Self-medication practice in developing countries: Theory and evidence from Cameroon

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Abstract

How do households in developing countries react during their morbid episodes to regain their health? Data from the Cameroon Demographic and Health Survey shows empirically that households in developing countries choose between self-medication and conventional medicine, whatever their income level. The following dissertation formulates an economic model that explains how healthcare choices affect the health status of households. The model explains how self-medication, a widespread practice in developing countries, is a choice that is not solely driven by income constraints. The model also highlights the various risks associated with self-medication in terms of the quality of medicines or infusions.

Keywords: Healthcare choice; Self-medication; Disease; Developing country
Code JEL: C51, D91, I11.

1 Introduction

Self-medication[1] can be defined as the treatment of self-recognized disorders or symptoms by the use of medicines without prior consultation by a qualified health professional (WHO 2022). When properly practised, self-medication can provide some benefits to individuals and health systems: It saves time spent queuing up for medical consultations, saves scarce medical resources from being used on minor conditions, lightens the workload of doctors, decreases healthcare costs (since medical consultations will be reduced or avoided.) and reduces absenteeism from work. Despite the potential benefits of self-medication, there are several undesirable effects, including wasted economic resources due to prolonged treatment because of poor infection management, late or incorrect diagnosis, drug interactions, and adverse reactions (Alhomoud et al. 2017; Ayalew 2017; Bennadi 2013; Montastruc et al. 2016) which are sometimes irreversible (e.g. hepatic and renal disorders). Widespread throughout the world, self-medication remains a phenomenon that is increasingly threatening the health of populations, particularly in developing countries where antibiotics are available without prescription in drug stores and sold on the street at low prices. Then, understanding what guides the healthcare choices of households in developing countries (during morbid episodes) is a key to designing appropriate interventions to promote responsible self-medication and rational use of medicines.

This paper contributes to this objective by providing a theoretical framework to understand how healthcare decisions are made in developing countries. We formulate a model of healthcare choice where sick agents choose between self-medication and conventional medicine to find: What determines the healthcare decision-making process of (developing country) households during their illness episodes? How does the perceived severity of illness affect this decision-making process? How do the risks associated with self-medication affect the treatment process of self-medicating households? How do awareness campaign policies on responsible self-medication affect the healthcare decision-making process of households? The implications of the model are as follows. First, although relatively poor households always choose self-medication over doing nothing, there is also a fraction of relatively wealthy households, i.e. those who can choose conventional medicine, who deliberately decide to self-medicate despite the risks. This is consistent with our descriptive analysis using Data from the Cameroon Demographic and Health Survey. Second, the proportion of agents likely to choose conventional medicine rather than self-medication increases with the severity of the illness. This is because assessing the seriousness of an illness is primarily a matter of how economic agents feel. It is linked to the concerns that individuals have about their state of health. When these are judged to be sufficiently important or serious, households tend to seek better quality healthcare. Lastly, after the self-medication process, only agents who have practised responsible self-medication will be cured. These lucky households are those who took into account the quality of the treatment and the accuracy of the diagnosis in the self-medication process.

The model developed to approximate individual behaviour is an extension of Jack (1999) (based on the

[1] Self-medication can involve both modern and traditional medicine.

widely used Grossman (1972) model) with a different framework. Contrary to the orthodox approach of utility maximization, consumers in our model only focus on their health production functions. At the beginning of their sick periods, each agent compares the psychological profit he would obtain from self-medication to the psychological profit accruing from choosing conventional medicine. He knows that conventional medicine is costly even if it always guarantees a full recovery; and, producing their health good can be obtained at a lower cost, but can be risky.

We used data from Cameroon to establish a novel fact contradicting that the relation income (related to the different prices of healthcare alternatives) is the only key to healthcare provider choice in developing countries. If income-price is the only key component in the decision-making process of an agent, then one would observe that self-medication is a practise undergone only in households with low earnings. The fact that self-medication is also practised by high-income households means that there is another important component that enters into the agent's decision-making process. We therefore estimate the structural parameters of the model by using the maximum likelihood estimation technique. The likelihood function is constructed by matching the expected probability of choosing self-medication generated by the theoretical model (expressed as a function of financial capacity and other characteristics) with the corresponding household occupational choice observed in the data. We also added an econometric analysis of the implications of our model. In particular, we apply reduced-form estimates that make use of a richer set of variables than the one appearing in the theoretical model. We test whether the data confirm that the probability of self-medicating decreases with the cost of self-medication and perceived risk, and whether income is not always an essential component in the decision process. We also test whether for diseases with high perceived risk, income, and the consultation cost reduce the probability of self-medication, but for diseases with low risk, only the cost of self-medication matters. We estimate a probit model expressing the probability of self-medicate as a function of disposable income, consultation cost, the empirical perceived risk of the disease, education, and other variables including demographic and geographic characteristics.

Several other studies have addressed the self-medication problem observed across countries. Demographic and socio-economic characteristics (Audibert and Mathonnat 1998; Fuentes and Villa 2008; Kamgnia 2006; Mwabu, Ainsworth, and Nyamete 1993; Ngwen 2018), poor access to healthcare (Balamurugan and Ganesh 2011; Omolase et al. 2007), increase of lay people's awareness about treatment protocols (Asefzadeh, Barkhordari, and Moghadam 2003; Fuentes and Villa 2008; Klemenc-Ketis, Hladnik, and Kersnik 2011), change in the treatment approaches and pattern of diseases (Sontakke et al. 2011), high costs of healthcare (Leyva-Flores, Kageyama, and Erviti-Erice 2001; Yousef et al. 2008), and ease of drug purchase without having a prescription (Sedighi, Ghaderi-Sohi, and Emami 2006) are among the frequently reported provoking factors of self-medication around the world. However, very few of these studies (Jamhour et al. 2017) have focused on the health knowledge (or experience) of individuals as a key to healthcare decisions. This paper is therefore a complementary work to these previous studies in these respects.

The rest of the paper is organized as follows. Section 2 presents the data and establishes the stylized facts of self-medication in a developing country. Then Section 3 develops the theoretical model. Section 4 shows econometric results from the reduced form. Structural estimation of the theoretical model is performed in Section 5. Section 7 draws some concluding remarks. Section A provides additional tables, figures, and other technical details.

2 Evidence

In this section, we establish stylized facts about the healthcare decision-making choices of households observed in a developing country by using Data from Cameroon. Cameroon currently has one of the lowest levels of publicly-funded healthcare in Sub-Saharan Africa (with a per capita income of 9.20 USD). The health budget fell by 24% between 2016 and 2018, reflecting a general trend of economic decline and resource scarcity. Cameroon also faces significant income and health inequalities, due in part to the health sector's reliance on out-of-pocket spending which accounts for 70% of total health expenditures. A recent household study in Cameroon's three northern regions (Adamawa, Far North, and North) revealed that 64 percent of patients who did not seek care at a health centre or from a health professional cited cost as the most important reason (Nde et al. 2019). Also, health expenditures increase the poverty rate by almost 2 percentage points and exacerbate the depth of poverty by almost 12 percentage points in the country. Another major problem facing the supply of healthcare in Cameroon is the acute shortage of qualified personnel, which is aggravated by geographic distributional inequalities of the national health workforce and the absence of basic infrastructure and equipment in health facilities (Tandi et al. 2015). Consequently, this has resulted in a consistent fall in the standards of care in public health facilities throughout the country. According to the WHO, with a doctor/patient ratio of 1.24 per 10,000, Cameroon is considerably lower than the expected ratio of 2 per 10,000. With all these characteristics, self-medication seems to appear as a solution for Cameroonian households during their morbid episodes. A solution that is made all the more popular by the availability and proximity of informal, inexpensive healthcare services such as traditional practitioners and street vendors.

The main data used in this section comes from the 2017 FINSCOPE survey on consumption in Cameroon. This survey was carried out in Cameroon by the National Institute of Statistics in collaboration with the Ministry of the Economy, Planning and Regional Development. Data from the FINSCOPE Consumer Survey whose main objective is to measure levels of access and use of financial services by all adults is particularly interesting because it contains a section on healthcare facilities and also incorporates the income ranges of the individuals.

Table A1 and Table A2 present the behaviours of Cameroonian households in terms of healthcare services according to their income. In each table, we present the number of households who answered 'yes' to each modality of the question 'When you are sick, where do you generally go for treatment?'. We have also added conditional row frequencies for each income range to obtain information purged of the

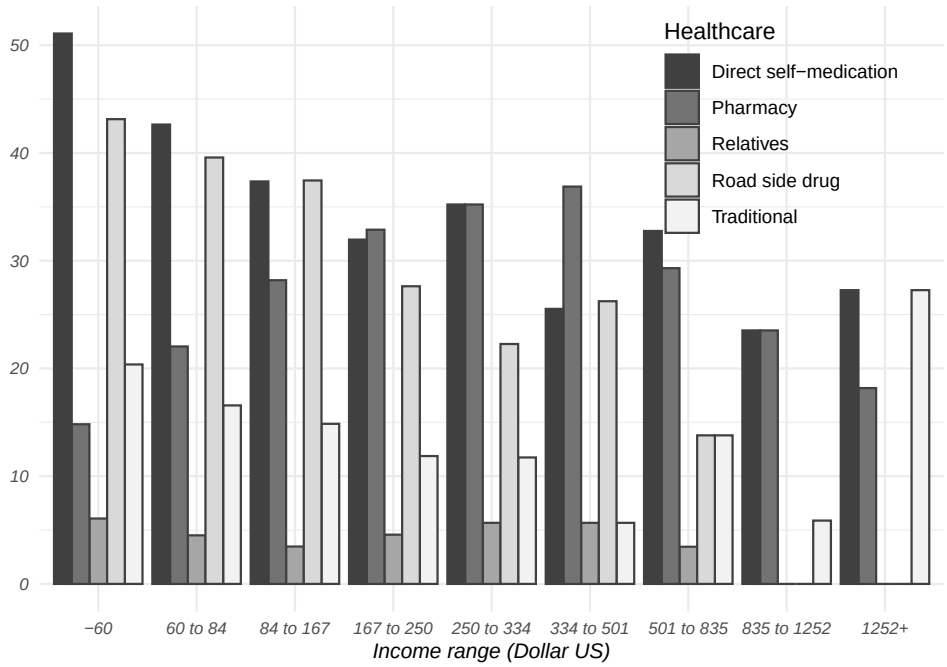

Figure 1: Conditional (row) frequencies of self-medication healthcare services by income range.

income structure. Several points can be made from Table A1. The vast majority of households use public health services, while very few have access to private health services. Of just over 6,000 individuals surveyed, 82% and 20% said they used public and private health services respectively. The sawtooth pattern of conditional frequencies shows a lack of correlation with Cameroonians' income. This can be explained by the fact that this practise is of better quality. Going to the hospital implies undergoing medical check-ups that provide information on what individuals suffer from and thus reduce bias. The choice of private healthcare facilities presents an interesting result. It shows an increasing relationship with income ranges. This is explained by the fact that private healthcare facilities are more expensive than public healthcare facilities. Private healthcare facilities offer immediate attention, are generally well-equipped, and offer services and care of better quality compared to public healthcare facilities.

