

DEMAND AND EQUILIBRIUM PRICE OF HEALTH CARE: A STRUCTURAL EQUATION APPROACH

Zakaria FIRANO^{a)}, Abdelilah ELHAMYANI^{b)}, Abdenbi EL MARZOUKI^{c)}

Mohammed V University of Rabat, MOROCCO

^{a)} e-mail: zakaria.firano@fsjes-agdal.um5.ac.ma, ORCID: 0000-0002-0454-6217

^{b)} e-mail: abdelilah.elhamyani@gmail.com, ORCID: 0009-0000-3995-9460

^{c)} e-mail: elmarzouki@yahoo.fr, ORCID: 0009-0008-5982-2347

Abstract: In this article, we propose a new approach to estimating health-care demand. The aim of this paper is to determine the production costs of health care from the demand function of care. To do this, we used an approach based on structural equations where consumption and demand are estimated to capture the dynamics of health costs within a self-managed public hospital. Following this approach, based on the equilibrium between supply and demand of health care, we used the social and professional characteristics of beneficiary to estimate the demand function, which will approximate the cost of health care. The results showed that the demand for care is largely dependent on economic, demographic, and perception factors. Also, the back testing and corroboration tests of the predictions affirm that the functions developed will allow a better cost forecast for the hospital unit, able to propose a budgetary and partial cost approach in the future. Some limitations can be mentioned in connection with the accessibility to accounting data and also the ignorance of time dimension or dynamic evolution of cost demand.

Keywords: structural equations, health care, demand for care, production costs, consumption of services.

JEL Classification: C3, D23, D61, I12.

1 Introduction

The issue of the determinants of demand for care has been the subject of major concern in recent years for several governments in both developed and developing countries. This research topic is of interest to many researchers working on this theme (e.g., Di Matteo 1998, and Hitiris Posnett 1992, Milne and Molana 1991, Kenkel 1990, Wedig 1988, McGuire and Yule 1987, Wagstaff 1986, Newhouse, 1977).

The issue is particularly important for developing countries, which are facing a growing demand for health services in a sometimes difficult economic context. Adverse macroeconomic conditions make it difficult to finance the health system (Abel-Smith, 1986). Therefore, to cover the costs coming from the health sector, the public policies of these countries aim to seek new sources of financing. However, according to several authors, these policies and programs have been characterized by inefficient use of resources to improve the health of populations. Thus, these programs have been unable to significantly reduce the regional inequalities suffered by many countries around the world (World Bank and Brunet-Jailly, 1991).

As a result, much research has been devoted to the study of the determinants of demand for medical care in developing countries (Akin, Guilkey and Denton 1995, Sauerborn, Nougara and Latimer 1994, Gertler, Locay and Sanderson 1987, Dor, Gertler and Van der Gaag 1987, Akin, et al. 1986, Musgrove 1983). In developed countries, due to the existence of health insurance systems, health care is provided free of charge or at low cost. Under these conditions, a basic model of supply and demand suggests that demand should be infinite or at least extremely high, leading to "overconsumption" of care by patients (the so-called moral hazard problem).

However, it is important to keep in mind that health care is not a convenient service: the health request is an intermediated request, that is, it goes through a prescriber (the doctor or health practitioner) who will decide on behalf of the patient what the latter will "consume." In this configuration, prices play only a secondary role in increasing the demand for care, and an increase in health expenditure, if it comes from new medical and technological discoveries, can be considered a collective optimum (Dormont, 2009). The divergence in quality makes the price mechanism incomplete.

However, in developing countries, it is rather the problem of access to care that is of greatest concern to governments, especially in certain remote geographic areas. Despite the efforts made by many developing countries to build health facilities in remote areas, attendance by a disadvantaged social class is still limited, due to socioeconomic conditions, remoteness, low levels of education, and perceptions of the health services provided. These barriers in accessing health services generate social inequalities in health.

Cost management in public structure in Morocco depends on the legal form of the care unit. The health-care structures under the control of the Ministry of Health have a budget nomenclature set by this department, and the accounting process remains for public purposes based on revenues and expenditures with the primary control under the Ministry of Finance. Furthermore, autonomous structures, such as University Hospital Centers (CHU), can have cost accounting management based on analytical and management accounting, but this is dependent on the degree of development of management skills. In the case study presented in this research work, the nonexistence of analytical and management accounting requires the use of this innovative approach focused on the demand for care.

This work is structured as follows. The following point is devoted to a literature review of the determinants of care demand. In the second time, a detailed analysis of demand and consumption data is carried out. Next, we propose a description of the methodology of structural equations. Finally, a discussion of the results and an analysis of the predictive capabilities of the model are presented.

2 Determinants of care demand

In health economics, the demand for care function represents the relationship between the amount of care requested as a function of various variables. Among these variables, the (monetary) cost to the patient is of course fundamental; However, it is not the only factor influencing the demand for care. In particular, non-monetary costs, including the time required to seek

care, are also recognized as important determinants of care demand.

Since the pioneering work of Arrow (1963), it has been known that health care has certain unique characteristics that differentiate it from other goods and services. It is important to take these characteristics into account when estimating the demand for care; otherwise, biased coefficients with uncertain interpretation will be obtained.

First, the demand for care is a demand derived from the demand for health. Care is not requested per se (it does not generally provide a gain in utility to its consumer), but because it has an effect, a priori positive, on the health of the individual. This finding led health economists to postulate that each individual was a producer of a "healthy good," and that health care could be considered as inputs of this production function, among others.

Secondly, the request for care is an intermediated request: it most often goes through a prescriber (doctor, pharmacist, or specialist) who determines, at least in part, what care and medication the patient should consume and in what quantity. In specialized terms, the demand for care is codetermined with the supply of care. This last point is important for empirical estimation: unless a complete system of joint determination of supply and demand for care is estimated, the estimated coefficients cannot be interpreted as reflecting causalities. In fact, this joint estimate is almost never made; however, care supply factors should be included in the demand estimate to minimize biases arising from this intermediated nature of care demand (Zukevas, 2013).

The demand for care is generally estimated in the following linear form¹:

$$\log D_i = \alpha_i + \sum_{i=1}^n \beta_i p_i + v_i$$

The coefficient " β " corresponds directly to the logarithmic derivative of demand, which can be shown to be equal to the elasticity of demand divided by the price. When the coefficient " β " is close to zero, then the demand is inelastic, that is, a low sensitivity of demand to the price of the good: when the price of care increases by 1%, the demand for care decreases little.

¹ The demand for care is an elasticity ($\epsilon_{d,p}$) defined as: $ED = \partial D / \partial P * P / D$. The use of a linear form is only for simplicity of interpretation.

However, an elasticity close to 1 (in absolute value) means that the demand for care will decrease sharply as a result of an increase in price.

