and retail pharmacy market.

Lastly, two personal interviews were conducted with a government official at the RFDA Department of Food and Drugs Inspection and Safety Monitoring to cross-check the current regulations of retail pharmacies. They were also briefed on the key themes and the conclusions of the study, to confirm that they are reasonable and applicable in a Rwandan policymaker context. This government official has a Master of Science in Pharmacology and work

experience from several pharmaceutical regulation bodies. Thus, these personal interviews also served as respondent validation of the findings.

4.2 Ethical Aspects

This project was approved by the National Health Research Committee of Rwanda's MoH. Their scientific review approval notice (reference number NHRC/2022/PROT/021) is attached as Appendix A. The most important ethical consideration in this study is the anonymity of the respondents. The interviewees received an information sheet before the interview, on audio-recording, deidentifying during transcription, and voluntary withdrawal of participation.

4.3 Data Sample

Out of the fourteen respondents, ten are included in the sample. One respondent was used for a pilot interview, and one respondent had not worked in a retail pharmacy for quite a long time. Ten of the remaining interviews were conducted with Kigali-based retail pharmacists, and two were Muhanga-based. Muhanga is a small city in the Southern province with just over 300,000 inhabitants, meaning its population size is about a third of that of Kigali (National Institute of Statistics of Rwanda, 2012). The Muhanga interviews were carried out to see if there are any differences between retail pharmacies in a big versus small city. However, as only two interviews were conducted in only one small city, these interviews will not be included in the sample but rather be of inspiration of further studies.

The average interview duration was 58 minutes, excluding the time spent on serving customers in cases where the pharmacist was alone in the workplace. All respondents had obtained a five-year (University of Rwanda, n.d.) bachelor's degree in pharmacy from the University of Rwanda, except for two respondents who had obtained their BSc from India and Kenya respectively. Only two respondents had obtained a master's degree, but they were among those who were excluded from the sample. The average number of years of experience was 6.5 years, meaning graduating between 2015 and 2016. [8]

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[8] If the two Muhanga interviews had been included in the sample, the average interview duration would have been 57 minutes and the average number of years of experience 6.4 years, meaning also graduating between 2015 and 2016. Both respondents had obtained their BSc in pharmacy from the University of Rwanda, and the gender balance was fifty-fifty. Thus, an inclusion of the Muhanga respondents in the final sample would not have significantly affected the average characteristics of the sample. However, for the reliability of the qualitative data, they still have to be disregarded.

The data sample was obtained through purposive sampling. The author's way of access to respondents is illustrated in Figure 1. Snowball sampling was used with origins in requests over LinkedIn's InMail feature as well as in physical visits to different retail pharmacies. After finishing the interview each respondent was asked whether they knew someone else who would be interested in being interviewed. The first physical visits however can be regarded as maximum variation sampling, as the snowball sampling form the LinkedIn InMail requests only generated male respondents, so respondents a-e were all female respondents.
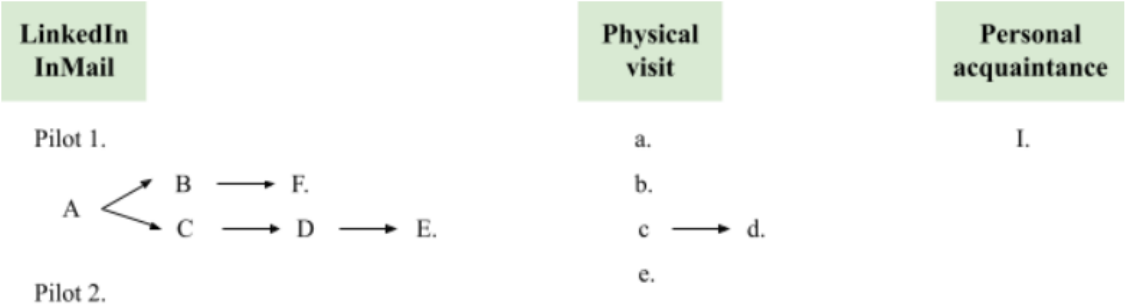
Figure 1. The figure displays the way of access to all respondents. Each respondent is named (A-E) for respondents originally accessed through LinkedIn's InMail function, (a-e) for respondents originally accessed through physical visits to retail pharmacies, and (I) for the one respondent accessed through personal acquaintances. The alphabetical order of respondents illustrates the time at which the pharmacists were interviewed. A dot (.) after each respondent implies that no further respondents were accessed through that particular respondent.

Although purposive sampling is indeed non-random, there were efforts to make the sample as representative as possible. First, out of the ten retail pharmacists in the sample there were six males and four females, which is a gender balance corresponding to that of the 2021 registry (National Pharmacy Council, 2021b). Second, the sample includes seven pharmacists of small independent retail pharmacies and three pharmacists of bigger retail pharmacies, meaning pharmacies with more than one branch. According to the RFDA's Pharmaceutical Database, there are 23 big pharmacies in Kigali (out of 339 retail pharmacy businesses). Third, respondents were both pharmacy owners and pharmacy employees, the occupational ratio being fifty-fifty. For Rwanda and Kigali, this ratio is about 30 percent following the RFDA's Pharmaceutical Database. Fourth, Table 2 below shows there was a thorough geographical spread of respondents over Kigali's districts and sectors.

Table 2. The table displays the geographic location in terms of districts and sectors of the number of retail pharmacist respondents in the interview sample.

	District						
Respondents	*Gasabo District*				*Kicukiro District*	*Nyarugenge District*	
	6				1	3	
	Sector						
Respondents	*Kacyiru Sector*	*Kimihurura Sector*	*Kinyinya Sector*	*Remera Sector*	*Niboya Sector*	*Muhima Sector*	*Kimisagara Sector*
	1	1	1	3	1	1	2

5. Results

Following a theme analysis of the interview transcripts, this section will present six themes of the strategic interaction of retail pharmacies and their customers. These themes will be incorporated into the games in 6 Analysis. Only especially highlighting quotes will be included in the text, referencing to the respondents using ID-codes (see Appendix D). Where several quotes are summarized into a general argument follows a risk of subjective interpretation of the verbatim answers. This lies within the interpretivist nature of qualitative analysis methods. (Clark et al., 2021) The six key elements presented below are (1) profit-prioritizing practice, which relates to both Game 1 and 2; (2) the expensive prescription, (3) medical advice in retail pharmacies, (4) strong customer demand, which relate to Game 1; (5) conflict of interest, which relates to both Game 1 and 2; (6) collaboration problem, which relates to Game 2.

5.1 Profit-Prioritizing Practice

Before going over the results that relate directly to the payoffs of Game 1 and 2, this section will present the scope of the malpractice of retail pharmacist respondents prioritizing commercial interests over proper health consultation, since Game 1 and Game 2 both aim to illustrate this behavior.

Seven out of ten respondents to some extent admitted to having sold antibiotics without prescription. Most commonly this regarded broad-spectrum antibiotics such as Amoxycillin, but seldom higher-generation antibiotics. This malpractice was depicted as something they try to avoid but cannot always guarantee. For example: "Not perfectly, but you can try to work professionally" [ID10]; "I cannot assure you every antibiotic I can give, but Amoxicillin I can give" [ID9]; "If someone tells you that she has pain in the throat, you can give those [patients] Amoxicillin" [ID6].

One unexpected finding is that three respondents considered it uncontroversial selling antimalaria drugs without the patient having been tested for malaria, because the patients coming to ask for antimalaria "describe their symptoms like fever, nausea, headache… That time you can give them like the medication for malaria, yeah. Most of them doesn't [sic] go to get checked because they know the symptoms." [ID2]. This is pharmacists giving in for patients' wish to self-medicate, according to the second cause for self-medication as defined by the World Health Organization in 2.1: "for example if they tell you 'I suffer[ed] from malaria three times, and I know [the] sign and symptoms', and he or she tell[s] you the sign and symptoms, you're supposed to know all of them, yes you can give him an antimalaria." [ID6].