Table A2, shows that self-medication seems to be a common practice in Cameroon. Almost 45% said they self-medicate directly, just under 40% said they use street vendors, just over 20% said they use pharmacists, while 17% said they use traditional practitioners and only 5% use a member of their community. Analysis by income range shows that relatives and roadside drug vendors are the only practices abandoned by high-income households (with a monthly income of 835 USD or more). On the other hand, direct self-medication, pharmacists, and traditional medicine remain practices that are also used by high-income households. For example, 27% of households earning more than 1252 USD claim to use either traditional medicine or self-medication, and 18% use pharmacies.

It is observed that individuals with high incomes still resort to informal medicine. This suggests that

income (with respect to price) is not the only key component within the healthcare decision-making process of households. The stylized facts that we have documented hold very broadly across countries and over time[2]. This raises the question of what common forces are behind the healthcare decision-making process of households. Answering this question is not only interesting in its own right, but also helps to better design interventions to promote responsible self-medication and rational use of medicines. In what follows, we propose a model of the economic agent's healthcare, whose driving forces are his health knowledge and his disposable income. We establish that our model can explain these stylized facts.

3 Theoretical model

The model we develop in this section is particularly attractive because it delivers some stylized facts that can be comparable to those observed in a developing country. These countries are characterised by a high proportion of the informal sector, which absorbs more than 60-90% of the population (ILO 2009). As a result, the populations of developing countries are largely made up of individuals with unstable incomes, no health insurance and enormous difficulties in accessing quality healthcare[3].

The economy is made up of agents who are sick or in need of treatment. The need of treatment is defined here, *à la* Chambaretaud and Hartmann (2004), as the difference between the actual state of health and the desired state of health. The sick agents who differ in their health knowledge [4] θ and their level of financing capacity z, choose, at the beginning of their morbid episode, how to regain their health: either by producing their missing health good h themselves (self-medication) or buy it to the conventional health market (choose conventional medicine for example, going to the hospital). The individuals know that conventional medicine is costly even if it always guarantee a full recovery; and, producing their own health good can be obtained at a lower cost, but is risky. With this information, agents' decision choices are based on their comparative advantages when they self-medicate according to their knowledge θ and their financing capacity z. The model identifies agents that choose hospital by the subscript n and those that choose self-medication by subscript s.

3.1 Conventional medicine

Conventional medicine[5] is characterised mainly by the quality of medicines and diagnostic equipment, specialised doctors and a high level of treatment care. In the model, we assume that conventional

[2]We also used data from Ghana, Benin, and Nigeria and observed the same stylized facts.

[3]These difficulties of access include: the high cost of healthcare added to informal costs (corruption) (UNDP 2011) and the time spent waiting in hospital queues before being seen. In developing countries this fraction of time is quite significant and can even cover an entire day

[4]This knowledge represents both the level of experience in the health field from previous morbid episodes and the level of education in the health field.

[5]It includes public health establishments (general, central and regional hospitals, health centres and integrated health centres) and approved private establishments (profit-making hospitals, biomedical analysis laboratories).

medicine choice is safe and always guarantees a full recovery if and only if the household[6] has a financing capacity z at least greater than the conventional cost of healthcare required $d > 0$. The amount of the conventional cost of healthcare d includes all expenses for consultations, health books, examinations, medicines. An agent who chooses conventional medicine will go to the health market and buy his missing health level h at price d. As we can see, h is a level of health good required by the (sick) agent to regain his health. If the economic agent cannot buy the good h, then his level of health will deteriorate by a value of υ. This means that the health acquisition function for conventional medicine h_n is constant and independent of health knowledge.

$$h_n = h \text{ if } z \geq d \quad \text{or} \quad h_n = -\upsilon \text{ otherwise.} \tag{1}$$

Knowing that his expenditure level equals d when $z \geq d$ and is zero when $z < d$, the *psychological* profit of the agent who chooses conventional medicine can be written as

$$\pi_n(z) = -\upsilon \mathbf{1}[z < d] \tag{2}$$

Where $\mathbf{1}[\cdot]$ is a binary indicator function which takes the value 1 if the statement in brackets is true and 0 otherwise. Equation (2) states that when an individual knows he can acquire the health good at the costly standard market price d gets a zero psychological gain[7]. Equation (2) also states that an agent who cannot go to hospital and chooses to do nothing obtains a psychological loss υ due to the deterioration in his health level. We assume that the agent knows exactly the true value of υ in his decision-making process[8].

3.2 Self-medication

Although there are several definitions of self-medication in the literature (Baracaldo-Santamaria et al. 2022; Montastruc et al. 2016; Pouillard 2001; Thoër, Pierret, and Lévy 2008), our definition is close to the traditional definition of self-medication which include direct and indirect self-medication[9]. Whatever its definition (direct or indirect), self-medication is always a risky choice. There are a number of risk factors directly linked to the process of self-medication, including misdiagnosis and poor-quality medicines. Misdiagnosis arises from the similarity of symptoms between several illnesses. Since the individual's self-diagnosis is based on the symptoms observed, the economic agent is liable to make a mistake. For example, the initial symptoms of Covid-19 are comparable to those of influenza. In fact,

[6] We used the terms sick agent, agent, individual and household interchangeably. Likewise for the terms health knowledge, knowledge and ability.

[7] The assumption of a psychological profit $\pi_n(z) \geq 0$ can also be used. This assumption change the values of some threshold parameters but left unchanged the main implications of the model.

[8] In Appendix A.4 we relax this assumption and analyse how it modifies the implications of the model.

[9] Direct self-medication refers to the use of knowledge acquired throughout one's life and previous morbid episodes, whereas indirect self-medication refers to the use of external sources such as family, friends, neighbours, the pharmacist or suggestions from advertising (newspapers or magazines) to treat oneself.

the two viruses share similar symptoms: a runny nose, fever, cough, aches and fatigue. Since these symptoms cannot be used to distinguish between flu and Covid-19, screening for the virus is the only way to be sure (WHO 2023). The quality of drugs is closely linked to where they are sourced. Medicines purchased in a pharmacy will be of better quality than those bought on the street. The medicines sold on the street are of dubious origin and are poorly preserved. Vendors in the informal sector obtain most of their supplies from wholesalers, who are also informal. In Cameroon, for example, wholesalers obtain their supplies from India, and the medicines enter the country via Nigeria (Pouillard 2001).

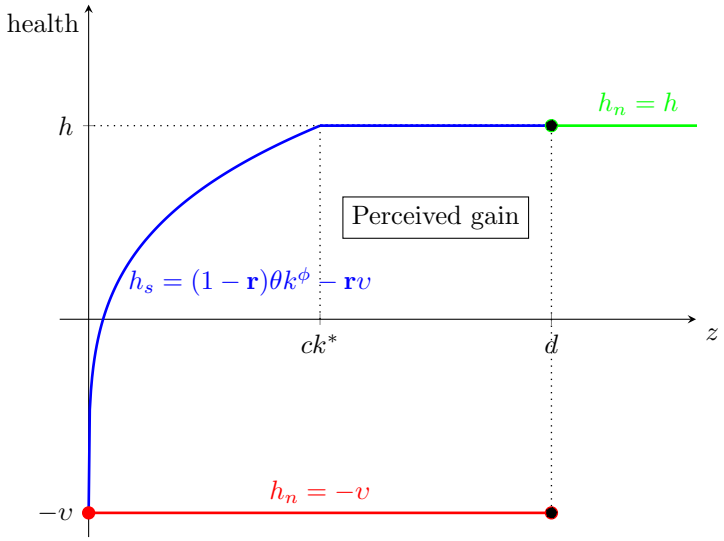

Figure 2: Perceived gain from self-medication : view from agent.

Taking into account these factors into the expected production function, an agent with health knowledge θ uses capital k to produce a level of health h_s[10] according to the technology

$$h_s(\theta, z, \mathbf{r}) = (1-\mathbf{r})\theta k^{\phi} - \mathbf{r}\upsilon \tag{3}$$

where $\phi \in (0,1)$ is the elasticity of health level h_s with respect to capital k and $\mathbf{r} \in (0,1)$ represents the perceived risk which clearly shows that the household who choose to self-medicate, bets on his health.; this risk is almost always different from the *effective risk* r, which remains unknown to the sick agent; the effective risk is the true value of the risk to which the agent practising self-medication is exposed. The level of knowledge θ includes both acquired and borrowed knowledge. The former refers to knowledge in terms of experience accumulated throughout previous episodes of illness (direct knowledge), while the latter refers to knowledge derived from the experiences of family members, friends, street drug sellers and pharmacists (indirect knowledge).

[10]This level of health is not necessarily equal to h. It is a level of health deemed acceptable by the economic agent, to the point where he no longer demands health.

With a health knowledge level θ, the household is only looking for the optimal level of investment k^* that will enable him to achieve h at the lowest cost $ck \leq z$ where c is the fixed price per unit of capital k. Figure 2 presents a graphical illustration of the perceived advantage of self-medication over conventional medicine from the point of view of the individual. Given the potential risks $\mathbf{r}$, the resulting expected profit maximisation problem is

$$\max\{(\theta k^{\phi} - ck) - \mathbf{r}(\theta k^{\phi} - \upsilon)\} \text{ such that } 0 \leq ck \leq z \tag{4}$$

The first expression of equation (4) is the profit perceived by the agent who chooses self-medication before taking his treatment. The second expression is the psychological loss of the agent who remains ill after self-medication. He risks losing both his health and his investment. The first-order condition in equation (4) gives the optimal capital

$$k^*(\theta, \mathbf{r}) = \left[(1-\mathbf{r})\frac{\phi\theta}{c}\right]^{\frac{1}{1-\phi}} \tag{5}$$

Equation (5) clearly shows that optimal capital and perceived risk move in opposite directions. At the lower bound, an individual who does not take risk into account ($\mathbf{r} = 0$) will invest the optimal capital $k^*(\theta)$

$$k^*(\theta) = \left(\frac{\phi\theta}{c}\right)^{\frac{1}{1-\phi}} \tag{6}$$

The condition $ck \leq z$ implies that at the optimal level $k^*(\theta, \mathbf{r})$, given a level of knowledge θ, the sick individual will only self-medicate without constraint if his financial capacity satisfies z the following inequality :

$$z \geq \left[(1-\mathbf{r})\frac{\phi\theta}{c^{\phi}}\right]^{\frac{1}{1-\phi}} \equiv \bar{z}(\theta, \mathbf{r}) \tag{7}$$

The critical threshold $\bar{z}(\theta, \mathbf{r})$ varies between 0 and $\bar{z}(\theta) \equiv (\phi\theta/c^{\phi})^{1/(1-\phi)}$; where $\bar{z}(\theta)$ is the boundary of households practising self-medication without taking risk into account. Equation (7) shows the minimum level of financial capacity required $\bar{z}(\theta, \mathbf{r})$ to practise an self-medication given a knowledge θ. Then, for a given knowledge θ, *limited* self-medicate households are those with a financial capacity z below the critical threshold $\bar{z}(\theta, \mathbf{r})$. During their morbid episodes, the maximisation constraint of these households will be binding, so that they will use all their available financial capacity z in their self-medication processes, even if they would like to invest more. Using equation (6) the agent expected profit who self-medicate takes the following form

$$\pi_s(\theta, z, \mathbf{r}) = \begin{cases} (1-\phi)[(1-\mathbf{r})\theta]^{\frac{1}{1-\phi}}\left(\frac{\phi}{c}\right)^{\frac{\phi}{1-\phi}} - \mathbf{r}\upsilon \text{ if } z \geq \bar{z}(\theta, \mathbf{r}) \\ (1-\mathbf{r})\theta\left(\frac{z}{c}\right)^{\phi} - z - \mathbf{r}\upsilon \text{ otherwise} \end{cases} \tag{8}$$

The right-hand side of equation (8) shows that psychological profit function $\pi_s(\theta, z, \mathbf{r})$ is constant for households with $z \geq \bar{z}(\theta, \mathbf{r})$ and increase for households with $z < \bar{z}(\theta, \mathbf{r})$.