Much has been written about the analysis of the determinants of demand because of its multidimensional nature. In fact, there are several families of determinants, namely, economic, demographic (age and sex), socioeconomic and price of care, and finally factors related to the quality of care and its perception.

3 Economic Determinants

Theoretically, the cost of treatment should have a negative impact on the use of health services. However, the extent of this negative effect is debated within the literature: it is the question of "elasticity" of the demand for care. The literature is not unanimous on this issue. Some studies lead to an inelastic demand for care at the cost of care in the context of developing countries, for example, studies like Akin (1995) in Nigeria and Akin, et al. (1998) in Sri Lanka. However, other studies conclude, unlike the latter, that price is elastic on the demand curve such as; Dor, et al. (1987), Dor and Van der Gaag (1988, 1993) and Sauerborn, et al., (1994).

Other studies take better account of the quality of care as a determinant of decisions to appeal to health facilities. In these studies, quality positively influences the demand for care in the face of rising costs. In this sense, improving the quality of care is likely to mitigate the negative effect of price increases on the demand for care (Abel-Smith, 1992; Lavy and Quigley, 1993; Mwabu, et al., 1993; Mariko, 2002).

A series of studies highlight the distance traveled to receive health care and waiting times as important determinants of health-care consumption. Akin, et al., (1985) show that the proximity of the health infrastructure and the socioeconomic characteristics of households determine the expansion of the population's access to medical and health care. This point is particularly important in the context of developing countries, particularly Morocco, where health provision remains subjected to strong spatial and regional inequalities throughout the country (Hanchane and Firano 2015).

4 Demographic Determinants

Health care as a whole can be divided into two subcategories: preventive care and curative care. However, as far as the demand for curative care is concerned, the latter is primarily a function of the person's state of health (the demand for health care is not an "intrinsic" request: we do not generally treat ourselves for pleasure). Demographic factors such as age, sex, and family size are important determinants of the health status of individuals and as such play an important role in explaining the demand for health services.

The age of the individual plays an important role in explaining the demand for health care. Indeed, age has an effect on both the incidence of disease and the need for care. The incidence of disease is high in children and the elderly, which explains why, in theory, there is a U-shaped relationship between age and health-care demand (Akin, et al. 1985). The impact of age on the use of health facilities is linked to associated pathologies. Depending on whether you are a newborn or an adult in old age, the pathologies are different and can guide the nature of the care to be requested. As for gender, depending on whether one is male or female, certain biological and natural factors may predispose to certain specific health needs and lead one or the other category to use health services more than the other.

Household size is another demographic characteristic that may explain the demand for health services. The correlation between family size and the level of care consumption is not stable. Providing for the health needs of all members in the case of a large family can be difficult, especially when the per capita household income is low, but the presence of more adults in a large household would increase the household income and subsequently increase the consumption of health services.

5 Quality and perception

The quality of health care is identified as one of the key determinants of caregiver choice. However, there may be a difference between the objective quality of care and the quality perceived by patients.

Some studies attempt to control for the "objective" quality of care. Thus, some authors propose five indi-

cators of quality, namely, the number of medical personnel, availability of essential drugs, operation of the laboratory, existence of a connection to electricity, and running water. Using these factors as quality variables, they conclude that the quality of care positively and strongly influences the demand for medical services.

Other authors use the availability of medicines, qualified personnel, and the treatment process as indicators of quality. They also conclude that quality has a positive impact on health-care demand, particularly drug availability and treatment process which are the two main significant factors.

The general conclusion to be drawn from this work is that quality improvement could increase the demand for medical care by attracting new users or increasing the intensity of service use by existing users. However, the lack of staff training and the unavailability of medication can inhibit the use of care, despite the overall functioning of health services.

The perception of the usefulness of treatment for a given disease can have an important influence on the demand for care. This perception depends, in particular, on the level of education of the individual. Indeed, the level of education plays an important role in decision-making about health care: it can influence the demand for care as well as the choice of care providers. For example, Welch (1970) states that people with a level of education pay more attention to their lifestyle than people without any level of education, and are thus likely to avoid certain medical treatments compared to illiterate households.

People with less education consult less than people with a high level of education. Another important finding is that women with a high level of education use specialist doctors more often than men. In contrast, men with tertiary education consult less with specialists than those with high school and elementary school diplomas. Such a phenomenon is probably at work in the fact, where the poor people in Morocco have a lower reported morbidity rates than the rich people.

The main objective of each health system is to provide equal access to health services for the entire population regardless of their socioeconomic status, income, and geographic location. Despite these efforts, experience

shows that problems of unequal access to care still persist and not all people have equal access to health services.

Several authors have developed work in which they demonstrate that inequalities in the use of care are strongly related to the costs of care. In addition, the possession of supplementary health insurance is also a source of inequality, especially when it comes to the use of specialist care. However, the inequality in the use of care can also be explained by aspects related to health systems as a whole, namely, the organization and financing of health systems. Indeed, significant inequalities in access to care persist, including for countries that have implemented universal coverage. In addition, the "care provision" component can also be described as one of the determinants of the care consumption of different social classes.

Research shows that the type of delivery of health systems (public and private) impacts the nature of the use of care. This research confirmed that public financing of care has a positive impact on overall mortality and morbidity rates. This positive impact must be accompanied by a reduction in costs for the poorest classes, to improve their state of health, and consequently a reduction in inequalities in care, as shown by several international experiences. In France, for example, the introduction of Universal Medical Coverage, a free health protection scheme for the poor or the unemployed at the end of their rights, has helped to reduce inequality in the consumption of care.

Several studies have attempted to compare the performance of different health systems. The recommendations of the latter have shown that public health systems are more relevant in terms of cost-effectiveness, while social insurance systems are better in terms of quality of care. In terms of the provision of care, several studies have attempted to answer the following question: does the offer provided by a health system at a given date really improve the social well-being of individuals?

Several researchers have shown that health resources explain the regional disparities observed within the countries studied. Other authors have reported that the consumption of care increases according to the offer provided by a health system within a geographic area, especially among the poor. These results highlight the relationship between resources and access to care. In

other words, scarce resources will automatically be accompanied by difficult access to care, especially for the poorest of the population. This last point has important implications in the Moroccan context. Indeed, it has been established that the supply of care in Morocco is limited and unevenly distributed throughout the country (Hanchane and Firano, 2015). Under these conditions, international experience teaches us that this unevenly distributed supply of care reinforces preexisting inequalities in access to care. To limit the negative effect of resource scarcity, targeting policies are sometimes put in place. The latter aim to target people with the highest need for care and, in particular, the poorest, taking into account geographic distribution to avoid problems of exclusion and inclusion.

With regard to the supply in terms of human resources, the literature compares between the types and methods of remuneration of doctors. In the context of managed care, several American studies have found that the shift from fee-for-service to capitation has decreased the use of health services. This result alone does not lead to an improvement in the efficiency of the systems or, on the contrary, a reduction in access to care.