It should be noted that the interviewees were never asked explicitly if they ever sold antibiotics without prescription. Instead, they answered the question implicitly by being asked about their practice and routine when a customer enters and demands an antibiotic drug without prescription (see Appendix C). It is thus possible that more respondents have sold antibiotics OTC, or do so to a larger extent, but did not say during interviews.

In sum, the malpractice of prioritizing profits over health consultation in terms of selling non-prescribed antibiotics seems to happen frequently among the respondents, especially so broad-spectrum antibiotics. This provides an important background to Game 1 and Game 2, which aim to illustrate these phenomena.

5.2 The Expensive Prescription

As was displayed in Table 1, seeking health consultation in private health institutions such as private clinics is expensive to finance out of pocket for an uninsured patient, and CBHI patients do not have cost coverage neither. For public health institutions on the other hand, health consultation is much cheaper for uninsured patients, and CBHI patients have cost coverage (although they have to follow the channel of transfer). Part of the aim of this essay is to examine why uninsured and CBHI patients still have incentives to self-medicate from OTC purchases in retail pharmacies, where neither have cost coverage. So, the alleged costs in Table 1 for a Rwandan with CBHI to obtain a prescription from a public health facility were transportation costs, low drug availability, and long waiting time. The interview responses confirm most of these costs, which legitimizes the hypothetical payoffs for the patient in Game 1.

It was the general belief of the respondents that the physical distance to the closest prescriber was important to a patient's decision to seek healthcare. First, this relates directly to their

transportation costs. Likewise, the interviewees expressed the view that closer proximity of the retail pharmacy to a prescriber increases sales, because a larger stream of insured people would go to retrieve their prescribed medication at their pharmacy. For example: "Here it's very good because we're near the hospital and the hospital has all the insurance […] They usually come by feet." [ID4]. The respondents were also asked how a retail pharmacy could expand their business: "That doesn't depend on income, it depend[s] on where the pharmacy is. [...] If you are on a strategic place where people come and buy, then you will get [an] income and be able to expand […] I think the location of the pharmacy really has a big, big importance for the pharmacy to do business." [ID4].

Second, the distance to the closest prescriber is further related to the cost of the facility of choice not having the required medication on stock. Thus, there is indeed a cost of obtaining a prescription in the potentially low drug availability, because the patient might still have to go elsewhere to get the prescribed medication in question: "the availability of medicines in public health facilities is very minimum [minimal, sic] compared to the private sector so most people are looking for medicines in the community pharmacies. Because this is where they will get more medicines [that] they want." [ID7]; "in every district here in Rwanda we have a district hospital, but medicines are not as many […] if they prescribe to you a drug, and you don't find it in that hospital, for example from Nyarugenge, you have to do the work [to go] from Nyarugenge [central Kigali] to come to take it to Butare [Northern Kigali], and it's too far. […] That's why the patients would prefer to come to the pharmacies." [ID6].

Third, the long waiting time of getting to a prescriber in a public setting was the one cost for a Rwandan healthcare seeker which was most strongly underscored by respondents. For example, an employee of a big retail pharmacy said they had many doctors around within a five-minute walk. Thus, they thought the hassle for their customers to go to the doctor is not only constituted by the physical distance, but also by how long time it usually takes for patients to reach a doctor once at the facility [ID3]. This was the view of all respondents. For instance, when asked what might hinder people from consulting a doctor, another said: "Because you can pass [spend, sic] like a whole day at the hospital, that's the main reason, they prefer to buy the medication without going to the doctor. […] Takes a long period to get to the doctor. Because most of the time there are long line[s], so you have to wait, even the tests take a long period of time." [ID2].

Fourth, a cost presented in Table 1 for a CBHI patient was having to follow the channel of transfer to obtain cost coverage for health consultation. This was however only discussed in the

pilot interview, so the potential costs of having to go to a health post or health center, where the describing authorization of antimicrobials as said is more limited, before being referred to a district hospital, unfortunately cannot be further discussed in this study. Thus, it also remains unclear whether this cost is equivalent to the monetary cost for an uninsured patient having to pay for public health consultation out of pocket. This will be covered in the discussion, as these unexplored costs are important since uninsured and CBHI patients were bundled together to constitute the player of a local patient in Game 1.

Essentially, a majority of the costs of visiting a public health facility for a prescription in Table 1 seem to be supported by the respondents of this study: "It's easier to come to the pharmacy" [ID3]. Most also said that they do not think a majority of their customers go to a prescriber when recommended to do so by the pharmacist, but would rather go to another pharmacy. For example: "I don't think they do that [go to a prescriber when recommended to]. But, for us it can be counted like a loss, if in looking like at the business part, we are losing a client, but like the next-door pharmacy will give them the medication, so if you are putting business [in] front, you would be giving the medication whenever they want." [ID2].

There is one disregarded, although not unsurprising, distinction, in that the opportunity cost seems to differ between Rwandans. A majority of respondents namely brought up the generalization of people in the capital being busier than in smaller cities and rural areas, which implies that the payoffs of the local patient in Game 1 might only apply to urban settings. For example: "In town, they want to save their time. In rural area[s], they want to save their money." [ID10]. When time is scarce it is valued more highly. Thus, the opportunity cost associated with visiting a public health facility is likely higher for people in Kigali compared to the rest of the Rwandan population – possible even so high that it exceeds the monetary cost of paying for medication from a retail pharmacy out of pocket (again, the patient considered here is a CBHI patient or an uninsured patient). To get the respondents' view on customers' cost of obtaining a prescription, they were presented with the idea of introducing a rebate on antibiotics for patients with a prescription to encourage them to visit a prescriber before going to a retail pharmacy, for example one response was exactly that: "most of the people who lives [sic] in Kigali, they are always busy […] you can have to stay at the hospital just to get like the right medication prescribed for like eight to twelve hours, it's not compared to that discount." [ID2].

In sum, the costs for a CBHI or uninsured patient to visit a public health facility as displayed in Table 1 and incorporated into the local patient payoffs in Game 1, have been confirmed by the

interview findings. The important distinction of Kigali-based patients will be formulated as a new precondition of Game 1 in 6.1 below.

5.3 Strong Customer Demand

The theme of a strong customer demand on antibiotics is also related to the payoffs of the local patient in Game 1.

According to all the retail pharmacists interviewed, their customers have a strong belief in the ability of antibiotics to treat most diseases – both viral and bacterial, including minor ailments: "we have to teach the people coming to us that antibiotics are not the drug to treat everything. But because people believe in antibiotic[s], people would only have [the] flu and believe that […] 'I take Amoxycillin and I get better'." [ID4], for example. The second cause for self-medication, as defined by the World Health Organization in 2.1, was also brought up as an important driver of the strong customer demand. For instance one respondent said: "Maybe they have previously prescribed the same medicine and they want it for the second time […] So people might come […] because they have been using the same medication for quite sometimes [sic] over a prescription, but they don't have it for the moment and they want the same medicine." [ID7].

To get a sense of the perceived customer demand on antibiotics, the respondents were asked how they would describe AMR in Rwanda. They thought of it as a common problem, drawing on accumulated experience as retail pharmacists: "I could see people changing […], going to more advanced antimicrobials. One of the suspected reasons of course were probably the resistance of the previously used ones, that did not work and they wanted more advanced antimicrobials." [ID7]. Similarly, one respondent referred such experiences to a general lack of knowledge on the problem of AMR, primarily among customers but also sometimes among pharmacy staff:

> At the counter, on a normal day, a person can come and say, "I want Amoxycillin", and you ask them "For what", and they say "Someone told me to just take it, I have a headache" […] So, we've had cases like that over the years where people just come in and ask for antibiotics, and people at the counter also are not aware that antibiotic resistance can happen, so we just dispense, so if someone is simply taking Amoxycillin at the counter for a reason that you don't know, maybe they do not have an infection, they just hear that people take antibiotics and they're healed, so such cases have led to resistance, in that we see doctors prescribing higher generations of antibiotics […] where a child at one year old is being prescribed a third generation of antibiotic. [ID3]

Equivalently, another respondent also raised the importance of pharmacists needing to be up to

date education-wise themselves. NPC already tries to care for this, where part of the annual license renewal is that pharmacy professionals have to complete the so-called CPD, Continuing Professional Development, a "professional obligation for pharmacists […] to remain informed about the profession in scientific, social and legal terms and to maintain a level of competence sufficient to provide pharmaceutical services, including pharmaceutical care, effectively and efficiently." (National Pharmacy Council, n.d.b). NPC does not state explicitly though whether CPD also includes knowledge on AMR.