3.3 Implications

Let $\Pi(\theta, z, \mathbf{r}) = \pi_s(\theta, z, \mathbf{r}) - \pi_n(z)$ be comparative profit of the two alternatives. The presence of the conventional cost d reveals two types of sick agents among households. The first class is made up of households who have the financial capacity to choose conventional medicine during their morbid episodes ($z \geq d$), while the second class is made up of households those who can not ($z < d$). Since at beginning of his morbid episode each agent knows his health knowledge θ and initial wealth endowment z, given the perceived risk $\mathbf{r}$, sick agents chooses to self-medicate if his choice can ensure an non-negative comparative profit $\Pi(\theta, z, \mathbf{r})$ regardless of his class.

$$\Pi(\theta, z, \mathbf{r}) = \begin{cases} (1-\phi)[(1-\mathbf{r})\theta]^{\frac{1}{1-\phi}} \left(\frac{\phi}{c}\right)^{\frac{\phi}{1-\phi}} - \mathbf{r}\upsilon \text{ if } a \geq b \\ (1-\mathbf{r})\theta \left(\frac{z}{c}\right)^{\phi} - z - \mathbf{r}\upsilon \text{ otherwise} \end{cases} \tag{9}$$

where the statement $a \geq b$ respectively corresponds $d \geq \bar{z}(\theta, \mathbf{r})$ and $z \geq \bar{z}(\theta, \mathbf{r})$ for household with $z \geq d$ and those with $z < d$. Equation (9) shows that the profit function $\Pi(\theta, z, \mathbf{r})$ decreases with the perceived risk $\mathbf{r}$. This relationship between perceived risk and the individual's psychological benefit leads us to the following proposition

Proposition 1 *Consider a sick agent with health knowledge θ and financing capacity z.*
(i) If $\mathbf{r} = 1$, then $\Pi(\theta, z, \mathbf{r}) = -\upsilon$ for all $z \geq 0$.
(ii) If $d < \bar{z}(\theta, \mathbf{r})$, then $\Pi(\theta, z, \mathbf{r}|z \geq d) < 0$ for all $\mathbf{r}$.
(iii) If $z < \bar{z}(\theta, \mathbf{r}) < d$, then (a) if $\theta < (c/z)^{\phi}(z + \mathbf{r}\upsilon)/(1-\mathbf{r})$, $-\upsilon < \Pi(\theta, z, \mathbf{r}|z < d) < 0$ for all $\mathbf{r}$. (b) if $\theta > (c/z)^{\phi}(z + \mathbf{r}\upsilon)/(1-\mathbf{r})$, there exists critical risk $\underline{\mathbf{r}}(\theta) = (\theta z^{\phi} - z c^{\phi})/(\theta z^{\phi} + \upsilon c^{\phi})$ such that $\forall \mathbf{r} \in (\underline{\mathbf{r}}, 1)$, $\Pi(\theta, z, \mathbf{r}|z < d) < 0$ and $\forall \mathbf{r} \in (0, \underline{\mathbf{r}})$, $\Pi(\theta, z, \mathbf{r}|z < d) > 0$.
(iv) If $\bar{z}(\theta, \mathbf{r}) \leq z < d$ or $\bar{z}(\theta, \mathbf{r}) \leq d < z$, there exists another critical risk $\bar{\mathbf{r}}(\theta)$ such that $\forall \mathbf{r} \in (\bar{\mathbf{r}}, 1)$, $\Pi(\theta, z, \mathbf{r}) < 0$ and $\forall \mathbf{r} \in (0, \bar{\mathbf{r}})$, $\Pi(\theta, z, \mathbf{r}) > 0$.

Proof 1 *See Appendix A.3*

Proposition 1 (i) tell us that, households with a definite aversion to self-medication feel condemned when they do not have sufficient financial means to go to hospital. And during their morbid episodes, they are indifferent between investing in his health and doing nothing. Proposition 1 (ii) says that when self-medication is more expensive than going to hospital, households no longer take perceived risk into account in their decision-making process. Proposition 1 (iii) states that very poor households with insufficient health knowledge will always self-medicate rather than do nothing, whatever their level of perceived risk. Proposition 1 (iii) and (iv) show that, given a level of knowledge θ and financial

capacity z, a sick household will consider self-medication as a deliberate choice only if his perceived risk is relatively low. Equivalently, an economy where self-medication is widespread and popular means the majority of households in that economy have a low risk aversion to the practice.

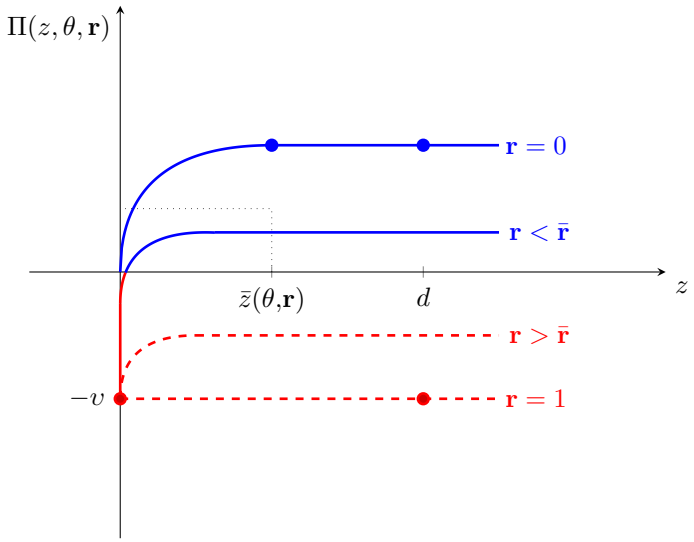

Figure 3: Illustration of comparative profit functions with perceived risk.

The rest of this work considers households with relatively low perceived risks or households with $\mathbf{r} \in (0, \bar{\mathbf{r}})$ for all $z \geq \bar{z}(\theta, \mathbf{r})$ and $\mathbf{r} \in (0, \underline{\mathbf{r}})$ for all $z < \bar{z}(\theta, \mathbf{r})$. For households with $z \geq \bar{z}(\theta, \mathbf{r})$, there exists a threshold knowledge $\theta^*(\mathbf{r})$ that ensure a non-negative psychological profit. This critical health ability level is obtained by setting the upper right-hand side of equation (8) to zero and solving for θ.

$$\theta^*(\mathbf{r}) = \frac{1}{1-\mathbf{r}} \left(\frac{c}{\phi}\right)^{\phi} \left(\frac{\mathbf{r}\upsilon}{1-\phi}\right)^{1-\phi} \tag{10}$$

The critical health knowledge level $\theta^*(\mathbf{r})$ has a dual role. For households with a financial constraint $\bar{z} \leq z < d$, it determines which households deliberately self-medicate and which are forced to do so. Whereas for those without a financial constraint $z \geq d > \bar{z}$, this cut-off knowledge determines which of unconstrained households have sufficient knowledge to self-medicate rather than go to hospital. Households with relatively high levels of knowledge ($\theta \geq \theta^*(\mathbf{r})$) do not feel the need to go to hospital and are therefore insensitive to the cost constraints d as long as self-medication remains relatively low. During their morbid episodes they only care about the condition $\bar{z} \leq z$. However, for households with relatively low levels of knowledge i.e. those with $\theta < \theta^*(\mathbf{r})$, the lack of financial means is felt. They will choose conventional medicine if they can afford it ($z \geq d$), but will be forced to self-medicate if they cannot. In fact, in a perfect market without the constraints $z < d$, households below the cut-off $\theta^*(\mathbf{r})$ would choose conventional medicine. But because of the imperfection in the market, these households are forced to self-medicate since the certainty equivalent of their psychological profits is a deterioration

in their health level $(-\upsilon)$. For an in-depth analysis, we define the critical level of financial capacity

$$z^*(\mathbf{r}) = \frac{\mathbf{r}\upsilon\phi}{1-\phi} \tag{11}$$

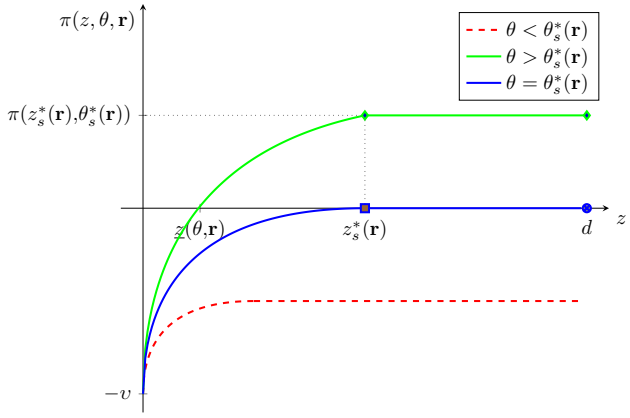

Figure 4: Illustration of psychological profit functions of sick households.

The critical level of financial capacity z^* does not depend on household characteristics[11]. A household with financial capacity levels below $z^*(\mathbf{r})$ exhibits a positive psychological profit if his health knowledge satisfies the following inequality

$$\theta > \left(\frac{c}{z}\right)^{\phi} \frac{z+\mathbf{r}\upsilon}{1-\mathbf{r}}$$

And for those with financial capacity above $z^*(\mathbf{r})$, their health knowledge θ would still be larger than θ^* for a deliberate self-medication. The behaviour of this situation thus exhibits selection conditions that are depicted in Figure 5 and summarized in the following proposition, with no further proof.