However, other authors state that the fee-for-service to capitation encourages physicians to have more responsibility toward their patients, especially to validate clear objectives vis-à-vis the poorest populations. This observation was made by the author in the case of Sweden, Great Britain, and the Netherlands. In addition, we show that capitation pricing is more effective in terms of improving care management and allows for better planning of care services than other compensation systems. This system is qualified as efficient for the poorest or for those who have a low level of education that does not allow them to master and understand the care chains.

6 Data and analysis

The data used come from care operations carried out in a self-managed public hospital. The statistics relate to care operations in 2019. The analysis of the descriptive statistic from the database of the study hospital provides an initial idea of the determinants of morbidity

and demand for care in the population of hospital users. The chart in Figure 1 shows the geographic characteristics of the sample of hospital users.

Almost half of the users are from the Rabat Salé region with beneficiaries from other regions because of the specificities of the care to be provided. The available data do not make it possible to determine the cause of this rural–urban morbidity differential. It can be hypothesized that this differential is at least in part due to a difference in perception of the disease, which, in turn, depends on the level of education (figure 1).

We insisted on considering in our sample a stratification taking into account the presence of the gender parameter. Thus, women represent more than 54% of the beneficiaries and men are close to 45%. This distribution indicates an increasing use of care by women and also helps to explain the extension of the age group benefiting from health services (table 1).

The services of the study hospital are intended, in particular, for the greater Rabat region, but given the university nature of the latter, it can also offer its services to other regions of Morocco. However, the analysis of our sample of more than 16,000 beneficiaries indicates a supremacy and dominance of the cities of the Rabat region with a marginal presence of the cities of Casablanca and Taza (Figure 2).

We have insisted in our work on the inclusion of the geographic dimension to identify the effects of distance on the demand for care and also to integrate the costs of care in the choice of use of health services. Overall, most of the beneficiaries belong to the Rabat city area, indicating a marginal effect of the costs of access to care. However, this assumption will be tested in the proposed model.

The data used concern most age groups of care recipients. The analysis of the bell curve confirms that it includes all ages combined. We have beneficiaries in the median age is around 60 years old and whose extreme value affirm the existence of old and age-specific populations.

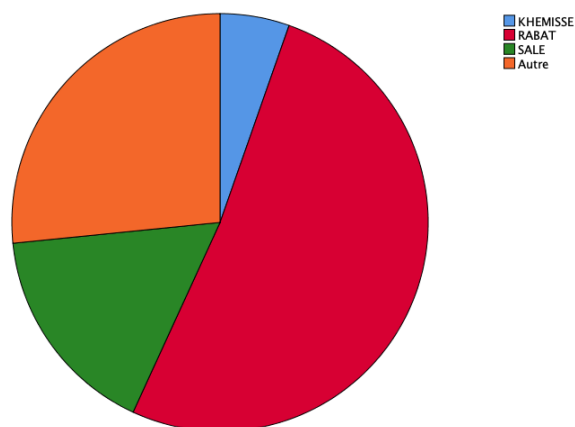


Figure 1. Geographic distribution of patients
(Source: Author's own research)

Table 1. Gender analysis of beneficiaries
(Source: Author's own research)

Gender	Number	Percentage	Cumulative number	Cumulative %
<i>Man</i>	8227	45.80	8227	45.80
<i>Women</i>	9736	54.20	17,963	100.00
Total	17,963	100.00	17,963	100.00

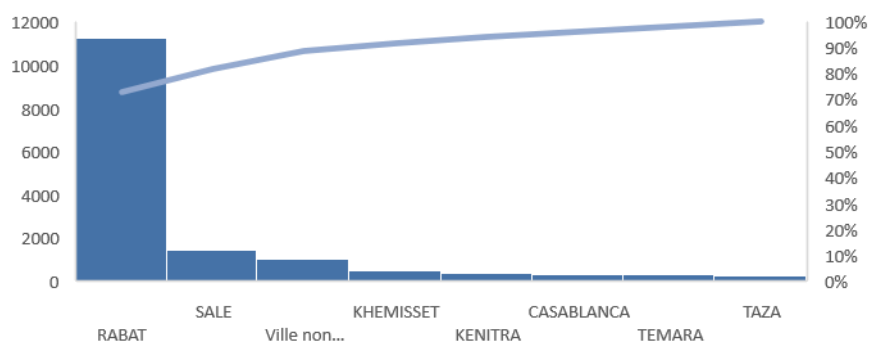


Figure 2. Geographic distribution of beneficiaries
(Source: Author's own research)

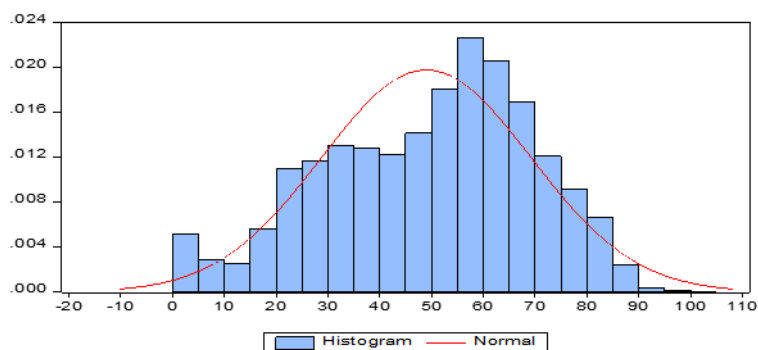


Figure 3. Age of the study population
(Source: Author's own research)

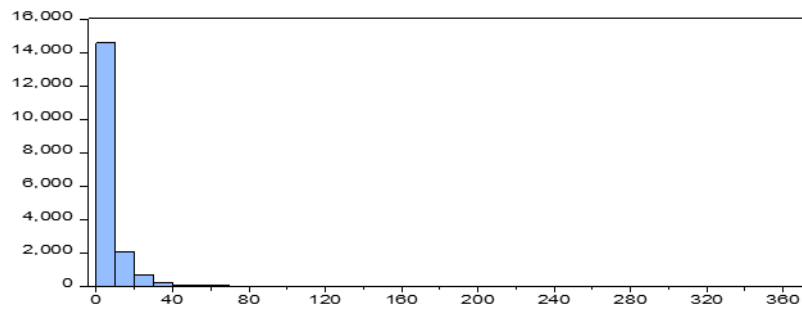


Figure 4. Average length of hospital stays (per day)
(Source: Author's own research)