Still, to increase the awareness of AMR and to sensibilise customer demand on antibiotics, day-to-day education in retail pharmacies seems to make up an important point of contact: "When it's possible, when you have the time you do explain like, for example if the patient had been taking like three doses of a certain antibiotic without any relief of the ailment, that time can you explain like 'Maybe you got a resistance on this medication, it's better to go to check [with] the doctor and they can prescribe another alternative'." [ID2]. This is also an important part of the pharmacy profession according to Good Pharmacy Practice (National Pharmacy Council, 2021a). However, there is not always enough time for such day-to-day knowledge transfer, which might speak in term of implementing a public awareness campaign. The proposal of implementing such an awareness campaign to educate the population was brought up to also get the pharmacists' opinion on customer demand on antibiotics, where for example one respondent explained: "sometimes we're too busy or overwhelmed, and you don't give as much information as you're supposed to, so if there are different alternat[iv]es for that information to the public, it would definitely help." [ID3].

The strong customer demand on antibiotics were already incorporated into the payoffs of the local patient in Game 1, in terms of the high payoff of self-medicating. This will be further discussed in 6.1 below, and the need for increased awareness on AMR will be discussed in 7.1.

5.4 Retail Pharmacy Medical Advice
This theme relates to the patient payoffs in Game 1 as well.

Just like customers have a strong belief in antibiotics, pharmacists have a strong belief in their own clinical knowledge. This has implications for the health consultation a customer can expect when visiting a retail pharmacy. For instance: "If I ask the patients some questions, about their feelings, then I can understand that patients they have this disease, so this medicine can help. […] I do the act of doctor!" [ID1]. In other words, many respondents thought of their education

and accumulated experience to at times be able substitute a medical prescriber's work. Health consultation is indeed an important part of the pharmacy profession according to Good Pharmacy Practice, especially when it comes to dispensing OTC drugs (National Pharmacy Council, 2021a). So, when asked explicitly if it really is a problem that people visit retail pharmacies before they visit a prescriber, for example one respondent said that:

> coming to a community pharmacy is a good thing to even reduce the workload from the hospitals, because not all the, you know, disease[s] are going to be managed by them, [some] might be having a cough, [some] might be having 'sneezery' conditions, you come to a pharmacist and they can help you. It's not a problem to me, the problem comes when those pharmacists are trying to manage cases that should be managed at the hospital. [ID7]

However, the definition of a case which should be referred to a medical doctor is not unequivocal: "it depends on the situation again of the patient, if it looks [like] it's not like a serious ailment, you can give some advice, and propose some medication that can help the patient. But if it can be something serious it's better to refer them to a specific doctor." [ID2]. This clarifies the difficulty for retail pharmacists to balance health consultation and business.

Because of the high costs for uninsured and CBHI patients to visit a public health facility, as confirmed in theme two, and also because visiting private health institutions is expensive to finance out of pocket, it can be argued that the strong incentives of visiting a retail pharmacy for health consultation is also caused by the pharmacists' medical advice basically being for free in relation to a prescriber's medical advice. This was also expressed by for instance this respondent, saying about an uninsured patient: "he say[s] 'Oh, I can go in the pharmacy, I don't have some money to pay the hospital for the exams, for whatever, for consultation, so if I can go and check [with a] pharmacist, they can give me like medicine which can help me'." [ID1]. Essentially free medical advice is a benefit of visiting a retail pharmacy which was not initially included in Table 1 – customers are offered quick service, high drug availability, and also medical advice free of charge. This legitimizes, again, the relative costs of going to a prescriber to a retail pharmacy, and the relative benefits of going to a retail pharmacy to a prescriber, meaning the local patient payoffs in Game 1. This will be further discussed below in 6.1.

5.5 Conflict of Interest
So far, the themes have been related to the payoffs of the local patient in Game 1. This section will relate to Game 1 as well, but now on the payoffs of the retail pharmacy, so the findings are predominantly associated with Game 2.

It cannot be denied that Rwandan healthcare seekers' strong faith in antibiotics does have an amplifying effect on retail pharmacists' dispensing of antibiotics. However, customer demand is only the initial step. When a customer asks for an antibiotic without a prescription, it is up to the pharmacist whether to satisfy this demand or not. It was the general belief of the respondents that when they were not the owner of the pharmacist themselves, and that owner was not an educated pharmacist, the refusal of such customer demand with regard to professional practice was much harder to sustain. For example:

> people coming in community pharmacies […] they find there two people, the owner and the pharmacist, that have two different professional orientations, and work orientations. The pharmacist is there to help, professionally, and the owner is there to you know, get money. And the two sides sometimes don't agree with rating a client. [For clients to] go without getting medication, and orientating a client to a clinic, might be not the satisfaction to the owner because the owner is losing a client. [ID7]

In relation to this conflict of interest between a non-pharmacist pharmacy owner and their supervising pharmacist, many respondents had experienced reprimands from a non-pharmacist boss in previous workplaces. Such debates often entailed threats of cutting the salary, according to the interviewees. For instance:

> Here, it's different from where I worked before I came here, because [here] the owner is the pharmacist so he understand[s] that concept. Where I was working [before] the owner is just a businessman. […] "We are here to sell!" And you can't explain to him it's for the good of the patient […] he could say, "See we didn't make the total, I'll give you like half of your salary or something". [ID4]

Many of the respondents who were currently pharmacy owners themselves referred their desire to open their own business to such threats of salary cuts. For example: "when the boss was there, she started discussing with me: 'You are here to sell medicine. At the end of the month, how will I pay you, when you are telling patient to go back […] you have to give medicine for everyone who enter this pharmacy'. In that case I said no. If it's this, I will try to open my own pharmacy." [ID10].

This conflict of interest is not only problematic in itself, for the respect for the pharmacy profession. It also increases unnecessary sales of antibiotics, thus increasing AMR. As an example, one respondent said:

> if the people come here, I refuse to give them antibiotics, he go[es] to another pharmacy, that is owned by like a nurse, the nurse, she, or, another pharmacist, which is under pressure on their boss, he can take decision to give that medicine. So it [will] increase the resistance of antibiotics. […] In, like, to ten or fifteen years, it will be a big problem if there is no decision taken. [ID1]

In essence, retail pharmacies are indeed driven by profit-maximization, but according to the respondents, the prioritization of profits to customer health, which is in violation with the pharmacist Code of Ethics, happens mainly when the supervising pharmacist is employed by a non-pharmacist pharmacy owner. As one respondent said about Rwandan retail pharmacists:

> if they are not working for their own, they are pressurized to make huge money rather than implementing their knowledge, so that's why for instance instead of being guided by the pharmacy profession, they are trained to make huge money [...] Also there are […] some pharmacies [which] are owned by people who have never done pharmacy. That's also a challenge. […] normally the cornerstone of that malpractice is to make money. [ID5]

Now, the next question would be why not more pharmacists open their own pharmacy. This was generally considered to be due to lack of startup capital: "the pharmacists, most of them don't have like the required income to open a pharmacy" [ID2]; "because of the capital, it is very, very difficult to start. For example here in Rwanda, when you finish your bachelor degree […] I think [the salary] it's at four hundred thousand Rwandan francs. To open a pharmacy, at least you need seventeen million, so you can imagine." [ID10]. As covered in 2.2.3, this is also the reason why the regulation was changed in 2013, so that anyone with sufficient capital to open a retail pharmacy under the condition that they hire a supervising pharmacist. Before, only pharmacists were allowed to open a retail pharmacy, but then the pharmacy business was on a downturn. Thus, it seems to be considered by regulators that the end justifies the means: the goal of strengthening the pharmacy business justifies the associated risk of potentially having some malpractice caused by this conflict of interest.