Proposition 2 *Consider a sick agent with health knowledge θ and financing capacity z.*
(i) For $0 < z \leq z^*(\mathbf{r})$ the agent is limited, and he deliberately self-medicates if $\theta \geq (c/z)^{\phi}(z+\mathbf{r}\upsilon)/(1-\mathbf{r})$ or otherwise he is forced to self-medicates.
(ii) For $z^*(\mathbf{r}) < z$, there is a critical knowledge $\theta^*(\mathbf{r})$ indifferent between self-medication and conventional medicine. In particular, $\forall\theta > \theta^*(\mathbf{r})$ agent chooses to (deliberately) self-medicate and $\forall\theta < \theta^*(\mathbf{r})$, if $z \geq d$, agent chooses conventional medicine or otherwise he is forced to self-medicates.
(iii) For $z^*(\mathbf{r}) > d$ the sick agent always choose conventional medicine.

Proposition 2 (i) says that relatively very poor households practice limited (insufficient) self-medication. Only extremely talented households will practise deliberate, limited self-medication. Proposition 2 (ii)

[11]For a fixed perceived risk $\mathbf{r}$, $z^*(\mathbf{r})$ is the value of z, given by equation (7), evaluated at $\theta^*(\mathbf{r})$

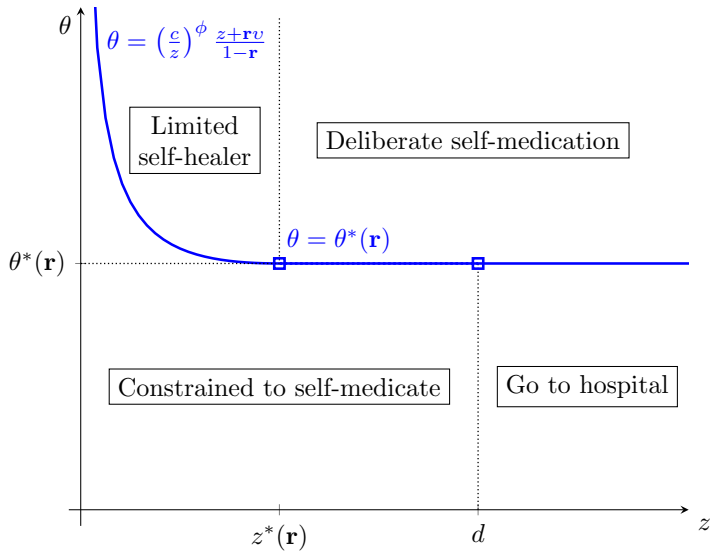

Figure 5: Different types of sick households.

shows that there is fraction of households that deliberately self-medicates during their morbid episodes. A policy aimed at reducing the cost of conventional medicine will not affect these households, because for them, this alternative is not even an option. Proposition 2 (ii) highlights important information about relatively wealthy households, i.e. those able to choose conventional medicine. In fact it shows that there is also a fraction of households that are able to choose conventional medicine but deliberately decide to self-medicate. This result is interesting because it shows that self-medication is not only for households unable to afford the services of conventional medicine. Proposition 2 (iii) states that for diseases where the cost of self-medication is high, households turn to conventional medicine, even for those with a high level of knowledge. This observation is quite logical, since in this situation producing one's own health becomes very costly for the agent.

3.4 Ex-post analysis of self-medication

The previous section deals with the decision-making choices made by households at the beginning of their morbid episodes. It shows how the economy is segmented, given each household's level of knowledge θ, financial capacity z and perceived risk of illness $\mathbf{r}$. While the perceived risk of the economic agent depends on a number of subjective factors such as the results of previous episodes of illness, the quality of the relationship with the seller of the drugs or the advisor and a number of individual characteristics, the effective risk depends mainly on two objective factors: the probability of making an incorrect diagnosis p and the quality of the drugs or infusions q.

$$r = r(p,q) \text{ with } \forall \kappa = \{p,q\}, \partial r(p,q)/\partial \kappa = r_{\kappa} > 0$$

This means that the effective risk r increases with the probability of making an incorrect diagnosis and the poor quality of the drugs. In addition, $r(1,q) = r(p,1) = r(1,1) = 1$, $r(p,0) = r(p)$, $r(0,q) = r(q)$ and $r(0,0) = 0$. Consequently, for a given disease, the effective risk r will always be fixed, whereas the perceived risk $\mathbf{r}$ varies from one household to another. The health risk curve θ_r^* is therefore obtained by fixing $\mathbf{r}$ to r in equation (10). Since the true value of the effective risk remains unknown to the agent, the behaviour of the risk curve therefore reflects the conditions for selecting households that will recover after self-medication. These selection conditions are depicted in Figure 6, and summarized in the following proposition, with no further proof.

Proposition 3 *Consider a sick agent with health knowledge θ and financing capacity z who chooses to self-medicate $\theta > \theta^*(\mathbf{r})$ against the effective risk r. There is a critical health knowledge θ_r^* that separates those who will recover from those who will remain sick at the end of their treatment. Particularly, $\forall\ \theta > \theta_r^*$, the agent recovers after treatment, and $\forall\ \theta < \theta_r^*$ he remains sick.*

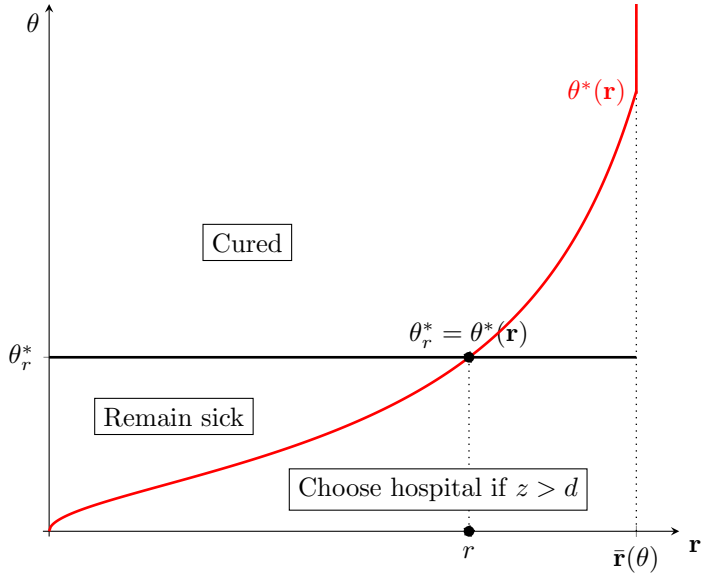

Figure 6: Ex-post segmentation of self-medicate households.

Proposition 3 says that after the self-medication process, those who do not pay attention to the quality of the treatment used or who remain sick because of a misdiagnosis remain ill. The cured set is made up of agents who take into account the quality of the treatment and the accuracy of the diagnosis.

4 Data and reduced form results

For this section we used data from the fourth and the third waves of the Cameroon Household Survey, which took place in 2014 and 2007 respectively. The data covers just over 45,000 individuals (46,554) for the fourth wave and almost 52,000 (51,836) individuals for the third wave of the 10 Cameroon

provinces distributed in both urban and rural areas. The Cameroon Household Survey (ECAM) aims to establish key indicators of poverty and household living standards in Cameroon. The survey also attempts to provide a picture of the behaviour of individuals during morbid episodes. In the 'household health' section, the fourth survey goes a little further than the third. In the former, it was possible to extract information enabling the calculation of the perceived empirical risk. We therefore use the fourth survey to provide a descriptive analysis of common diseases and the motivations behind the choice of different healthcare services. After a descriptive analysis, we use the data to test some implications of our model from probit regressions. Since the behaviour of Cameroonians can change over time due, for example, to health policies introduced by the government, we perform a static comparative analysis of years 2007 and 2014. We also added an analysis using the fourth survey to capture the change in the individual's behaviour according to the perceived risk.

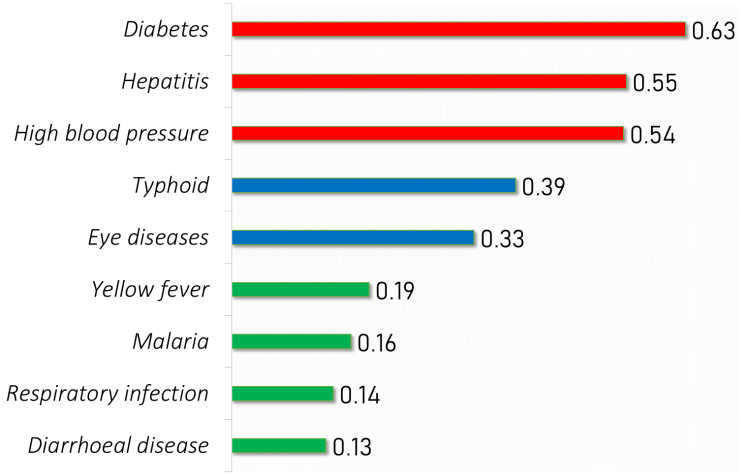

Figure 7: Empirical perceived risk with common diseases in Cameroon.

4.1 Analysis of common diseases

We perform an analysis of common diseases by providing an empirical perceived risk. We define the perceived empirical risk for each disease as the number of people who choose conventional health service out of the total number of individuals who reported having suffered from this disease at the last morbid episode. This statistic therefore varies between 0 and 1. A value of 0 means that the disease in question poses no risk to self-medication in the population, while a value of 1 means the exact opposite. The bar graph in Figure 7 sorts common diseases by their perceived risks in Cameroon. These frequent disorders presented include diabetes, hepatitis, high blood pressure, typhoid, eye diseases, yellow fever, malaria, respiratory infections and diarrhoeal disease. It is observed that the perceived risks of these diseases can be categorised into 3 major groups. A first group in which the habitual diseases have the highest perceived risks ranging from 54 percent to about 65 percent. These diseases include diabetes, hepatitis and high blood pressure. A second group with moderate risks composed of typhoid and eye diseases. They range

from 33 percent to about 40 percent. Finally, a third group with less perceived risks ranging from 13 percent to about 20 percent made up of yellow fever, malaria, respiratory infections and diarrhoeal diseases. Diabetes is perceived to be highly risky by 63 percent of Cameroonian households. This is because the prevalence is increasing in the general population of developing countries and particularly in this Cameroonian context. The causes of diabetes (type 2) are largely related to economic development. Urbanisation, globalisation and mechanisation that improve people's daily lives lead to reduced physical activity. Cameroonian households perceive diarrhoeal diseases to be less risky by 13 percent. This can partly be explained by the fact that public authorities through immunisation programmes provide protection against diarrhoeal disorders, effective disease surveillance and outbreak investigation help control and preserve the health of populations.