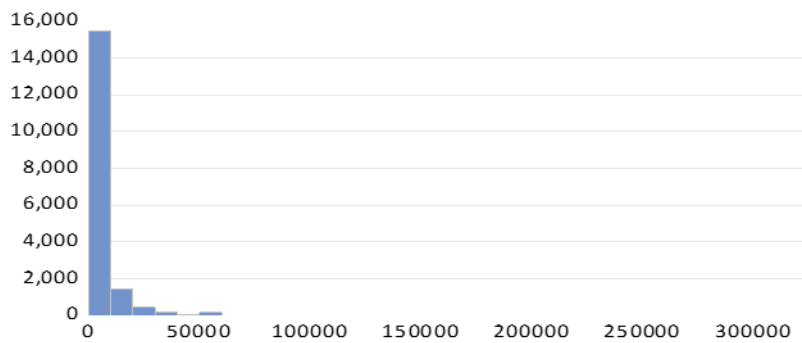


Figure 5. Distribution of invoiced amounts
(Source: Author's own research)

Table 2. Descriptive statistics (amount invoiced)
(Source: Author's own research)

Average	Median	Maximum	Minimum	Typical deviation	Jarque–Bera
6284	3000	320,000	32	13,000	Prob (0.00)

Table 3. Type of coverage
(Source: Author's own research)

Coverage	Number	Percentage
<i>Far</i>	12,530	69.75
<i>CNOPS</i>	2705	15.06
<i>DIRECT PAYMENT</i>	2000	11.13
<i>DNA</i>	331	1.84

To determine the factors with significant effects on the demand for care, the length of the beneficiaries' stays was also reported as a determining variable in the analysis of beneficiaries' behaviours. An important observation of the length of stay is the importance of short periods of stay where the dominant frequency is around 10 days. The most important stays that exceed 40 days represent only a minimal or even negligible fraction.

In determining the factors explaining the demand for care, the amount invoiced traces the elements that explain the cost production function within the hospital, and therefore, this variable constitutes an approximate representation of the interaction between supply and demand. The study of the amount billed reveals a heterogeneity in the use of resources in all hospital services.

The distribution of invoiced amounts deserves a very in-depth analysis by services and also by pathology.

However, a global analysis indicates on average that the expenditure far exceeds 6000 MAD with a median around 3000 MAD, indicating a significant dispersion between the services and the pathologies studied. Statistically, the recipe produced by the care units does not follow a normal distribution. This is confirmed by the normality test (Jarque–Bera). As such, it should be noted that the distribution of invoiced amounts is truncated on the right with a degree of dispersion of more than 13,000 MAD.

The majority of beneficiaries are covered by the FAR mutual insurance company and CNOPS. Paying customers represent only 11% of beneficiaries. The introduction of the coverage factor makes it possible to define the notion of universal coverage transcribed in the very sense of creating coverage mechanisms. From here, a fundamental hypothesis can be put forward regarding the positive effect of coverage on the demand for care.

The richness of the database indicates the existence of several pathologies at the service of clients and the mean concerning hospitalization in oncology, ophthalmology, and urology. However, the predominance of oncology is to be taken with nuance in the sense that the recurrent and medium-term nature of the treatment stipulates regular access of the patient to this type of pathology. Taking into account the acts and the nature of the service provided to the beneficiaries is of crucial importance because the cost and price of care will depend indefinitely on the pathologic typology achieved. In this section, we propose a discussion on the methodology adopted to capture the determinants of the demand for care in public hospitals. We will first discuss Structural Equation Modeling (SEM) with reference to traditional single-equation techniques such as regression analysis. Next, we will present the two main approaches to SEM based on covariance and partial least squares.

7 Modelling Approach

The main objective of empirical estimation of demand for care is to get an idea of the factors that influence the demand for care, as well as their magnitude. Indeed, economic theory provides an incomplete guide to the determinants of care demand: it tells us that the variables influencing the health status of individuals

will have an effect on their demand for care, but the theory does not provide a prediction on the nature or magnitude of the effects of these variables. For example, economic theory predicts that age will have a positive effect on the demand for care (the older a patient is, the higher his demand for care), and that the price will have a negative effect (the higher the out-of-pocket expenses, the lower the demand). However, the theory does not provide information on the magnitudes of these effects (which is the largest) or their interaction: is the effect of price on demand greater or smaller for older people than for middle-aged people? Empirical estimation of care demand functions helps answer these questions.

On other points, the theory does not provide an indication of the variables to be included in the empirical estimate. Thus, the theory predicts that health preferences and attitudes to risk will influence the demand for care. However, these variables are unobservable, and it is necessary to find by empirical exploration variables to approximate preferences (we speak of "proxy" variables for preferences). On the nature of these variables, the theory is silent, hence an empirical approach is needed.

As mentioned above, most econometric models of demand for care are so-called "reduced form" models, that is, they do not include structural variables related to the determination of supply (this is the approach that should theoretically be followed in the presence of a joint determination of supply and demand; however, too limited nature of the data most often does not allow such an estimate to be made).

Under these conditions, we chose to estimate a model that determines the demand for care according to a particular design. It is a question of quantifying the demand for care, which is an unobservable variable according to its own determinants, and also modeling the consumption of production units to arrive at an approximation of production costs. These two elements will make it possible to approach the price of the health offer and establish an approximation of the care market in the study hospital. The unobservability of the two functions (demand and supply) requires the use of structural equations.

A structural equation refers to a statistical association by which one variable (X) influences another (Y). When there is only one dependent variable predicted

by one (or more) independent variable in our statistical model, the structural equation is univariate and can be expressed as follows:

$$Y_i = \alpha_i + \sum_{i:1}^n \beta_i X_i + v_i$$

This equation represents a simple regression model with two variables (X and Y). The significance test of β_1 will provide empirical evidence to determine whether X influences Y or not. Unlike equation 1, describing the relation between price and quantity of demand, equation 2 presents the fundamental relation between the latent variables and the characteristics of beneficiary, where we need to estimate.

Increasing the number of independent variables transforms our model into a multivariate model. However, this still corresponds to a univariate model in that we still have only one dependent variable to predict. Nevertheless, the need to be able to estimate models with more than one dependent variable has also led to the invention of some multivariate techniques useful in quantitative research.

SEM effectively overcomes the above limitations. Therefore, we can define SEM as a simultaneous multivariate technique that can be used to estimate complex models, including observed and latent variables. SEM can easily be used for the same purposes as traditional univariate (e.g. regression) and multivariate techniques are used. This specific feature transforms SEM from a routine statistical technique to a comprehensive framework for statistical modeling. Yet this is not the new contribution of SEM. What makes SEM a specific statistical technique is the fact that it can handle latent variables.

A latent variable is a hypothetical or an unobservable concept (e.g., happiness) that we measure using a set of observable variables (e.g., job satisfaction, family, goals achieved). The main reason we want to use latent variables is that many latent concepts are multifaceted and cannot be represented by a single indicator (element or question) as they encompass more than one aspect. Researchers have traditionally used different types of factor analysis procedures to discover one or more latent variables among a set of indicators. While traditional approaches to factor analysis are exploratory in nature, SEM approaches factor analysis in a confirmatory manner.