Nevertheless, as one respondent pointed out, the current sanctions for malpractice in terms of prioritizing profits over proper health consultation only strikes the supervising pharmacist and not the pharmacy owner. Potentially a non-pharmacist owner would have to hire a new pharmacist if their supervising pharmacist were to be suspended from malpracticing, and they would have to hire a new one within a certain time span to avoid RFDA closing the pharmacy permanently (see 2.2.3). Hence, given that it is still considered necessary to strengthen the Rwandan pharmacy business by allowing anyone to open a retail pharmacy, there seems to be a need for improved regulation to tackle the conflict of interest between pharmacy owner and supervising pharmacist: "If the pharmacist is the owner, and there is an issue in the pharmacy, then the pharmacist, even the owner is going to get sanctions. But if you are working for a non-pharmacist owner, and an issue comes in your pharmacy, the sanction is going to come on the pharmacist, not the owner. […] So, if that person [the non-pharmacist owner] is going to be

held accountable for the issues that are going to be in this pharmacy, then this would make him more responsible, more vigilant potentially." [ID7].

In short, the retail pharmacy's strategy to sell OTC antibiotics in Game 1 and Game 2 seems to apply primarily when the pharmacy owner is not a pharmacist themselves. This will be further discussed in 6.1 and 6.2. The need for regulation on conflict of interest will be covered in 7.1.

5.6 Collaboration Problem

Lastly, the interview findings relating exclusively to Game 2 will be covered.

The hypothesized Game 2 was not constructed as a standard prisoner's dilemma game, because it was assumed that the market shrinks when none of the pharmacies sell OTC antibiotics such that the highest payoff equilibrium was also the only equilibrium. It was however assumed that (N, N) was still the societally optimal outcome because no pharmacy would sell antibiotics without a clinically proven need thus eliminating the spread of AMR, but this was not displayed in the payoffs. Interestingly, the interview responses indicate that the strategic interaction of retail pharmacists who own their own business suffers from a collaboration problem, such that they could reach a higher payoff equilibrium if only they managed to collaborate.

In terms of the strategic interaction of retail pharmacies, it seems as if all pharmacists would like to act according to the professional practice that they have been taught since school, such as to not dispense antibiotics without using a prescription that stems from a clinical exam. However, the fact that some might malpractice, "cheat", to gain more money induces more such malpractice. For example, one outlined this dilemma as: "You see, if I follow regulation here, and the neighbor [pharmacies] don't follow, I will not have a customer. This competition will reduce the number of pharmacies that follow regulation." [ID8]; "even us who own our own pharmacy, they [we, sic] are competing with other retail pharmacy [pharmacies, sic], which are not following the rules, so it will be difficult for us also to follow all the rules. Because when you respect [the rules], you will not get enough client[s]." [ID9]. Thus, it seems as if the respondents perceived their interaction with other retail pharmacists as a collaboration problem.

In regard to collaboration problem though, it seems like pharmacists do not lack means to communicate with each other. For instance, it became clear during interviews that there is a big WhatsApp group for all Rwandan pharmacists where they can ask each other on how specific patient cases should be handled. Thus, it seems to hold true that despite frequent possibilities to communicate, retail pharmacists still do not collaborate on not selling OTC antibiotics.

Hence, this alleged collaboration problem between retail pharmacists must instead be overcome by regulators to ensure commitment to professional practice. The regulation defining malpractice as prioritizing profits above health consultation does not mention non-prescribed antibiotics explicitly, and it is hard to detect selling OTC antibiotics as such malpractice when antibiotic sales are not recorded for inspection. This will be further discussed in the policy proposals of 7.1.

Essentially, the respondents shared the view of them being in a collaboration problem as pharmacy professionals, as everyone would like to act according to clinical praxis but cannot, as the profit orientation induces competing pharmacies to deviate from this. This finding will be incorporated in 6.2 below as a reconstruction of Game 2. The policy proposals to move the equilibrium to the most societally beneficial one will be discussed in 7.1.

6. Game Analysis: Two Reconstructed Games

The six key elements presented above were (1) profit-prioritizing practice, which relates to both Game 1 and 2; (2) the expensive prescription (3) strong customer demand (4) retail pharmacy medical advice, which relate to Game 1; (5) conflict of interest, which relates to both Game 1 and 2; (6) collaboration problem, which relates to Game 2. This section will present an analysis of these interview results, in terms of Game 1 and Game 2 being adjusted to present strategic interaction more aligned with reality.

As stated, the first theme does not relate directly to any game payoffs. Instead, the first theme of profit-prioritizing malpractice provides a validating background of Game 1 and Game 2 since both aim to illustrate just that behavior. It became apparent during interviews that it is indeed common for retail pharmacies to sell non-prescribed antibiotics, especially so broad-spectrum antibiotics. This legitimizes the proceedings of analyzing their economic incentives from a game theoretical perspective.

6.1 Game 1
Following key themes two through five, Game 1 needs to be re-constructed to take into account the interview findings.
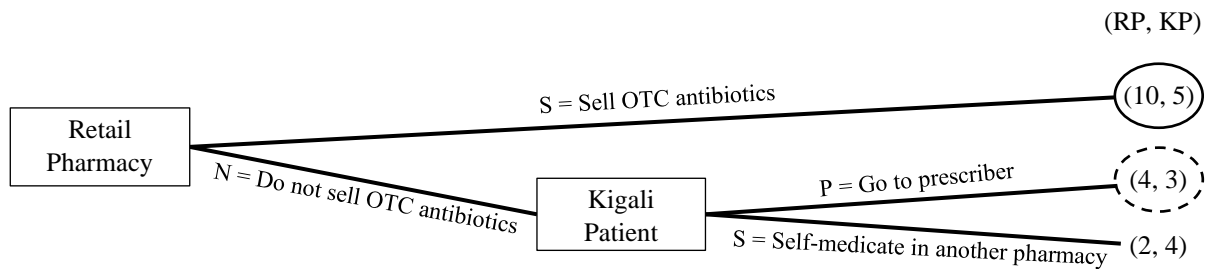
First, in accordance with the second theme of the expensive prescription, an important prerequisite of Game 1 must be the distinction that the local patient regards a local patient, uninsured or with CBHI, in Kigali specifically. This is not only because the sample contained

only Kigali-based retail pharmacies, but also because of the respondents' view on people in urban areas such as Kigali carrying higher opportunity costs of visiting a public health facility. People in Kigali allegedly being busier implies that this opportunity cost is so high that it exceeds the monetary cost of paying for medication from a retail pharmacy out of pocket.

Second, when the hypothetical games were initially presented, it was assumed that a pharmacy professional will act as if (s)he is responsible for the pharmacy's survival on the pharmacy market. As was found with the fifth key theme of conflict of interest, malpractice in terms of prioritizing profits over health consultation most frequently arises from pressure from a non-pharmacist owner. Hence, the retail pharmacy's strategy S of selling antibiotics without prescription seems to apply primarily when the owner of the retail pharmacy in question is not a pharmacist themselves. Therefore, yet another precondition of Game 1 will be that the retail pharmacy player is a non-pharmacist pharmacy owner. So, the new assumptions following themes two and five are (1) the local patient player is an uninsured or CBHI patient living in Kigali (2) the retail pharmacy player is a non-pharmacist pharmacy owner.

Third, according to retail pharmacists themselves they play an important role in health consultation to uninsured and CBHI patients, as they can essentially receive free medical advice relatively quickly. Looking at the responses in theme four of retail pharmacy medical advice, it seems as if these Rwandans prefer to try the retail pharmacy first. This happens among other things with antibiotics, in line with the third theme of customer demand. A customer would rather try to immediately self-medicate on antibiotics by retrieving it without prescription from a retail pharmacy, and does not seriously consider going to the doctor until the retail pharmacist tells them that they need to get an antibiotic prescription first. This is also in accordance with the findings in the second key theme, the expensive prescription. Thus, following themes two, three, and four, Game 1 needs to be reconstructed into a game in extensive form such that the players' strategic interaction is sequential following this temporal dimension:

Game 1: The game between a retail pharmacy (RP) and a Kigali patient (KP) in extensive form.