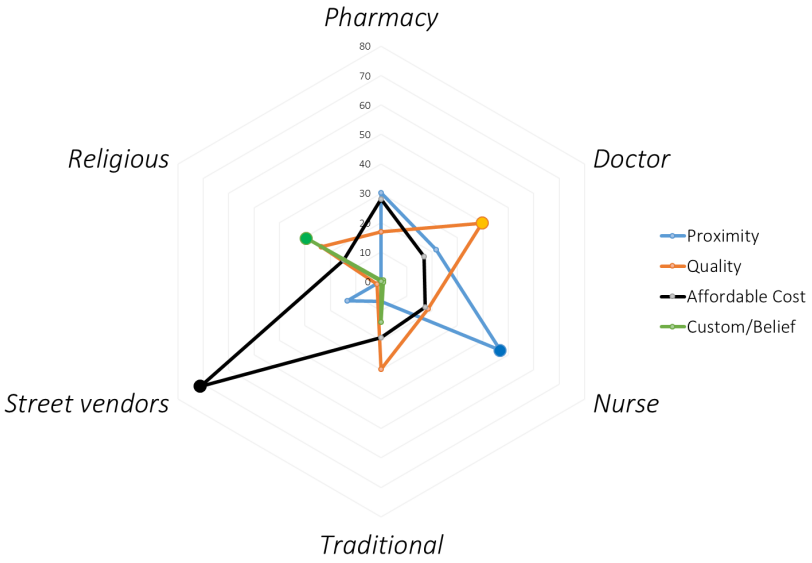

Figure 8: Motivations profile behind the choice of healthcare services in Cameroon.

4.2 Motivations behind the choice of different healthcare services

Figure 8 presents a star graph that highlights the motivation profiles that govern the choice of healthcare services in Cameroon. Proximity, quality, affordable cost and custom or belief are the factors retained in order to choose among the healthcare services. The choice of the pharmacy by individuals mainly depends on the proximity (about 30 percent). Households seek medical assistance from doctors mainly because of the quality of care (about 40 percent). It is observed that individuals get closer to nurses when they are ill and this healthcare choice relies on proximity, quality and affordable cost. Nurses in health centres are easier to reach by households than doctors (50 percent over 40 percent for doctors). Of course, the quality of healthcare offered by doctors is of superior quality (40 percent over 20 percent, the double). Nevertheless, the cost of choosing a doctor or nurse is almost similar. Quality, affordable cost, custom or belief and proximity determine the choice of traditional healthcare services. Most individuals

use traditional products when they are ill principally due to the quality of the products (about 30 percent), affordability of these traditional medicines, customs or belief. A factor which hinders the use of traditional medicines is the proximity. Most of the time, traditional healers are found in remote areas and not accessible to all. The choice of informal healthcare providers such as street vendors depend essentially on the affordable cost (more than 70 percent) and proximity of sales point (about 15 percent). These medicines bought from street vendors are generally of poor quality and wrongly conserved. Households may also resort to religious practices when ill because of their customs or beliefs (about 30 percent). Individuals instead seek religious or spiritual assistance when they believe the illness a individual suffers from arises from supernatural causes. In this case only spiritual assistance is said to heal the patient.

4.3 Reduced form results: Probit estimates

Before estimating the structural parameters of the model, we test some implications of our model by using reduced form estimates. Contrary to structural form, reduced form makes use of a richer set of variables than the one appearing in the theoretical model. We test whether the data confirm that the probability of self-medicating decreases with the cost of self-medication and perceived risk, and whether income is not always an essential component in the decision process. We also test whether for diseases with high perceived risk, income and the consultation cost reduce the probability of self-medication, but for diseases with low risk, only the cost of self-medication matters. We estimate a probit model expressing the probability of self-medicate as a function of disposable income, consultation cost, the empirical perceived risk of the disease, education and other variables including demographic and geographic characteristics[12].

[12]Self-medicate is a dichotomous variable defined as 1 if for a given disease, an individual chooses to self-medicate (or does not choose a conventional healthcare service) and 0 otherwise. Consultation costs, are ex-post that was paid by patients. We use these variable as a proxy of the ex-ante costs which remain unknown. This variable has a negative effect on healthcare resort. Education level which is captured in terms of years is supposedly discriminates for individuals' choice of modern treatment against traditional practitioners and informal drug vendors. The age of the investigated is introduced in terms of years.

Table 1: Probability of choosing self-medication: Probit estimates.

	Year		Perceived risk			
Characteristics	2007	2014	ECAM IV	Weak	Medium	High
Income (log)	-0.045***	-0.026***	-0.027***	-0.029***	0.007	0.049
	(0.015)	(0.005)	(0.005)	(0.005)	(0.024)	(0.061)
Cost (log)	-0.180***	-0.121***	-0.121***	-0.120***	-0.122***	-0.163***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.024)	(0.052)
Education	-0.055***	-0.061***	-0.062***	-0.061***	-0.078***	-0.033
	(0.005)	(0.005)	(0.005)	(0.005)	(0.026)	(0.049)
Age	-0.013***	-0.012***	-0.011***	-0.011***	-0.017**	-0.021
	(0.001)	(0.001)	(0.001)	(0.001)	(0.007)	(0.013)
Male	0.128***	0.194***	0.192***	0.188***	0.427**	0.283
	(0.033)	(0.034)	(0.034)	(0.035)	(0.179)	(0.358)
Musulman	0.159***	0.039	0.039	0.055	-0.198	
	(0.049)	(0.048)	(0.048)	(0.049)	(0.265)	
Rural	0.407***	0.405***	0.401***	0.399***	0.398**	0.534*
	(0.034)	(0.036)	(0.036)	(0.037)	(0.185)	(0.316)
Alone	-0.013	-0.017	-0.012	-0.019	-0.061	0.822**
	(0.034)	(0.035)	(0.035)	(0.036)	(0.183)	(0.349)
Medium			-0.211**			
			(0.086)			
High			-0.487***			
			(0.139)			
Constant	2.178***	1.639***	1.623***	1.629***	1.409***	0.593
	(0.145)	(0.085)	(0.085)	(0.087)	(0.480)	(1.183)
Obersvations	8,121	6,809	6,809	6,437	257	115
Pseudo-R2	0.212	0.179	0.181	0.179	0.164	0.184
Log-Likelihood	-4341	-3869	-3860	-3655	-145.3	-51.15

Standard errors in parenthesis. The stars *, ** and *** respectively indicate significance at 10, 5 and 1 percent.
ECAM IV is the fourth Cameroon Household Survey which took place in 2014.

Table 1 reports estimates of the probability choosing self-medication using the probit model. The first two columns show the results of the static comparative between 2007 and 2014, while the last four columns show the 2014 results taking into account the perceived risk.

Focusing on the first two columns. We are more than 95% sure that income, consultation cost, education, age, gender and living area are significant characteristics that affect the probability of practising self-medication in 2007[13] and 2014. We note that the probability of choosing self-medication slightly decreased with disposable income (resp. consultation cost) in 2014 compared to 2007 but remains significant. This can be explained by the remarkable but insufficient efforts made by the government of Cameroon in terms of health infrastructure and professionals (see, MinSante 2014-2020). Even if thet total national budget allocated to the Ministry of Health has increased in volume since 2008, rising from just over 158 million dollars (95 billion CFA francs) to just over 277 million dollars (166

[13]This finding is similar to that of Ngwen (2018) in the case of Cameroon, Audibert and Mathonnat (1998) for the case Cote d'Ivoire and Mwabu et al. (1993) in the case of Kenya.

billion CFA francs) in 2014, the proportion of the state budget allocated to the health function is still below the commitments made by African heads of state at the Abuja summit in April 2001, which called for 15% of the national budget to be allocated to the health function. Estimates of the coefficient of the cost of consultation show that for an individual, the total expenditure on self-medication during a morbid episode has a negative effect on the probability of choosing self-medication. This means that the more costly the medical expenses, household the less likely they are to practise self-medication. As we expect, education reduces the probability of self-medicates. This can be explain by the fact that the more educated an individual is, the more he is aware of the potential risk of self-medication. The demographic characteristic age reduces the probability of choosing self-medication during a morbid episode. This can be explained by the fact that the older a person gets, the more fragile their health becomes and the more exposed they are to the risks of self-medication. The positive sign associated with the coefficient on the variable male suggests that, in average and according to the sex, men resort to self-medication when ill than women. Since men are generally household heads, self-medication acts as the first line of treatment and saves working time during their morbid episodes. Probit estimates also reveal a positive relation between living areas and the probability of self-medicate. This means that the average Cameroonian living in a rural area is much more likely to self-medicate than those living in an urban area. This difference can be explained by the scarcity of centres in rural areas and the difficulty of accessing a conventional health service (see, MinSante 2014-2020).

Taking into account the level of perceived risk (column ECAM IV on Table 1) gives similar results to previous estimates. As predicted by our model, we can see the negative effect of perceived risk on the probability of resorting to self-medication during a morbid episode. Individuals perceiving a medium or high risk are more likely not to turn to self-medication when compared to those perceiving a low risk. The significance of this effect in the overall model prompts us to estimate a disaggregated model based on the perceived risk of the disease in order to observe the effect of different selected variables on the probability of self-medication for each stage of risk. The results of these estimates are presented in the last three columns of Table 1 namely : Weak, Medium and High. The findings of these new estimates reveal that disposable income still has a negative effect on the probability of self-medication, but this effect is only significant when the perceived risk is medium or high. Moreover, irrespective of the individual's perception of the risk associated with their illness, the likelihood of turning to self-medication significantly decreases with high medical costs. The negative effect of the individual's years of study and age is only significant when the perceived risk is low. The same holds for the positive and significant effects of residing in a rural area. Conversely, men perceiving the risk of illness as low or medium are more likely than women to resort to self-medication, and this effect is significant.

5 Structural estimations

This section presents how we derive the likelihood function of the model and use it to produce structural parameter estimates. The goal is to use these structural estimates to first partition the health knowledge - financial capacity space (θ, z) into limited self-healers, deliberate self-healers, constrained self-healers and conventional healers and second, run some counter factual policy simulations later on.