The most common SEM approach is based on covariance matrices that estimate model parameters accordingly using only the common variance (Hair, et al., 2021). This confirmatory approach is widely known as covariance-based SEM (CB-SEM) and was developed by Jöreskog (1969). The fact that CB-SEM uses a common variance means that indicator measurement error is taken into account when estimating the model (Mehmetoglu and Jakobsen, 2016). This specific feature makes CB-SEM estimates less biased than techniques by assuming no measurement error is made (Harlow, 2014).

The main purpose (and advantage) of CB-SEM is to statistically test theories (hypothetical models) in their entirety. One way to assess the adherence of model estimates to the data is to use fit quality measures. These adjustment measures are obtained by calculating the difference between the implicit variance-covariance matrix of the estimated model and the variance-covariance matrix (S) of the sample. The smaller the difference between them, the better the theoretical model adapts to the data (Mehmetoglu and Jakobsen, 2016). Therefore, the CB-SEM algorithm seeks to find the set of parameter estimates that minimize the difference between the matrices (Chin, et al., 2010).

The fact that CB-SEM uses omnibus fit measures makes it an appropriate technique for statistically comparing alternative models. These measurements will then determine which of the competing models best matches the data. In addition, with regard to the model put in place, CB-SEM makes it possible to correlate erroneous terms as well as to specify non-recursive structural relationships (Grace, 2006). The above-mentioned features of CB-SEM are the reasons for the growing popularity and application of CB-SEM techniques in social science publications.

Despite the invaluable innovative features of CB-SEM, it often suffers from nonconvergent and inappropriate solutions (Bagozzi and Yi, 1994). Solutions are not converging when a method estimation algorithm is unable to arrive at values that meet the predefined final criteria, while solutions are inappropriate when the values of one or more parameter estimates are not feasible (Anderson and Gerbing, 1988). Nonconvergence can be caused by small sample sizes (Anderson and Gerbing, 1988), complex models (Chin, 2010), too few indicators (Hoyle, 2011), too many indicators (Deng,

et al., 2018), or formative measurement models (Sarstedt, et al., 2019).

The second approach is partial least squares SEM (PLS-SEM). PLS-SEM uses total variance to estimate model parameters (Hair, et al., 2021). The fact that PLS-SEM uses total variance means that indicator measurement error is ignored in the model estimate. However, this is an expected result since SLP-SEM focuses more on optimizing predictions than statistical accuracy of estimates (Vinzi, et al., 2010).

Unlike confirmatory analysis, PLS-SEM is primarily an exploratory technique (Hair, et al., 2012). It should, therefore, be used when the phenomenon in question is relatively new or evolving and the theoretical model or measurements are not well formed. In fact, PLS-SEM should additionally be used instead of CB-SEM when the researcher uses it exploratorily.

Because of its algorithm, PLS-SEM is able to avoid the nonconvergent and inappropriate solutions that often occur in CB-SEM (Sirohi, et al., 1998). Thus, it is suggested to use PLS-SEM when working with small samples with lesser than 250 observations (Reinartz, et al., 2009).

More specifically, a critical difference between CB-SEM and PLS-SEM concerns the way in which both methods conceive the notion of latent variables. CB-SEM considers constructs (i.e., the representation of a concept in a given statistical model) as common factors, which are supposed to explain the association between the corresponding indicators. Moreover, in PLS-SEM, constructions are represented in the form of composites, that is, in the form of weighted sums of indicators. As such, CB-SEM is also called a factor-based method, while PLS-SEM is called a composite-based SEM method.

8 Results and discussion

The assessment of the demand for care involves an estimation of the factors and determinants that explain the evolution of the beneficiaries' behaviors. Normally, the estimate of the demand for care, which reflects the quantity of services provided to clients, will not approximate the cost of care, but only the quantity that can be equalized with the health supply provided by the care units.

As such, we start a priori from several fundamental assumptions, which are as follows:

- H1: Equality between supply and demand in determining the prices of health acts and services. Hypothesis H1 is necessary and sufficient to have overall confidence in the demand-based approach. Normally, the estimation of care costs can only be valid through the analysis of the "supply" dimension; however, hospital units in Morocco as a whole do not have an analytical tracing or management accounting system, which makes the identification of care costs a delicate task. To address this shortcoming, we used the other side of the coin, namely, demand analysis that transcribes user behavior and makes it possible to report on the price actually incurred by customers. To do this, it was theoretically necessary to claim or accept that supply in care units equals demand.
- H2: There are no barriers to entry or exit from care units. The existence of barriers to entering or leaving care units may have a negative influence on the demand for care and consequently on the formation of the real prices borne by the beneficiaries. These barriers can take several forms such as transport costs, out of pocket, etc.
- H3: The care units have no profit objective. We have chosen to work on health-care production services that are of public utility and whose price hardly takes into account profit margins. This assumption makes it possible to reinforce the equality between supply and demand and also between the actual prices and production costs.

In the anchored theory approach, no theoretical assumptions are made. The choice of this conception is likely to facilitate the formation of a clean and innovative theory of the analysis of the demand for care. Thus, we have set up several latent variables that describe unobservable phenomena and that can theoretically be related to the intrinsic factors of customers. The latent variables identified are as follows:

- *Consumption of care*: The consumption variable describes the factors and elements used by hospital units, namely, the type of unit and the nature of the act. We know by theoretical conception that the care unit largely determines the cost related to the

acts performed within it. For example, the intensive care unit is very expensive compared to the cardiac surgery department. The second variable describes the consumption within the unit, namely, the type of pathology treated in favor of the patient.

- *The demand for care:* For us, the factors that determine the demand for care are related to the elements that characterize the patient. Based on the information available from our research unit, clients are reported through gender, age, city of residence, and nature of coverage (debtor). The choice of these intrinsic factors is decided via two approaches: the first is related to the theoretical and empirical reading carried out above and the second is related to the availability of information within the care units. The use of age is important because aging is recognized as a vulnerability factor that can accelerate the demand for care to a certain limit. Gender is also crucial because of the divergence in life expectancies between men and women as well as the difference in the lifestyles of each. The city of residence transcribes a factor describing the cost of transport and the ease or difficulty of accessing care. The use of this variable will validate or invalidate the hypothesis of barriers to entry or exit. A final variable is also to be introduced for its decisive role in the demand for care. We assume by this variable that the existence of a coverage mechanism will increase the demand for care and play in favor of better accessibility.
- *The function of determining prices:* The demand for care and the consumption made by the production units make it possible to determine the formation of the billing system or what we have called the price production function. As such, we considered that demand, consumption, and length of stay make it possible to represent the large part of the hospital's production function.

The overall structure of our model is as follows:

$$\begin{aligned} &\text{Fonction de production (latente)} = \\ &= f(\text{Demande}; \text{Consommation}; \text{Durée du séjour}) \end{aligned}$$

To support the estimate, we compared the results obtained with the invoiced amounts and observed at the supply level. This is similar to a back testing approach.