(RP, KP)

S = Sell OTC antibiotics   (10, 5)

Retail Pharmacy

N = Do not sell OTC antibiotics

Kigali Patient

P = Go to prescriber   (4, 3)

S = Self-medicate in another pharmacy   (2, 4)

In the new Game 1, the retail pharmacy chooses strategy first, because it is now assumed that the Kigali patient prefers to try the retail pharmacy for self-medication before even considering going to a prescriber. Note that the retail pharmacy player is now defined as a non-pharmacist pharmacy owner, meaning they primarily consider the survival of the pharmacy business and not patient health as a pharmacist pharmacy owner would to a greater extent. It is still assumed that when the retail pharmacy player does not sell OTC antibiotics, the patient can go to another pharmacy to get it without prescription such that the retail pharmacy player will lose a customer to their competitor. In this game it is only when the retail pharmacy has chosen to refuse the Kigali patient OTC antibiotics that they face the choice of either going to a prescriber or to go to another retail pharmacy to fulfil their desire to self-medicate.

The game is analyzed through backwards induction in the following way. The Kigali patient receives a higher payoff from self-medicating in another pharmacy than going to a prescriber, 4>3, like in the first Game 1. This is, again, because of the costs associated with going to a prescriber (transportation costs, low drug availability, and long waiting time) which were confirmed in the second theme, and the relative benefits of going to a retail pharmacy not least in terms of essentially free medical advice as described in theme four. Thus, branch (N, P) is eliminated. Now consider the retail pharmacy. They know that the Kigali patient will self-medicate in another pharmacy if they refuse to sell them OTC antibiotics. Thereby they would then receive lower payoff than if they decide to sell them OTC antibiotics, 2<10. Thus, also the branch (N, S) is eliminated. Note that the payoff would have, like in the first Game 1, been slightly higher in (N, P) with associated payoffs 4>2 because the patient going to the prescriber would also mean they would come back to the same retail pharmacy if they obtained a prescription, but still not as high as 10 because the patient going to a prescriber also brings the risk of them not needing an antibiotic such that they do not return – again, it is reasonable to

assume that the patient trusts the prescriber on what to do[9]. However, this outcome is not possible in the new Game 1 because the patient values getting an antibiotic without a prescription too strongly to rationally choose going to the prescriber if the pharmacy recommends them to do so, in line with theme two and three. In the end, the only branch remaining is that the retail pharmacy chooses S, such that the Kigali patient can self-medicate through them, and the circled outcome is the Nash equilibrium. It is the same Nash equilibrium as in the first Game 1. Note that the payoff for the patient is also the highest in this outcome (5>4>3). Similarly, it can still be assumed that (N, P) marked with a dashed line is the societally most beneficial outcome because the patient would not get an antibiotic unless there is a clinically proven need, hence eliminating the risk of AMR spreading.

This sequential version of Game 1 more accurately represents the situation described by respondents. Some policies are proposed in 7.1 to change the payoffs so that the dominant equilibrium moves to the societally optimal outcome.

6.2 Game 2

Game 2 can still be simultaneous, but like in the new Game 1, the retail pharmacy players need to be distinguished. Additionally, some payoffs need to be recalculated in accordance with theme five of the conflict of interest and theme six of the collaboration problem.

In a first revised version of Game 2 called Game 2a, the retail pharmacy players A and B are supervising pharmacists in retail pharmacies with a non-pharmacist pharmacy owner. They try to grapple the dual responsibility of making sales to not lose their salary from the non-pharmacist owner, while also trying to act according to professional practice. This is in accordance with theme five of conflict of interest. Since it was assumed that Game 2 shows the strategic interaction of two pharmacies which are the only ones to choose from in a free market, Game 2a can also illustrate that if none of the pharmacies sell OTC antibiotics, the pharmacists can act professionally without reprimands from pharmacist owners for losing customers to competitors. This in line with theme six of the collaboration problem.

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[9] The decision of the prescriber on whether or not to prescribe antibiotics is in practice important. Introducing them as a third player however would entail them getting their own payoffs, although it is most reasonable to assume that prescribers solely take decisions on a clinical basis. Hence, the importance of the prescriber's decision is considered in the payoff rates of the two current players.

Game 2a	Player 2: Pharmacy B	
Player 1: Pharmacy A	S = Sell OTC antibiotics	N = Do not sell OTC antibiotics
S = Sell OTC antibiotics	8, 8	8, 5
N = Do not sell OTC antibiotics	5, 8	10, 10

In the upper left cell of Game 2a, both pharmacies choose to sell OTC antibiotics. They receive equal payoff from this (8=8), like in the first Game 2, but now those payoffs are slightly lower than before. This is because although they earn an income from complying with the commands of the non-pharmacist owner, they also malpractice as pharmacists which is regarded as a disutility for educated pharmacists. In the upper right cell, only Pharmacy A chooses to sell OTC antibiotics while Pharmacy B does not. Because Pharmacy A gets to sell but does so by malpracticing, Pharmacy A receives the same payoff from this as if Pharmacy B also would have sold, meaning 8. Their payoff is not increased from gaining Pharmacy B's customers, because selling antibiotics without prescription is still in opposition of professional practice, so to the supervising pharmacist it does not matter whether his or her pharmacy owner gains more customers because it still means that they are pressurized to malpractice. Pharmacy B on the other hand only gets a payoff of 5 because although they do not malpractice, they lose their customers to Pharmacy A, which might result in salary cuts as recounted in theme five. In the lower left cell, this relationship between Pharmacy A and B is reversed. In the lower right cell, neither pharmacy sells OTC antibiotics. As pharmacists, the players both receive the highest payoff from doing so because they act according to professional practice. They also do not lose any customers to the competing pharmacy in this outcome because if both players collaborate, customers have nowhere to go to obtain OTC antibiotics so disputing with pharmacy owners becomes a non-issue.

Now, in Game 2a there are two Nash equilibria, both marked with diagonal lines, (S, S) and (N, N). However, (S, S) is the risk dominant Nash equilibrium. This means that it is less risky for each pharmacy to choose S if they are unsure about what the other pharmacy will choose. By choosing S they would receive a payoff of 8 regardless of what the other pharmacy chooses to do. If they on the other hand choose N and the opposite player chooses S, they could potentially receive even lower payoff, $5<8<10$. Thus, S is the best individual strategy, while the higher

payoff equilibrium (N, N) can only be reached if both pharmacies collaborate on choosing N simultaneously. More specifically, only if the pharmacy estimates the likelihood of opposite player choosing N as 60 percent or more, the pharmacy can be sure to also choose N to get the same expected payoff or higher compared to choosing S.[10] To ensure such a high expected probability of the opposite player choosing N, the pharmacy regulators could help overcome this risk dominance by ensuring commitment from both parties so that no-one will sell OTC antibiotics. Some proposals on how to alter the payoffs to achieve this will be discussed in the policy proposals in 7.1.

Game 2a regarded the retail pharmacy players as supervising pharmacists with non-pharmacist owners, to incorporate the themes of conflict of interest and collaboration problem simultaneously. However, it would look the same if the players were instead pharmacist pharmacy owners, were the equal payoff of 8 from both selling together with their competitor and selling instead of their competitor, could be explained by a loss in moral so great that it sets to zero the gain of the opposite player's customers. Instead of a payoff loss originating from salary cuts, pharmacist pharmacy owners would instead face payoff losses as business losses, just like in the first version of Game 2.

If instead the players of Game 2 are two non-pharmacist pharmacy owners, the first Game 2 remains intact in its payoffs, equilibrium (S, S), and non-equilibrium societally optimal outcome (N, N):

Game 2b: The game between non-pharmacist pharmacy owners.