5.1 Log-likelihood function of the model

Health knowledge θ is not observable by the econometrician and to best of our knowledge there is not exists any study that already estimate this component. Using our theoretical model, we assume that health knowledge θ follows a log-normally distribution[14] and is ex-ante correlated with financial capacity z, perceived risk $\mathbf{r}$ and year of education s[15]. We can write

$$\ln\theta = \delta_0 + \delta_1 \mathbf{r} + \delta_2 \ln z + \delta_3 \ln s + \epsilon \tag{12}$$

where z the financial capacity is captured by the monthly income. The error term ϵ is a centered, normally distributed with variance σ^2 process. Denotes by $\mathbf{x}$, the agent's decision during his morbid episode: $\mathbf{x} = 1$ means that the agent self-medicates despite the risks while $\mathbf{x} = 0$ means that the agent choose formal healthcare service. Using the law of total probability, such that the financing capacity z can be greater or not than the threshold $\bar{z}$, we have

$$\begin{aligned} \Pr(\mathbf{x}=1) &= \Pr\left[\Pi(\theta, z, \mathbf{r}) \geq 0\right] \\ &= \Pr\left[\Pi(\theta, z, \mathbf{r}) \geq 0 | z \geq \bar{z}\right] \Pr(z \geq \bar{z}) + \Pr\left[\Pi(\theta, z, \mathbf{r}) \geq 0 | z < \bar{z}\right] \Pr(z < \bar{z}) \end{aligned} \tag{13}$$

Substituting z and $\Pi(\theta, z, \mathbf{r})$ by their expressions given in Eq. (7) and Eq. (9), respectively, we get

$$\begin{aligned} \Pr(\mathbf{x}=1) = \Pr&\left\{(1-\phi)[(1-\mathbf{r})\theta]^{\frac{1}{1-\phi}} \left(\frac{\phi}{c}\right)^{\frac{\phi}{1-\phi}} \geq \mathbf{r}\upsilon\right\} \Pr\left\{z \geq \left[(1-\mathbf{r})\frac{\phi\theta}{c^\phi}\right]^{\frac{1}{1-\phi}}\right\} \\ &+ \Pr\left\{(1-\mathbf{r})\theta\left(\frac{z}{c}\right)^\phi \geq z + \mathbf{r}\upsilon\right\} \Pr\left\{z < \left[(1-\mathbf{r})\frac{\phi\theta}{c^\phi}\right]^{\frac{1}{1-\phi}}\right\} \end{aligned} \tag{14}$$

[14] See for example Nguimkeu (2014) in the case of entrepreneurial ability.

[15] Year of education were firstly transformed as $x = x' + 1$ to keep null observation after the logarithm transformation. We alos try the model with disease cost c; but this specification gives worst results and were ignored in our analysis.

Taking the logs in the inequalities in the above terms yields

$$\begin{aligned}\Pr(\mathbf{x}=1) = \Pr\left\{\ln\theta > \ln\frac{(c^{\phi}\mathbf{r}\upsilon)^{1-\phi}}{(1-\mathbf{r})\phi^{\phi}(1-\phi)^{1-\phi}}\right\}\Pr\left\{\ln\theta < \ln\frac{c^{\phi}z^{1-\phi}}{(1-\mathbf{r})\phi}\right\} \\ + \Pr\left\{\ln\theta > \ln\frac{(z+\mathbf{r}\upsilon)c^{\phi}}{(1-\mathbf{r})z^{\phi}}\right\}\Pr\left\{\ln\theta > \ln\frac{c^{\phi}z^{1-\phi}}{(1-\mathbf{r})\phi}\right\}\end{aligned} \tag{15}$$

Now the probability to self-medicate can be obtain as a function of parameters ψ and observables W by plug-in the distributional specification of $\ln\theta$ given by Eq. (12)

$$\Pr(\mathbf{x}=1) = \Phi[h_1(\psi,W)]\Phi[-h_3(\psi,W)] + \Phi[h_2(\psi,W)]\Phi[h_3(\psi,W)] = H(\psi,W) \tag{16}$$

where $W=[1,c,\mathbf{r},z,s]^{\top}$ is the vector of covariates, $\psi=[\upsilon,\delta_0,\delta_1,\delta_2,\delta_3,\phi,\sigma]$ is the set of parameters, and $\Phi(\cdot)$ is the cumulative distribution function of the standard normal. The functions $h_i(\cdot)$, $i=1,2,3$, appearing in Eq. (16) are defined by

$$h_1(\psi,W) = \frac{1}{\sigma}\left\{\delta_0 + \phi\ln\frac{\phi}{c} + (1-\phi)\ln\frac{1-\phi}{\mathbf{r}\upsilon} + \ln(1-\mathbf{r}) + \delta_1\mathbf{r} + \delta_2\ln z + \delta_3\ln s\right\} \tag{17a}$$

$$h_2(\psi,W) = \frac{1}{\sigma}\{\delta_0 + \ln(1-\mathbf{r}) - \ln(z+\mathbf{r}\upsilon) - \phi\ln c + \delta_1\mathbf{r} + (\delta_2+\phi)\ln z + \delta_3\ln s\} \tag{17b}$$

$$h_3(\psi,W) = \frac{1}{\sigma}\{\delta_0 + \ln(1-\mathbf{r})\phi - \phi\ln c + \delta_1\mathbf{r} + (\phi+\delta_2-1)\ln z + \delta_3\ln s\} \tag{17c}$$

Given a sample of independent observations of size n, $\{(\mathbf{x}_i,W_i), i=1,\ldots,n\}$, the log-likelihood function of the econometric model can therefore be written as:

$$L_n(\psi|\mathbf{x}_i,W_i) = \sum_{i=1}^{n}\{\mathbf{x}_i\ln H(\psi,W_i) + (1-\mathbf{x}_i)\ln[1-H(\psi,W_i)]\} \tag{18}$$

The maximum likelihood estimation is therefore performed over the set of parameters $\psi = [\upsilon,\delta_0,\delta_1,\delta_2,\delta_3,\phi,\sigma]$. These parameters correspond respectively to the health deterioration parameter υ, the constant term of the health knowledge distribution, δ_0; the interactions between health knowledge and perceived risk (δ_1), financial capacity (δ_2) and education (δ_3); the productivity of capital in the self-production technology, ϕ; and the standard deviation of the health knowledge distribution, σ.

Table 2: Structural maximum likelihood estimates of the model.

Parameter	Symbol	Whole	Low	Malaria	Diarr.	Resp.	Others
Log knowledge and medication parameters							
Log knowledge - Constant	δ_0	4.0585	4.0356	0.8242	0.9467	1.1194	1.4339
		[0.1508]	[0.1652]	[0.125]	[0.7111]	[0.4672]	[0.1172]
Log knowledge - Risk	δ_1	3.1304	3.9719	-	-	-	-
		[0.3225]	[0.3663]	-	-	-	-
Log knowledge - Income	δ_2	-0.0708	-0.0760	-0.0236	-0.0034	-0.0415	-0.02
		[0.0083]	[0.0088]	[0.0059]	[0.042]	[0.021]	[0.0058]
Log knowledge - Education	δ_3	-0.6346	-0.7081	-0.3355	-0.2284	-0.4105	-0.3252
		[0.0534]	[0.0581]	[0.0504]	[0.28]	[0.191]	[0.0466]
Health deterioration	υ	9.8352	9.2430	1.6318	1.2372	1.402	1.4434
		[2.6632]	[2.5569]	[42.20]	[3.6207]	[64.17]	[16.43]
Capital share	ϕ	0.2237	0.2293	0.0873	0.1732	0.1182	0.0873
		[0.0083]	[0.0087]	[0.0066]	[0.0442]	[0.0232]	[0.0057]
General informations							
Standard deviation	σ	2.0052	2.0707	0.5931	0.8514	0.7036	0.6136
		[0.111]	[0.1164]	[2.6916]	-	[6.5993]	-
log-Likelihood	L_n	-4047	-3823	-692	-35	-62	-940
Number of Obs.	n	6911	6539	1323	79	127	1610

Estimate standard errors for each coefficient are in brackets.

Low, Diarr and Resp respectively correspond to Low perceived risk disease, diarrhoea and respiratory infection

5.2 Structural results

Maximum likelihood estimates are reported in Table 2. For a comparative analysis, the results were provided for the whole sample and for the group of individuals with a low perception of risk ($0 < \mathbf{r} < 0.2$). The estimates obtained for the whole sample are based on the assumption that all individuals experience the same disease during their morbid episodes, and that the perception of risk therefore varies from one individual to another between 0 and 0.65. We also estimated the structural form parameters for some diseases, namely malaria, diarrhoea, respiratory infection and others diseases. For each of these low risk diseases, the structural model in (12), is estimated by fixing the parameter δ_1 to zero[16] and the results have been reported in columns *Malaria* (malaria), *Diarr* (diarrhoea), *Resp* (respiratory infection), and *Others*. Care should be taken when interpreting the δ_k parameters of the model, as they represent correlations and not causalities.

The deterioration parameter υ is estimated at nearly 10 for the sample as a whole, and is slightly lower for individuals with a low perception of risk. The estimate for each of the low-risk diseases shows that this parameter is much lower (below 2) even if it becomes statistically insignificant[17].

[16] We fixed $\delta_1 = 0$ to avoid perfect multicollinearity during estimations.

[17] This may be due to the relatively small sample sizes.

The constant term of the logarithm of (health) knowledge δ_0 is estimated at around 4 both for the sample and for those with a low perception of risk. For malaria, diarrhoeal disease, and respiratory infection, δ_0 is estimated at around 1. This parameter represents the level of health knowledge that does not depend on the perceived risk, financial capacity or education of a sick individual or in others words knowledge that does not depend on the observable characteristics of the individual. Therefore, it can be seen as accumulated knowledge from past experiences or previous morbid episodes. The value and sign of δ_1 shows that correlation between the perceived risk and health knowledge is positive. And for low perceived risk diseases like malaria, diarrhoeal disease, and respiratory infection, this correlation is respectively estimated at 0.64, 0.52, and 0.56. The parameter (δ_2), shows a negative correlation between financial capability and health knowledge. Assuming all other things equal, an increase by 10% in income level is associated with a fall by around 0.71 % in health knowledge. Consequently, the higher an individual's income, the less attention they pay to their level of health knowledge. This may be due to the fact that the individual knows that the increase in income enables him to access better quality health services (conventional medicine in the case of our work) during his morbid episode. A look at each disease shows that the negative correlation between income and level of health knowledge is almost non-existent for diarrhoea and relatively weak for malaria, respiratory infection and other diseases. Although malaria and respiratory infections remain more severe in African countries, these diseases are the most likely to be self-medicated, whatever the level of household income. The parameter estimates for δ_3 indicates that there is a negative correlation between years of schooling and health knowledge. This parameter is estimated to be 0.63 for low perceived risk sample and means that each additional year of schooling can be associated with approximately 63.46 % average decrease in health knowledge. The point estimate of 0.22 of the self-medication production parameter, ϕ, means that a 10% increase in the capital devoted to a business leads to about 2.24 % increase in health level in the whole sample.

5.3 Identification of Self-healers

We return to the issue of whether the initial assignment of self-medication and conventional medicine choice during a morbid episode to the sample households has content. We start by comparing the estimated fraction of individuals in each occupation choice relative to the true data.