Table 4 traces the relationships between latent variables and observable variables. The lines in the table describe the assumed causal relationships between the different elements building the anchored model. The coefficients or parameters to be estimated are also named in the table.

The structure of the covariance was estimated on the basis of data from the study hospital and allows to describe, as a first step, the nature of the existing relationships. We note in Table 5 that all relations are positive except for the relationship between the typology of the act and the summation of care in the production units. For other variables, the following hold good:

- Gender positively affects the demand for care. Therefore, the hypothesis that the gender influences this demand above all, in case where this variable is crossed with age.
- Age is also positively correlated with demand, in the sense, the closer individuals get to the degree of aging, the more they will have health problems.
- Similarly, the existence of coverage has a significant positive influence on the demand for care. The same is true for the influence of the hospital units used, which are also highly dependent on the demand for care. This observation affirms that some care units are increasingly requested by beneficiaries.
- Demand and consumption trace a positive dependency pattern with the pricing function. As such, the demand for care expressed by clients and the consumption of care units have a positive influence on the production costs of health services.

It should be noted that we calibrated the dependency structure between the invoiced amounts and the pricing function to a correlation level equal to unity. Thus, we assume that the invoiced amounts are imperatively equal to the production costs.

Analysis of the dependency structure between exogenous variables gives important conclusions. Indeed, the relationship between the demand for care and the consumption made by the units is positive, which implies that any additional demand implies additional activity in the care units and vice versa. In addition, the demand for care and the length of stay are positively dependent on the longevity, reflecting the longevity of the duration of patients in the premises and attesting to a lack of preventive care approaches.

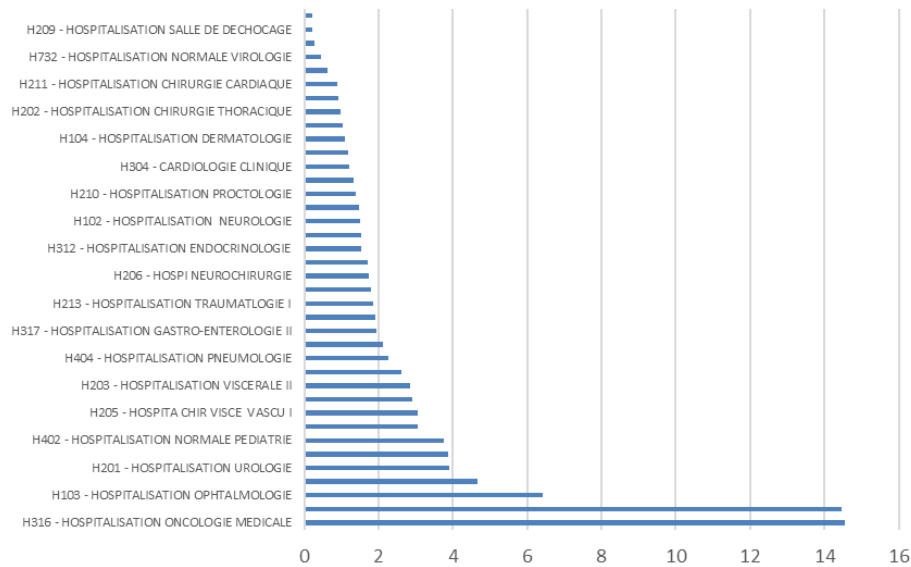


Figure 6. Distribution of acts by pathology as a percentage (% of total acts)
(Source: Author's own research)

Table 4. Presentation of SEM structure
(Source: Author's own research)

Latent variable	Link		Parameter
Fy	<===	Request	beta_dem
Fy	<===	Consumption	beta_cons
Fy	<===	Length of stay	beta_dur
Request	===>	Sex	A1
Request	===>	Age	A2
Request	===>	City1	A3
Request	===>	DEBTOR	A4
consumption	===>	Uh	b1
consumption	===>	Type	b2
Fy	===>	Invoice amount	

Table 6. Presentation of SEM structure
(Source: Author's own research)

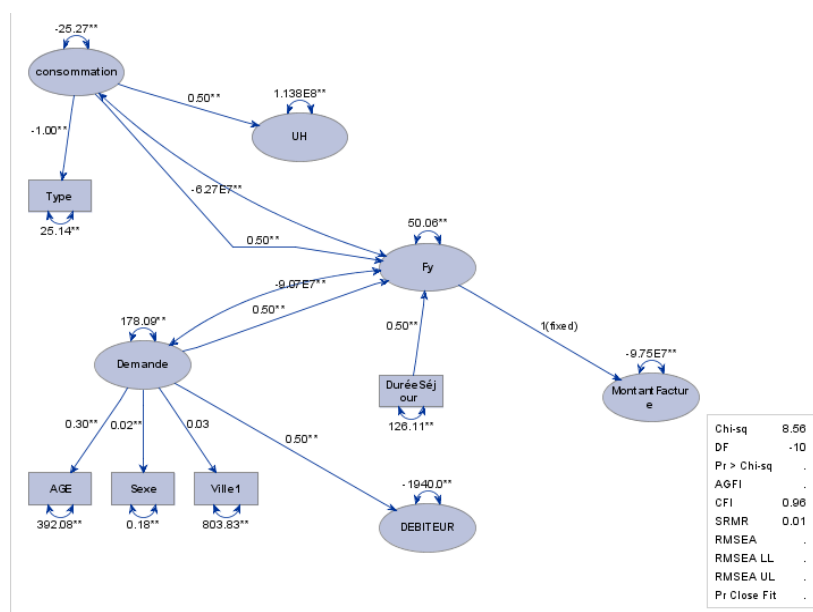
Path			Estimate
Fy	<===	Request	0.50000
Fy	<===	consumption	0.50000
Fy	<===	Length of stay	0.50000
Request	===>	Sex	0.00669
Request	===>	Age	0.69107
Request	===>	City1	0.02500
Request	===>	DEBTOR	0.50000
consumption	===>	Uh	0.50000
consumption	===>	Type	-0.99736
Fy	===>	Invoice amount	1.00000

Table 7. Presentation of SEM structure
(Source: Author's own research)

	Path	Parameter	Estimate	Value of the t-test	Pr > t
Fy	<===	Request	beta_dem	0.50000	-
Fy	<===	consumption	beta_cons	0.50000	-
Fy	<===	Duration Stay	beta_dur	0.50000	-
Request	===>	Sex	A1	0.01894	10.9786
Request	===>	Age	A2	0.29706	10.1371
Request	===>	City	A3	0.03281	1.1142
Request	===>	DEBTOR	A4	0.50000	-
Consumption	===>	UH	b1	0.50000	-
Consumption	===>	Type	b2	-0.99714	-151525
Fy	===>	Amount Invoice		1.00000	-