Game 2	Player 2: Pharmacy B	
Player 1: Pharmacy A	S = Sell OTC antibiotics	N = Do not sell OTC antibiotics
S = Sell OTC antibiotics	10, 10	14, 5
N = Do not sell OTC antibiotics	5, 14	8, 8

The policy proposals in 7.1 will also discuss how to change the equilibrium in this game.

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[10] If one player estimates the other player's probability of choosing N is 60%, their $E[payoff_S]$ equals their $E[payoff_N]$: $(8*0.4 + 8*0.6) = (5*0.4 + 10*0.6)$ while if they estimate the other player's probability of choosing N as for example only 50% their $E[payoff_S]$ is bigger than their $E[payoff_N]$: $(8*0.5 + 8*0.5) >$ $(5*0.5 + 10*0.5)$. Thus, for a player to choose N their estimation of the other player's probability of choosing N must be $\geq 60\%$.

7 Discussion

This study aimed to analyze and motivate the payoffs which make up the incentives of retail pharmacies to sell non-prescribed antibiotics and consumers to self-medicate on non-prescribed antibiotics. The aim was fulfilled by first mapping out two hypothetical games with payoffs based on previous research on AMR in Rwanda. Thereafter, using the identified themes of face-to-face semi-structured interviews with licensed retail pharmacists in Kigali, these games were modified to illustrate the Kigali retail pharmacy market more accurately. Game 1 of a local Kigali patient and a non-pharmacist pharmacy owner was reconstructed into sequential form to display the fact that going to the retail pharmacy first is easier and more desirable than going to a prescriber. Game 2 of two retail pharmacists was constructed to show a risk dominance equilibrium in the case of supervising pharmacists with non-pharmacist pharmacy owners, alternatively pharmacist pharmacy owners, but was maintained from the first version of Game 2 when the players were instead defined as non-pharmacist pharmacy owners. The equilibria and payoffs of these altered games can help Rwandan regulators to implement appropriate policies to effectively combat AMR as part of their AMRNAP. Four such policy proposals on how to alter the payoffs, such that a societally more beneficial equilibrium is reached, will be discussed below. Then follows a discussion on the limitations of this study, as well as proposals for further research.

7.1 Four Policy Proposals

The following four policy proposals are: (1) enforce an OTC dispensing protocol (2) introduce record-keeping of antibiotic sales (3) decrease the costs of visiting public health facilities (4) execute an awareness campaign for the general public as well as include antimicrobial resistance in retail pharmacists' CPD. These are far from the only solutions that could change the payoffs so that the dominant equilibrium moves to the societally optimal ones in terms limiting the spread of AMR. Neither will their respective pros and cons be covered extensively. Instead, the author leaves it to Rwandan regulators, mainly at RFDA, to assess the most efficient ways to alter the different payoffs.

7.1.1 OTC Dispensing Protocol

In regard to the first theme of profit-prioritizing practice, there is a need for a regulation explicitly prohibiting antibiotics to be sold without prescription. More specifically, an OTC dispensing protocol could be developed, either independently or as an additional part of Good Pharmacy Practice. As a suggestion, there also needs to be sanctions for selling antibiotics

without prescription, such that antibiotic sales follow the same standard procedures of sales of other prescription medicine in Good Pharmacy Practice. Such sanctioning could also help to overcome the collaboration problem of theme six, in combination with introducing record-keeping of antibiotics (covered below in 7.1.2). Not only would they help to ensure a high expected probability of the other pharmacies not selling OTC antibiotics, such that the risk dominance equilibrium of Game 2a is overcome, but harshened sanctions for malpractice by the malpractice being more clearly defined would also decrease the high payoffs in Game 1 and Game 2b for non-pharmacist pharmacy owners to sell non-prescribed antibiotics to demanding customers. Thus, the equilibria of the games could change to the societally optimal ones limiting the spread of AMR.

7.1.2 Record-Keeping of Antibiotic Sales

Also related to the fifth theme of conflict of interest, it would be beneficial to put into place regulation specifically targeting the clash of supervising pharmacist and non-pharmacist pharmacy owner. That is, given that current regulation on who can open a retail pharmacy remains in place to strengthen the Rwandan pharmacy business. Since the disputes described by interviewees are hard to prove to RFDA because it is one's words against another's – malpractice cannot be sanctioned unless detected – a more hands-on regulation to detect when malpractice is being done would be useful. That would, just like enforcing an OTC dispensing protocol, help to overcome the collaboration problem. Thus, keeping records on antibiotic dispensing could be introduced, similar to what is currently compulsory for narcotic drugs.

As of now, all pharmacies have to record their sales of narcotic drugs. These records are supervised by the RFDA such that they are equivalent to the physical stock, cashier purchases, and collected prescriptions of narcotics (Law N°03/2012 of 15/02/2012 Governing Narcotics Drugs, Psychotropic Substances and Precursors in Rwanda, 2012). The counterargument for such a policy would be the increased workload it would bring the pharmacists. The narcotic record-keeping as already time-consuming, and there are many more types and brands of antibiotics than there is of narcotics. However, replacing record-keeping of hand-written notes with an automized computer system could be developed by the RFDA to overcome this, as part of the AMRNAP. In essence, compulsory record-keeping of antibiotics could decrease non-pharmacist pharmacy owners' high payoff in Game 1 and Game 2b of selling antibiotics without prescription such that the equilibria in the games would shift to the societally optimal ones.

7.1.3 Decrease Costs of Visiting Public Health Institutions

There needs to be a decrease in the costs of visiting public health institutions, given the second theme of the expensive prescription and the fourth theme of retail pharmacy medical advice. Especially so in urban areas, where the opportunity cost of long waiting time seems to be particularly high. Transport costs are already being reduced by the health post initiative, where the aim of setting up health posts was to decrease the walking distance at community level to the closest public health facility (Universal Health Coverage Partnership, 2022). Still, public health settings are costly to visit considering the low drug availability and long waiting time. This is something to further examine (see 7.3). Essentially, decreasing the relative costs of visiting public health institutions would increase the low payoffs of going to a prescriber such that the equilibrium would move to the societally optimal one in Game 1. It would most likely also decrease the relative benefits of visiting a retail pharmacy as a first choice, as depicted in the revised Game 1.

7.1.4 Awareness Campaign and CPD

Looking at the fourth theme of strong customer demand, a public awareness campaign to complement day-to-day education in retail pharmacies and other health institutions could be executed. The everyday education in retail pharmacies on AMR and the dangers of misusing antibiotics could in turn be more strongly encouraged by the RFDA and the NPC, not least through Good Pharmacy Practice. With increased awareness among the general public, the local patient player would internalize the negative effects of gaining AMR from misusing antibiotics. In that way, the perceived high pay-off of self-medicating would be decreased so that the equilibrium would move to the societally optimal one in Game 1. The awareness campaign could be done in Radio Rwanda, which is especially important to reach the rural communities, on television, in newspapers, and on social media, by the RFDA and/or MoH. To increase the national awareness of AMR is also one of the explicit strategic objectives of Rwanda's AMRNAP (Republic of Rwanda, 2021).

A second note on education policy is to also include knowledge on antibiotic prescription practices in the CPD. In relation to the games, a critical assumption was made to define selling non-prescribed antibiotics as malpractice, namely that pharmacists have thorough knowledge on AMR and how it can be caused by misuse of antibiotics. However, considering the fact that many respondents expressed the opinion of broad-spectrum antibiotics like Amoxycillin not being equally risky to dispense without prescription, this might not be the case. It was also argued by Nisabwe et al. (2020) that there should be an increased focus on AMR in healthcare

education, including pharmacy education, at the University of Rwanda. To strengthen the knowledge base on AMR among retail pharmacists CPD seems like the appropriate channel, by making it a requirement for license renewal to be up to date on how different dispensing routines can affect the spread of AMR in the community. It would also make the NPC more involved in the process of implementing the AMRNAP.