The estimated partition of the health knowledge - financial capacity space (θ, z) into limited self-healers, deliberate self-healers, constrained self-healers and conventional healers using the maximum likelihood estimates is depicted in Fig. XX. This graph is obtained by evaluating the indifference curves given by the functions XX, XX and XX that appear in the stylized version of the model summarized in Figure 5. Ignoring the actual choice of the households, we reallocate the households in the estimated (z, θ)-space according to the criteria stated in Proposition 2. The graph shows that the structural model delivers sizes of occupations that are comparable to the observed assignment of entrepreneurial and subsistence status from the data.

The overall fractions of households by occupation predicted by the estimated model are closed to the actual fraction of households by occupation. Indeed, while the actual composition is 90.4% for subsisters and 9.6% for entrepreneurs the estimated model predicts 88.7% of subsisters and 11.3% of entrepreneurs among which about 9.5% are constrained and 1.8% are unconstrained (see percentages appearing in Fig. 5).

6 Counterfactual policy experiment

6.1 Public awareness campaigns

The role of most health awareness campaigns in developing countries is to inform people about the risks associated with self-medication. The implication of this policy is that agents integrate the risk parameters p and q into their healthcare choice process. Since the true values of the risks remain unknown, households will incorporate estimated parameters into their choice functions. We first analyse the effect of this policy on the risk of self-diagnosis and then deduce the effect on the choice of quality of treatment.

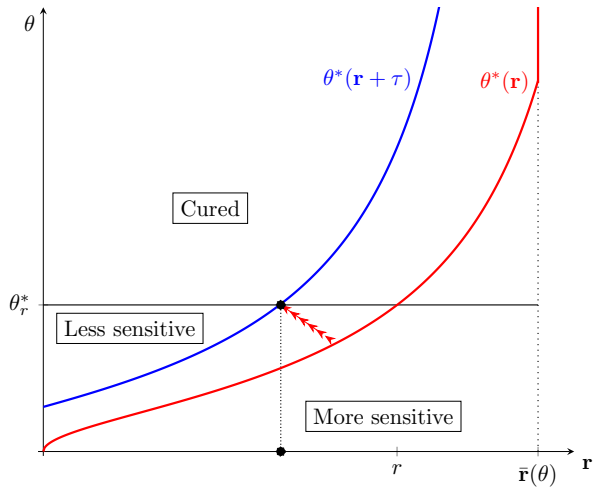

Figure 9: Awareness campaign and reaction from agents.

Let $\theta^*(\mathbf{r}+\tau)$ be cut-off talent of an agent with the new perceived risk $\mathbf{r}+\tau$ where $\tau \in (-\mathbf{r}, 1-\mathbf{r})$ denotes the individual's degree of sensitivity to the campaign. After a campaign to raise awareness of the dangers of self-diagnosis, the new decision curve changes as follows:

$$\theta^*(\mathbf{r}+\tau) = \lambda(\tau|\mathbf{r})\theta^*(\mathbf{r}) \quad \text{where } \lambda(\tau|\mathbf{r}) \equiv \frac{1-\mathbf{r}}{1-\mathbf{r}+\tau}\left(\frac{\mathbf{r}+\tau}{\mathbf{r}}\right)^{1-\phi} \tag{19}$$

with $\theta^*(\mathbf{r})$ defined in equation (10). The Figure 9 gives a graphical representation of how the economic agent reacts to an awareness campaign. As we can see, the agent is not very policy sensitive, as well as

$\theta^*(\mathbf{r}+\tau) < \theta^*(r)$.

7 Concluding Remarks

Self-medication is an alarming concept. This review focused on the self-medication of allopathic drugs, their use, its safety and reason for using it. It would be safe, if the people who are using it, have sufficient knowledge about its dose, time of intake, side-effect on over dose, but due to lack of information it can cause serious effects such as antibiotic resistance, skin problem, hypersensitivity and allergy. Hence, developing country like India where we have poor economic status, education status as well as poor healthcare facilities. People have less knowledge regarding risks associated with their self-medication. We are on the edge of sword whether to promote self-medication or not. Hence it is recommended that holistic approach should be taken to prevent this problem, which includes proper awareness and education regarding the self-medication and strictness regarding pharmaceutical advertising. Dispensing modes in the needs to be improved through proper education, strict regulatory and managerial strategies to make healthcare easily accessible and cost-effective

A Appendix

A.1 Tables

Table A1: Conventional healthcare services and Income (range) in Cameroon.

	Public hospital		**Private hospital**		**Confessional**		
Income (in USD)	Yes	Freq	Yes	Freq	Yes	Freq	Total
Less than 60	2374	82.40	406	14.09	353	12.25	2881
60 to 84	1004	80.77	262	21.07	166	13.35	1243
84 to 167	837	80.79	269	25.96	122	11.77	1036
167 to 250	358	81.73	115	26.25	53	12.10	438
250 to 334	214	86.64	81	32.79	25	10.12	247
334 to 501	127	90.07	53	37.58	15	10.64	141
501 to 835	48	82.75	17	29.31	8	13.79	58
835 to 1252	10	58.82	7	41.18	1	5.88	17
More than 1252	9	81.82	2	18.18	1	9.09	11
Total	4981	82.03	1212	19.96	744	12.25	6072

Yes: is the number of household that answer Yes. Freq: is the conditional row fraction (in percentage).

Table A2: Self-medication healthcare services and Income (range) in Cameroon.

	Traditional		**Relatives**		**Pharmacy**		**RS drug**		**Direct self**		
Income (in USD)	Yes	Freq	Yes	Freq	Yes	Freq	Yes	Freq	Yes	Freq	Total
Less than 60	587	20.37	175	6.07	427	14.82	1243	43.14	1472	51.09	2881
60 to 84	206	16.57	56	4.51	274	22.04	492	39.58	530	42.64	1243
84 to 167	154	14.86	36	3.47	292	28.19	388	37.45	387	37.36	1036
167 to 250	52	11.87	20	4.57	144	32.88	121	27.63	140	31.96	438
250 to 334	29	11.74	14	5.67	87	35.22	55	22.27	87	35.22	247
334 to 501	8	5.67	8	5.67	52	36.88	37	26.24	36	25.53	141
501 to 835	8	13.79	2	3.45	17	29.31	8	13.79	19	32.76	58
835 to 1252	1	5.88	0	0.00	4	23.53	0	0.00	4	23.53	17
More than 1252	3	27.27	0	0.00	2	18.18	0	0.00	3	27.27	11
Total	1048	17.26	311	5.12	1299	21.39	2344	38.60	2678	44.10	6072

Yes: is the number of household that answer Yes. Freq: is the conditional row fraction (in percentage).

Table A3: Formal and informal healthcare choice in Cameroon.

Disease	Pharmacy	Doctor	Nurse	Traditional	Street vendors	Religious	Others	Direct self	Perceived risk
Diarrhoeal disease	26	92	169	13	54	0	7	348	0.13
Respiratory infection	27	134	149	10	108	1	13	516	0.14
Malaria	208	1110	1636	46	674	2	44	3030	0.16
Other diseases	257	1600	1089	195	511	13	81	4696	0.19
Yellow fever	5	37	23	11	11	0	0	108	0.19
Eye diseases	14	154	48	9	18	1	2	214	0.33
Typhoid	12	222	122	23	8	0	12	167	0.39
High blood pressure	7	176	30	4	5	0	1	102	0.54
Hepatitis	1	12	3	0	0	0	0	6	0.55
Diabetes	1	74	11	0	2	0	0	30	0.63

Table A4: Motivations behind the choice of healthcare services in Cameroon.

	Proximity		**Quality**		**Cost**		**Relations**		**Family**		**Belief**	
Service	Yes	Freq	Yes	Freq	Yes	Freq	Yes	Freq	Yes	Freq	Yes	Freq
Pharmacy	293	30.21	164	16.91	271	27.94	61	6.29	93	9.59	5	0.52
Doctor	1761	21.54	3250	39.75	1374	16.81	729	8.92	563	6.89	63	0.77
Nurse	3324	46.86	1314	18.53	1234	17.40	515	7.26	367	5.17	54	0.76
Traditional	38	6.81	167	29.93	107	19.18	52	9.32	82	14.70	77	13.80
Street vendors	298	13.36	38	1.70	1589	71.22	53	2.38	89	3.99	1	0.04
Religious	0	0.00	8	23.53	5	14.71	0	0.00	7	20.59	10	29.41
Total	5750	29.62	4968	25.60	4626	23.83	1469	7.57	1268	6.53	222	1.14

Yes: is the number of household that answer Yes. Freq: is the conditional row fraction (in percentage).

A.2 Figures

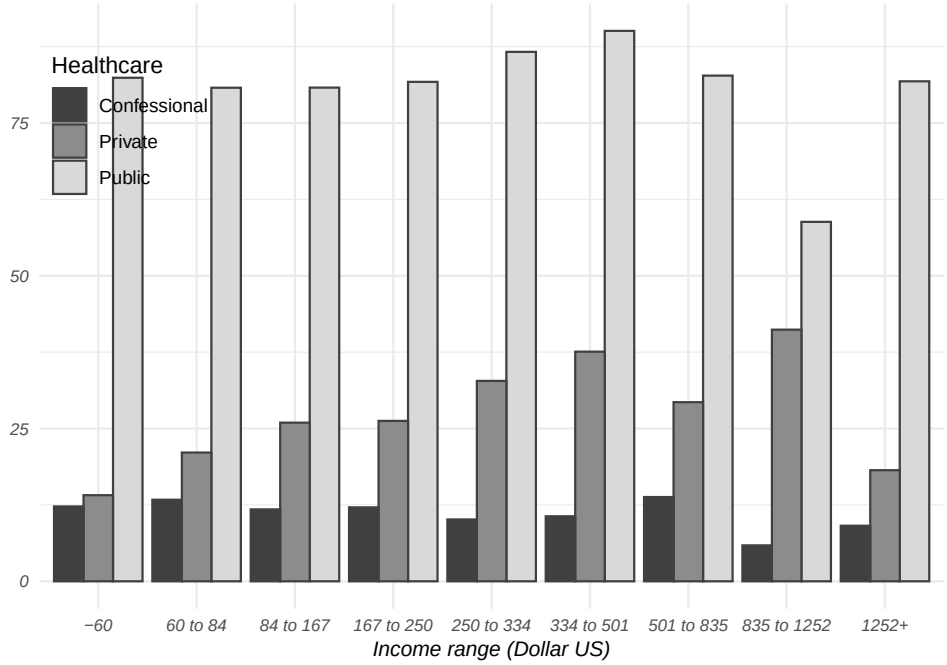

Figure A1: Conditional (row) frequencies of formal healthcare services by income range.