Table 8. Presentation of SEM structure
(Source: Author's own research)

Variable	Estimate	Standard error	Value of the t-test	Pr > t
Age	392.07850	5.11595	76.6384	<0.0001
City1	803.83147	8.72375	92.1429	<0.0001
Sex	0.18436	0.01172	15.7296	<0.0001
DEBTOR	-1940	0	-	-
Fy	50.05812	0	-	-
Length of stay	126.11341	1.36793	92.1928	<0.0001
Request	178.08767	0.20671	861.5	<0.0001
Consummation	-25.27073	0.0001509	-167412	<0.0001
Type	25.14150	0.0001524	165011	<0.0001
Uh	113834419	0	-	-
Invoice amount	-97497550	0	-	-

Figure 7. Presentation of SEM structure
(Source: Author's own research)

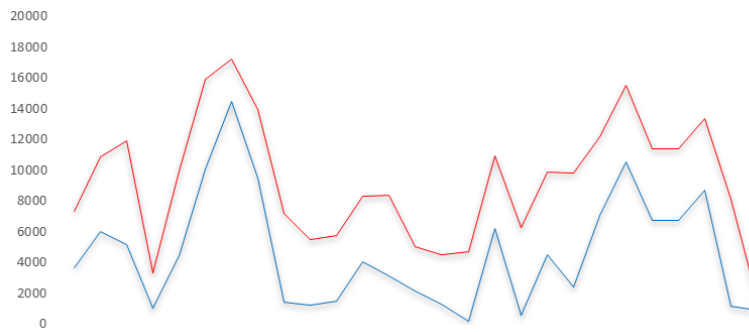


Figure 8. Presentation of SEM structure
(Source: Author's own research)

Relationship estimates were made using the maximum likelihood method. Table 7 represents the results achieved.

The estimated and unrestricted parameters are significant apart from the coefficient describing the place of residence whose critical probability is greater than 5%. For the coefficients whose restrictions are introduced, the coefficients have remained the same, but the second moments describing the dispersion have been estimated in Table 8.

Thus, according to the results of the estimates, the variances of the different coefficients are significant describing that the parameter is stationary and can be used either in prediction exercises or analysis and interpretation.

The network estimated using the maximum likelihood method is shown in Figure 7. The arrows in the network indicate the expected causal relationships between the latent or exogenous variables, and the numbers on these arrows are the coefficients estimated via the maximum likelihood.

Thus, the consumption of care units is positively dependent on the hospitalization units perfectly describing the potential correlation between the nature of the acts and consumption within the services. Consumption is also positively related to the production function of costs, describing the fact that each increase in consumption results in an increase in production costs (coefficient around 0.5).

Demand is described through four behaviors or characteristics of customers whose age and debtors are the most influential. In fact, the age and degree of aging of the population are the two parameters that affect the demand expressed by beneficiaries. The nature of the

debtor is also influential in the sense that the more generous the care regime, the more demand is expressed directly by clients and access to care becomes more automatic. In addition, gender and city of residence certainly have an influence on demand, but their impacts remain marginal compared to other factors.

The length of stay variable was considered exogenous because of its importance in the cost of producing care. Indeed, the more a client stays on the hospital premises either for hospitalization or other operations, the more the health expenditure tends to increase. This reason led us to consider that the variable length of stay is strictly exogenous. The coefficient estimated by the maximum likelihood method is 0.5, expressing a positive effect on the costing function.

In addition, for a calibration of the model results, we equalized the cost function with the invoiced prices to allow an equalization of supply with demand and also to allow a real estimation of costs at the level of care units. This restriction (coefficient equal to 1) makes it possible to have results in terms of costs similar to the amounts already invoiced.

In addition to detecting correlation structures between the determinants of care demand, the model thus designed makes it possible to perfect a model for forecasting care costs using the coefficients estimated in the model. To confirm this result, we conducted back testing to evaluate the predictive capabilities of our model.

The results shown in Figure 8 attest to the predicted convergence of the model, with an acceptable deviation that has already been measured by RMSE (Root Mean Squared Error) in the analysis of inferential outcomes. Thus, this model, beyond its ability to describe

the actual dependence between client demand, consumption, and the production function of care, will also be a relevant tool for approximating projected costs, which can be a conducive approach for budget analysis and also for management control purposes.

9 Conclusion

Throughout this work, we have tried to provide an analysis of the determinants of care demand to be able to capture the factors that can influence the use of health care. The objective of this work is budgetary, in the sense that we try to approximate the costs of producing care without recourse to cost accounting. Admittedly, without management accounting, cost estimation remains a complex or even impossible task. Thus, the innovation of this work is to provide a new way of looking at this cost problem. The supply–demand balance approach to determining an equilibrium price is the one adopted with the aim of arriving at a more economical estimate of production costs.

As such, we have used structural equations that will make it possible to model the components of supply and demand. The hospital's statistics on users and intervention services made it possible to approximate the functions of requests for care and also the function of service provision within the hospital. The predictive nature confirmed the usefulness of this approach, and also, the estimated parameters are in line with theoretical expectations.

The development of such a tool provides hospital management with a new method of approximating the prices of care services, therefore allowing more effective forward budgeting in the medium and long term. However, it should be noted that this approach cannot replace the development of management accounting. Although its predictive character is proven, the switch to cost accounting would be even more necessary for more efficient hospital management.

In an international level, being interested in the question of cost prediction seems to be becoming a subject of crucial importance, especially with the sustained increase in health-care costs and increase in user accessibility. From this perspective, our model is suitable for microeconomic predictions of costs and can be extrapolated macroeconomically to facilitate decision-

making in health policy. International health organizations can offer an advanced form of this system for more optimal predictive management.