7.2 Limitations

There are some limitations of the research design, primarily from data collection but also from the assumption that going to a prescriber is the optimal strategy in terms of decreasing AMR.

Since this study aimed to analyze the strategic interaction of retail pharmacies and their customers in the Rwandan health system, it can be argued that a qualitative approach is better to thoroughly examine their incentives and the nuances of those. It is argued by for example Obermann, Scheppe and Glazinski (2013) that qualitative research methods are better for analyzing health systems. Nevertheless, it would have brought additional value if quantitative data also had been collected as originally planned, after analyzing the interviews to ask the most appropriate questions given the specific context of Rwanda. This is mainly to get a less anecdotal idea of the magnitude of the problems highlighted in this study. An example of such quantitative data is the ratio of total sales made up by antibiotics. The interviewees claimed portions ranging from 10 percent up to 75 percent of total sales. The same applies to which extent pharmacists refuse their customers antibiotics without prescription – one respondent said 80 percent, another said 60 percent, etcetera. The sample would have needed to be much larger to draw any reliable numerical conclusions. Similarly, additional data on how frequently retail pharmacies are sanctioned by the RFDA, as well as the most frequent type of sanction, could have helped in evaluating the payoffs of retail pharmacies to sell non-prescribed antibiotics.

Furthermore, people with CBHI are generally people with very little money. It could also be people who are not insured via their workplace, for example because they are employed in the informal sector. In this study, it was hypothesized that they still prefer to visit retail pharmacies, partly because of the high drug availability and quick service in retail pharmacies, which are free to visit as opposed to the other private health institutions, and partly because of the other costs of visiting public health facilities. However, there was no data collected on how many Rwandans with CBHI actually do this. The fact that several retail pharmacies in Kigali not collaborating with any health insurance can survive on a relatively free market, indicates that there is still a considerably large customer base of people whose retail pharmacy purchases are

not covered by any insurance. Only three interviewees had not entered partnership with some health insurance, so the study would have benefitted from additional data from Rwanda Health Insurers Association on exactly how many they are in Kigali, as well as data on how big share of any retail pharmacy's customer base consists of people who are uninsured or only carry CBHI. The latter could have been included in the originally planned retail pharmacist survey.

Moreover, the fact that most respondents were accessed through snowball sampling strengthens the argument of one respondent saying that "since my friend asked, I was willing to participate" [ID9]. That is, snowball sampling brings a risk of ending up with a sample of respondents who are similar in characteristics and beliefs. In terms of education and years of experience it was indeed a homogenous sample, the main variation coming from respondents' gender, geographic location within Kigali, and role of supervising pharmacist or pharmacy owner. The female pharmacists found via maximum variation sampling can be assumed to not be equally prone to such disregards, however they cannot be said to be representative of the population either as they were still acquired through purposive sampling. However, all of these limitations also lie within the nature of interview studies. Finally, considering that the average number of years of experience was only 6.5 years, this study has likely disregarded senior pharmacists with more extensive experience with the pharmacy profession in Rwanda, including from before 2013 during which only pharmacists were allowed to open pharmacies. It would have been valuable to gain their perspective on the current retail pharmacy market.

Additionally, there are some unavoidable limitations in regard to the interviews themselves. Most importantly, since retail pharmacists were interviewed about their role in the Rwandan health system and about some possible policies, it is inherent for them to overstate their own ability as well as campaigning for policies which would most benefit their business. The latter became especially clear when discussing exclusive territories[11], which only three out of ten respondents supported, compared to for example awareness campaigns which gained support from nine out of ten respondents. Also, the matter of selling antibiotics without prescription can be sensitive and might be associated with pride. Perhaps even more so among highly educated, which all respondents are. This could have made them more inclined to save face, and not always answer truthfully in terms of their own malpractice, although the interview format likely reduced that risk compared to collecting data through surveys. Additionally, all respondents

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[11] Introducing exclusive territories is a policy to reduce intense business competition. Proposing this to interviewees was a way to examine their view on the horizontal competition among pharmacies, see Appendix C.

were proficient in English, but for the respondents whose English was not excellent some nuances of the discussion may have fallen short. Finally, since there was only one principal investigator of this study to analyze interview transcripts, it can be argued that the potential biases of this principal investigator have not been adequately reduced.

Lastly, in the construction and reconstruction of the games, it was assumed that all prescriptions on antibiotics are suitable. However, over-use of antibiotics may not only arise from OTC sales, but also from over-prescription. Nkurunziza et al. (2020) found from examining antibiotic prescription practices in Rwanda's Southern province that there was a very low antibiotic prescription suitability, meaning "prescriptions given with clinical evidence of bacterial infection" (p.23), especially among prescriptions to children. They also found over-prescription of antibiotics in general. (Nkurunziza et al., 2020) Thus, the assumption that all prescribers provide suitable prescriptions might not hold. This has implications on Game 1 because the assumption in all games that a customer consulting a prescriber is the societally optimal might not be correct.

7.3 Further Research
This study is one of few microeconomic applications to AMR, which has clarified some important properties of the retail pharmacy market in Rwanda and how they relate to the spread of AMR. However, there are some aspects which could be examined further in a future study.

The most important supplemental study would be to also gather data from retail pharmacy customers directly, since Game 1 focused on the strategic interaction of retail pharmacies with their customers. This is especially important when considering the second through fourth theme, as those are results regarding healthcare seekers based on what retail pharmacists have said about them. Retail pharmacists are certainly healthcare seekers too in personal capacity, but the most reliable data would be collected by *surveying Rwandan households* on for example how highly they value visiting a retail pharmacy to other health institutions. In parallel, the additional cost for a CBHI patient having to follow the channel of transfer to obtain cost coverage for health consultation, meaning the cost of having to go to a health post or health center to consult a nurse or general practitioner before being referred to a doctor at a district hospital, where the describing authorization of different antimicrobials also differ, could not be thoroughly analyzed. Thus, it also remains unclear whether this cost is equivalent to the monetary cost for an uninsured patient having to pay for public health consultation out of pocket. These are aspects however which can best be answered by uninsured and CBHI patients themselves and

not retail pharmacists, again calling for household surveys. It could have implications on the game, as uninsured and CBHI patients were bundled to constitute the player of a local patient together. If this difference in their cost of visiting a public health institution proves considerable, separate games for an uninsured and a CBHI patient could be constructed.

Also, more interviews could be conducted in *other Rwandan provinces*. There was an attempt to examine the situation in Muhanga in the Southern province by interviewing two Muhanga-based retail pharmacists (see 4.3). There, both admitted to having sold antibiotics without prescription, and both collaborated with one or several health insurances. They cannot be regarded as representative of Muhanga, but overall their answers corresponded to those in Kigali. The main difference between the cities would have been that there are fewer public and private health facilities in Muhanga. An important further study would thus be to interview retail pharmacists across the entire country, to see if there are any variabilities in relation to retail pharmacies' role in the spread of AMR between provinces, districts, sectors, etcetera.

Three employees in big retail pharmacies were included in this study. All of them thought malpractice is less common in bigger retail pharmacies. There are many plausible explanations. For example, there are often several pharmacists employed in the same branch. Not being solely responsible for the survival of the business as well as having fellow pharmacists to discuss with might increase the incentives to practice professionally. Also, the business owner is seldom physically present in each branch, which should decrease the extent of malpractice generated by conflict of interest. Big retail pharmacies also hold a larger share of the pharmacy market. If customers are refused non-prescribed antibiotics in a big retail pharmacy, they might try a small retail pharmacy instead. In the long run, this should have positive effects on the small retail pharmacy. Additionally, a small retail pharmacy might be more severely struck by refusing a customer non-prescribed antibiotics because they may already struggle with liquidity problems. It can thus be hypothesized that small retail pharmacies have more to gain from selling non-prescribed antibiotics than big retail pharmacies. Therefore, it would be interesting to further examine *how the rules of the game for a big retail pharmacy differ from the rules of the game for a small retail pharmacy*. Their strategic interaction could be illustrated for example in a sequential game where the big retail pharmacy chooses strategy first, to show that customers go to small pharmacies once they are refused OTC antibiotics in big retail pharmacies.