A.3 Proof of proposition 1

Proof 2 *For convenience, let recall the comparative profit* $\Pi(\theta,z,\mathbf{r})$ *of equation* (9)

$$\Pi(\theta,z,\mathbf{r})=\begin{cases}(1-\phi)[(1-\mathbf{r})\theta]^{\frac{1}{1-\phi}}\left(\dfrac{\phi}{c}\right)^{\frac{\phi}{1-\phi}}-\mathbf{r}\upsilon \text{ if } a\geq b\\ (1-\mathbf{r})\theta\left(\dfrac{z}{c}\right)^{\phi}-z-\mathbf{r}\upsilon \text{ otherwise}\end{cases}$$

where the statement $a\geq b$ *respectively corresponds* $d\geq\bar{z}(\theta,\mathbf{r})$ *and* $z\geq\bar{z}(\theta,\mathbf{r})$ *for household with* $(z\geq d)$ *and* $z<d$*. The function* $\Pi(\theta,z,\mathbf{r})$ *is continuous and differentiable on* $\mathbf{r}\in(0,1)$ *and we have:*

$$\frac{\partial\Pi(\theta,z,\mathbf{r})}{\partial\mathbf{r}}=\begin{cases}-\theta\left[\dfrac{(1-\mathbf{r})\theta\phi}{c}\right]^{\frac{\phi}{1-\phi}}-\upsilon \text{ if } a\geq b\\ -\theta\left(\dfrac{z}{c}\right)^{\phi}-\upsilon \text{ otherwise}\end{cases}$$

which is less than zero for all z*. Then* $\Pi(\theta,z,\mathbf{r})$ *decreases as the perceived risk* $\mathbf{r}$ *increases.*

(i) At the upper bound, $\Pi(\theta,z,1)=-\upsilon<0$ *for all* $z\geq 0$*.*
(ii) $d<\bar{z}(\theta,\mathbf{r})$ *means that self-medication costs more than conventional medicine; let* $d_{+}=\bar{z}-d>0$ *be this difference. Such that* $(1-\mathbf{r})\theta(z/c)^{\phi}-z-\mathbf{r}\upsilon$ *increases with* z *and reach his maximal value at* $\bar{z}$ *we have* $h=\theta(\bar{z}/c)^{\phi}$*. Then* $(1-\mathbf{r})\theta(\bar{z}/c)^{\phi}-\bar{z}-\mathbf{r}\upsilon$ *can be rewritten as* $(h-d)-(\mathbf{r}h+d_{+}+\mathbf{r}\upsilon)=-(\mathbf{r}h+d_{+}+\mathbf{r}\upsilon)<0$*.*
(iii) The function $\Pi(\theta,\cdot,\mathbf{r})$ *is continuous on* $\mathbb{R}_{+}$ *and differentiable on* $\mathbb{R}_{+}^{*}$ *and we have:*

$$\frac{\partial\Pi(\theta,z,\mathbf{r})}{\partial z}=\begin{cases}0 \text{ if } z\geq\bar{z}(\theta,\mathbf{r})\\ \dfrac{(1-\mathbf{r})\theta\phi}{c^{\phi}z^{1-\phi}}-1 \text{ if } 0<z<\bar{z}(\theta,\mathbf{r})\end{cases}$$

Since, $\lim_{z\mapsto 0}\frac{\partial}{\partial z}\Pi(\theta,z,\mathbf{r}|z<\bar{z})=+\infty$ *and* $\lim_{z\mapsto\bar{z}}\frac{\partial}{\partial z}\Pi(\theta,z,\mathbf{r}|z<\bar{z})=0$ *where* $\bar{z}(\theta,\mathbf{r})$ *is defined in Eq.* (7)*;* $\frac{\partial}{\partial z}\Pi(\theta,z,\mathbf{r})\geq 0$ *for all* $0<z<\bar{z}$*. Now,* $\Pi(\theta,z,\mathbf{r}|z<\bar{z})=0$ *implies that* $\theta=(z+\mathbf{r}\upsilon)/(1-\mathbf{r})(c/z)^{\phi}$ *however,* $\Pi(\theta,z,\mathbf{r})$ *increases with* $0<z<\bar{z}$ *this implies that for all* $\theta<(z+\mathbf{r}\upsilon)/(1-\mathbf{r})(c/z)^{\phi}$*,* $\Pi(\theta,z,\mathbf{r})<0$*. For all* $\theta>(z+\mathbf{r}\upsilon)/(1-\mathbf{r})(c/z)^{\phi}$*,* $\Pi(\theta,z,\mathbf{r}|z<\bar{z})>0$*. Since* $\Pi(\theta,z,0|z<\bar{z})=(z/c)^{\phi}(\theta-z(c/z)^{\phi})>0$ *and remembering that* $\Pi(\theta,z,\mathbf{r})>0$ *decreases with* $\mathbf{r}$ *and equals* $-\upsilon<0$ *at the upper bound* $\mathbf{r}=1$*. By the Intermediate Value Theorem, there exists one* $\underline{\mathbf{r}}\in(0,1)$ *such that* $\Pi(\theta,z,\underline{\mathbf{r}})=0$ *for all* $0<z<\bar{z}$*.*
(iv) For $\bar{z}(\theta,\mathbf{r})\leq z<d$ *or* $\bar{z}(\theta,\mathbf{r})\leq d<z$*,* $\Pi(\theta,z,\mathbf{r})$ *corresponds to upper right-hand side of Eq.* (9)*. Since* $\Pi(\theta,z,0)=(1-\phi)\theta^{1/(1-\phi)}(\phi/c)^{\phi/(1-\phi)}>0$ *and* $\Pi(\theta,z,1)=-\upsilon<0$*. By the Intermediate Value Theorem, there exists another* $\bar{\mathbf{r}}\in(0,1)$ *such that* $\Pi(\theta,z,\bar{\mathbf{r}})=0$ *for all* $\bar{z}(\theta,\mathbf{r})\leq z<d$ *or* $\bar{z}(\theta,\mathbf{r})\leq d<z$*.*

A.4 Taking into account the subjective nature of υ

The severity of the illness reflects the individual's physical condition. Assessing the severity of an illness is primarily a matter of how the agent feels. It is defined by the way in which the sick economic agent feels about the symptoms and the concerns he has about the deterioration in his state of health. In the model, the severity of the illness is captured by υ, the level of deterioration that the agent would suffer if he took no action to treat himself. In fact, υ represents the loss that the agent suffers if he does not take care of himself. Consequently, an individual's illness is serious only if the level of health at the start of the morbid episode, say h_0, is low and approaches the degradation υ. In other words, when this degradation increases and approaches h_0, the individual will tend to describe his illness as serious.

As we can see, the cut-off talent $\theta^*(\mathbf{r})$ increase with the deterioration level υ, i.e., $\lim_{\upsilon\to\infty}\theta^* = +\infty$. And that highlights an important fact about the relationship between the perceived severity of illness and households choice of healthcare. It shows that the proportion of agents likely to choose conventional medicine rather than self-medication increases with the severity of the illness. In other words, an agent who experiences symptoms and develops worries about his health will tend to go to hospital if he judges them to be sufficiently important or serious. This is illustrated in Figure A2 by the increasing curve of $\theta^*(\upsilon)$.

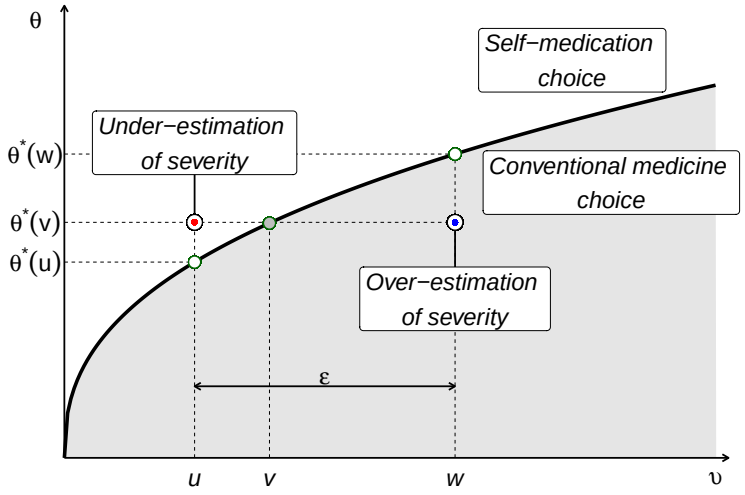

Figure A2: The severity of the disease and the perception of the agent.

The level of perception of the state of health being subjective (i.e. a function of individual characteristics such as age, gender and social situation) may lead the household to over- or under-estimate the seriousness of the illness from which he is suffering (see Mwabu 2007). Let's consider an agent with a talent $\bar{\theta} \equiv \theta^*(v) > \theta^*(u)$ and a perception of the seriousness of his health estimated at $u = w - \epsilon$ where w represents the real but *unknown* seriousness of the agent and ϵ represents the perception error term.

The net knowledge margin

$$\Lambda(u,w|\bar{\theta}) = \int_u^w [\bar{\theta} - \theta^*(\upsilon)]\mathbf{d}\upsilon \tag{20}$$

breaks down into two major components

$$\Lambda(u,w|\bar{\theta}) = \int_u^v [\bar{\theta} - \theta^*(\upsilon)]\mathbf{d}\upsilon - \int_v^w [\theta^*(\upsilon) - \bar{\theta}]\mathbf{d}\upsilon = \Lambda^+(u,v|\bar{\theta}) - \Lambda^-(v,w|\bar{\theta}) \tag{21}$$

The first expression in the right-hand side

$$\Lambda^+(u,v|\bar{\theta}) = \frac{\beta}{(2-\phi)v^\phi}\left[(v-u)^2 - \phi v(v-u) + u^2\left(\frac{v^\phi}{u^\phi} - 1\right)\right] \quad \text{where } \beta = \left(\frac{c}{\phi}\right)^\phi \left(\frac{1}{1-\phi}\right)^{1-\phi} \tag{22}$$

represents the *margin of available knowledge* regarding self-medication while the second

$$\Lambda^-(v,w|\bar{\theta}) = \frac{\beta}{(2-\phi)v^\phi}\left[(w-v)^2 + \phi v(w-v) + w^2\left(\frac{v^\phi}{w^\phi} - 1\right)\right] \tag{23}$$

represents the *margin of absent knowledge*. Then, when we consider a sick agent with health knowledge θ and financing capacity $z \geq d$ who estimates the severity of his health at υ; this agent who overestimates the seriousness of his illness ($\upsilon = w$ in Figure A2) will always choose conventional medicine only if the margin of absent knowledge for self-medication is strictly positive: $\Lambda^-(v,w|\bar{\theta}) > 0$. While, when this agent underestimates the seriousness of his illness ($\upsilon = u$ in Figure A2), he is lucky if his margin of absent knowledge for self-medication is null: $\Lambda^-(v,w|\bar{\theta}) = 0$; he is unlucky as soon as his margin of absent knowledge for self-medication is strictly positive: $\Lambda^-(v,w|\bar{\theta}) > 0$.

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