Ultimately, what exactly causes the long waiting time and low drug availability in Rwandan public health institutions? A deep-dive into the *Rwandan drug supply chain*, similar to what

Uwizeyimana et al. published in 2021, and the *bottlenecks in public health provision* would provide valuable further research. This would enable a more distinct analysis on the associated costs for an uninsured or CBHI patient.

8 Conclusion

Considering the vast number of medical research studies on AMR, this study pursued to fill a research gap on the important economic incentives of OTC antibiotic sales in Rwanda. Using a game theoretical approach, the aim of this study was to analyze and motivate the payoffs which make up the incentives of Rwandan retail pharmacies to sell non-prescribed antibiotics and Rwandan consumers to self-medicate on non-prescribed antibiotics. The aim was fulfilled by first mapping out two hypothetical games with payoffs based on previous research on AMR in Rwanda. Then, face-to-face semi-structured interviews were conducted with licensed retail pharmacists in Kigali. Six themes of the strategic interaction of retail pharmacies and their customers were identified in theme analysis: (1) profit-prioritizing practice, which related to both Game 1 and 2; (2) the expensive prescription (3) strong customer demand (4) retail pharmacy medical advice, which related to Game 1; (5) conflict of interest, which related to both Game 1 and 2; (6) collaboration problem, which related to Game 2. These themes were subsequently used to alter the hypothetical games to have them better correspond with reality. Game 1 of a local Kigali patient and a non-pharmacist pharmacy owner was reconstructed into sequential form to display the fact that going to the retail pharmacy first is easier and more desirable than going to a prescriber. Game 2 of two retail pharmacists was constructed to show a risk dominance equilibrium in the case of supervising pharmacists with non-pharmacist pharmacy owners, alternatively pharmacist pharmacy owners, but was maintained from the first version of Game 2 when the players were instead defined as non-pharmacist pharmacy owners. Thereafter, four policies were briefly proposed to suggest different ways of altering the payoffs in these revised games to move the equilibrium to a societally more beneficial one. These were (1) enforce an over-the-counter dispensing protocol (2) introduce record-keeping of antibiotic sales (3) decrease the costs of visiting public health institutions (4) execute an awareness campaign for the general public as well as include antimicrobial resistance in retail pharmacists' CPD. The reformulated games in combination with the hands-on policy proposals can help Rwandan regulators to implement appropriate policies to effectively combat AMR. This is not only of great significance to Rwanda's recently adopted AMRNAP, but it is also an important step in combatting the severe global health problem of AMR worldwide.

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Appendices

Appendix A: NHRC Research Approval

National Health Research Committee of the Ministry of Health. (2022). "Scientific Review Approval Notice (Ref: NHRC/2022/PROT/021)".

Republic of Rwanda

MINISTRY OF HEALTH

National Health Research Committee
Ref: NHRC/2022/PROT/021

To: **Ms. Agnes Durbeej-Hjalt**
   Principal Investigator

Scientific Review Approval Notice

With reference to your request for approval of the Research Protocol entitled; **"What Are the Economic Incentives of Rwandan Community Pharmacies to Sell Non-Prescribed Antimicrobials?"**;

We are pleased to inform you that, following a thorough review and critical analysis of your proposal **(NHRC/2022/PROT/021)**, National Health Research Committee has approved your Research Protocol.

However,

1) Changes amendments on approach and methodology must be submitted to the NHRC for review and approval to validate the changes.

2) Submission to NHRC of final results using the attached template is mandatory

3) Failure to fulfill the above requirements will result in termination of study

Once again National Health Research Committee appreciates your interest in research.

Your final approval reference number is **NHRC/2022/PROT/021.**

Sincerely,

Dr. Parfait UWALIRAYE
Chairperson of NHRC

Date: 24/04/2022

Appendix B: Approval to Use RFDA Data

Rwanda Food and Drugs Authority. (2022). "Response to your request to use Rwanda FDA data for your research project (Ref. No: DAR/2230/FDA/2022)".

Kigali, 13/05/2022
Ref. No: DAR/ 2230 / FDA/2022

RWANDA FDA
Rwanda Food and Drugs Authority
P.O. Box 1984 Kigali
info@rwandafda.gov.rw
www.rwandafda.gov.rw

Agnes Durbeej-Hjalt
agnes.hjalt@gmail.com
Tel : +46 733 281 832

Dear Agnes,

<u>**Subject**</u>: **Response to your request to use Rwanda FDA data for your research project entitled "What Are the Economic Incentives of Rwandan Community Pharmacies to Sell Non-Prescribed Antimicrobials"**

Reference is made to your letter of the 04.05.2022 addressed to the Director General of Rwanda FDA, asking to have access to data regarding licensed pharmacies in Rwanda for your research project on antimicrobial resistance in relation to the Rwandan pharmacy market;

Reference is also made to the Scientific Review Approval Notice from the National Health Research Committee (reference number NHRC/2022/PROT/021), which shows that your research protocol for the research project entitled **"What Are the Economic Incentives of Rwandan Community Pharmacies to Sell Non-Prescribed Antimicrobials"** has been approved by the competent Authority in Rwanda;

We are pleased to inform you that Rwanda FDA has approved your request, and that you will be facilitated by the Food and Drugs Inspection and Safety Monitoring Department in charge of approving and updating the requested information in Rwanda FDA.

I thank you for your interest in working with Rwanda FDA.

Sincerely,

Digitally signed by Rwanda
FDA (Director General)
Date: 2022.05.13 23:17:24
+02'00'

Dr. Emile BIENVENU
Director General

Appendix C: Interview Schedule

Table 3. The interview schedule, revised after the pilot interview, for qualitative semi-structured face-to-face interviews. Before audio-recording the information sheet was handed over and interviewees were asked if they had understood the information on anonymity, voluntariness, and audio-recording.

Part	Theme	Main Question	Probe For
Introductory Questions	**Warming Up**	What is your background?	• Education • Years of experience • Previous workplaces • Current role
		How would you describe AMR in Rwanda?	• Customer demand • Role of retail pharmacies
1	**Retail Pharmacy Market**	How would you describe the retail pharmacy market in Kigali?	• Degree of business competition • How to earn more money • Balancing business orientation and health consultation • Scope of OTC antibiotic sales • Routine of handling customers demanding OTC antibiotics • Effect of refusing customers OTC antibiotics • Differences within different parts of Kigali • Differences between Kigali and other cities and rural areas
2	**Customers' Health-Seeking Behavior**	What are the costs and benefits for a customer to seek healthcare in the different healthcare institutions?	• Health consultation in retail pharmacy • Effects of health insurance • How costs could be decreased • Differences within different parts of Kigali: seeking healthcare and visiting retail pharmacy • Differences between Kigali and other cities and rural areas seeking healthcare and visiting retail pharmacy
3	**RFDA Regulation**	Do you think most retail pharmacies follow RFDA regulation?	• Regulation and sanctioning of malpractice • Malpractice in relation to AMR • Effect of pharmacy owner • How regulation could be improved
4	**Policy**	Rebate Education/awareness Make public healthcare more effective Exclusive territories More pharmacist owners More local manufacturing	• Best shape or form • How to implement • Effect on retail pharmacies and customers • Relative efficiency
		Any other action?	• Disregarded aspects
Closing Questions	**Winding Down**	Is there anything else you'd like to say that we haven't talked about today?	• Disregarded aspects

Appendix D: Table of Respondent IDs

Table 4. The characteristics of the interviewees in the final sample, each interviewee being assigned a specific ID code.

Pharmacy Owner	ID1, ID5, ID8, ID9, ID10
Pharmacy Employee	ID2, ID3, ID4, ID6, ID7
Big Retail Pharmacy (number of branches≥2)	ID2, ID3, ID4
Small Retail Pharmacy (number of branches=1)	ID1, ID5, ID6, ID7, ID8, ID9, ID10