10 References

- [1] Abel-Smith, B., 1986. The world economic crisis. Part 1: Repercussions on health. *Health Policy and Planning*, 1(3), pp.202-213. <https://doi.org/10.1093/heapol/1.3.202>.
- [2] Abel-Smith, B., 1992. Health insurance in developing countries: Lessons from experience. *Health Policy and Planning*, 7(3), pp.215-226. <https://doi.org/10.1093/heapol/7.3.215>.
- [3] Akin, J.S., Guilkey, D.K. and Hazel-Denton, E., 1995. Quality of services and demand for health care in Nigeria: A multinomial probit estimation. *Social Science & Medicine*, 40(11), pp.1527-1537. [https://doi.org/10.1016/0277-9536\(94\)00274-w](https://doi.org/10.1016/0277-9536(94)00274-w).
- [4] Anderson, J.C. and Gerbing, D.W., 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 103(3), pp.411-423. <https://doi.org/10.1037/0033-2909.103.3.411>.
- [5] Arrow, K.J., 2014. Arrow (1963): Uncertainty and the welfare economics of medical care notes on contributors. *Moral Hazard in Health Insurance*. <https://doi.org/10.7312/fink16380-007>.
- [6] Bennett, M.K., 1992. M. K. Bennett on population and food supply. *Population and Development Review*, 18(2), pp.341. <https://doi.org/10.2307/1973684>.
- [7] Brunet-Jailly, J., 1991. Health financing in the poor countries: Cost recovery or cost reduction? *World Bank Publications*.
- [8] Cissé, A., 2002. Chapter 16. Senegalese law. *National jurisdiction and international crimes*, pp.437. <https://doi.org/10.3917/puf.delim.2002.01.0437>.
- [9] Deng, L., Yang, M. and Marcoulides, K.M., 2018. Structural equation modeling with many variables: A systematic review of issues and developments. *Frontiers in Psychology*, 9. <https://doi.org/10.3389/fpsyg.2018.00580>.
- [10] Di Matteo, L. and Di Matteo, R., 1998. Evidence on the determinants of Canadian provincial government health expenditures: 1965–1991. *Journal of Health Economics*, 17(2), pp.211-228. [https://doi.org/10.1016/s0167-6296\(97\)00020-9](https://doi.org/10.1016/s0167-6296(97)00020-9).
- [11] Dor, A., Gertler, P. and Van der Gaag, J., 1987. Non-price rationing and the choice of medical care providers in rural Cote d'Ivoire. *Journal of Health Economics*, 6(4), pp.291-304. [https://doi.org/10.1016/0167-6296\(87\)90017-8](https://doi.org/10.1016/0167-6296(87)90017-8).
- [12] Dormont, B., Geoffard, P. and Lamiraud, K., 2009. The influence of supplementary health insurance on switching behaviour: Evidence from Swiss data. *Health Economics*, 18(11), pp.1339-1356. <https://doi.org/10.1002/hec.1441>.

- [13] Gertler, P., Locay, L. and Sanderson, W., 1987. Are user fees regressive? The welfare implications of health care financing proposals in Peru. <https://doi.org/10.3386/w2299>.
- [14] Hanchane S. and Firano Z., 2015. Pertinence et enjeux du RAMED, ONDH, Maroco.
- [15] Harlow, D.G., 2014. Statistical modelling for low cycle fatigue. TMS 2014: 143rd Annual Meeting & Exhibition, pp.639-646. https://doi.org/10.1007/978-3-319-48237-8_77.
- [16] Hitiris, T. and Posnett, J., 1992. The determinants and effects of health expenditure in developed countries. *Journal of Health Economics*, 11(2), pp.173-181. [https://doi.org/10.1016/01676296\(92\)90033-w](https://doi.org/10.1016/01676296(92)90033-w).
- [17] Hoyle, R., 2011. Structural equation modelling for social and personality psychology. <https://doi.org/10.4135/9781446287965>.
- [18] Hsiao, C., 2018. Panel models with interactive effects. *Journal of Econometrics*, 206(2), pp.645-673. <https://doi.org/10.1016/j.jeconom.2018.06.017>
- [19] Jöreskog, K.G., 1969. A general method for analysis of covariance structures with applications: Part I: General methodology*. *ETS Research Bulletin Series*, 1969(1), pp.1-22. <https://doi.org/10.1002/j.2333-8504.1969.tb00585.x>
- [20] Kenkel, D., 1990. Consumer health information and the demand for medical care. *The Review of Economics and Statistics*, 72(4), pp.587. <https://doi.org/10.2307/2109598>
- [21] Macrae, J., Zwi, A. B., and Gilson, L., 1996. A triple burden for health sector reform: 'post'-conflict rehabilitation in Uganda. *Social Science & Medicine*, 42(7), pp.1095-1108. [https://doi.org/10.1016/0277-9536\(95\)00338-x](https://doi.org/10.1016/0277-9536(95)00338-x)
- [22] McPake, B., Ajuong, F., Forsberg, B., Liambillia, W., and Olenja, J., 1993. The Kenyan model of the Bamako initiative: Potential and limitations. *International Journal of Health Planning and Management*, 8(2), pp.123-128. <https://doi.org/10.1002/hpm.4740080205>
- [23] Mehmetoglu, M., Jakobsen, T. G., 2016. Applied statistics using Stata: A guide for the social sciences. WISE.
- [24] Mills, J., Birks, M., 2014. Qualitative methodology: A practical guide. <https://doi.org/10.4135/9781473920163>
- [25] Milne, R., Molana, H., 1991. On the effect of income and relative price on demand for health care: EC evidence. *Applied Economics*, 23(7), pp.1221-1226. <https://doi.org/10.1080/00036849100000160>
- [26] Musgrove, P., 1983. Family health care spending in Latin America. *Journal of Health Economics*, 2(3), pp.245-257. [https://doi.org/10.1016/s0167-6296\(83\)80004-6](https://doi.org/10.1016/s0167-6296(83)80004-6)
- [27] Newhouse, J.P., 1977. Medical-care expenditure: A cross-national survey. *The Journal of Human Resources*, 12(1), pp.115. <https://doi.org/10.2307/145602>
- [28] Parkin, D., McGuire, A., Yule, B., 1987. Aggregate health care expenditures and national income. *Journal of Health Economics*, 6(2), pp.109-127. [https://doi.org/10.1016/01676296\(87\)90002-6](https://doi.org/10.1016/01676296(87)90002-6).
- [29] Peng, L., Meyerhoefer, C. and Zuvekas, S., 2013. The effect of depression on labor market outcomes. <https://doi.org/10.3386/w19451>.
- [30] Reinartz, W.J., Haenlein, M. and Henseler, J., 2009. An empirical comparison of the efficacy of covariance-based and variance-based SEM. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1462666>
- [31] Sarstedt, M. and Cheah, J., 2019. Partial least squares structural equation modelling using SmartPLS: A software review. *Journal of Marketing Analytics*, 7(3), pp.196-202. <https://doi.org/10.1057/s41270-019-00058-3>.
- [32] Sarstedt, M., Ringle, C.M. and Hair, J.F., 2021. Partial least squares structural equation modelling. *Handbook of Market Research*, pp.587-632. <https://doi.org/10.1007/978-3-319-57413-415>.
- [33] Sauerborn, R., Nougara, A. and Latimer, E., 1994. The elasticity of demand for health care in Burkina Faso: Differences across age and income groups. *Health Policy and Planning*, 9(2), pp.185-192. <https://doi.org/10.1093/heapol/9.2.185>.
- [34] Sirohi, N., McLaughlin, E.W. and Wittink, D.R., 1998. A model of consumer perceptions and store loyalty intentions for a supermarket retailer. *Journal of Retailing*, 74(2), pp.223-245. [https://doi.org/10.1016/s00224359\(99\)80094-3](https://doi.org/10.1016/s00224359(99)80094-3).
- [35] Vinzi, V.E., Chin, W.W. and Henseler, J., Wang, H., 2010. Handbook of partial least squares: Concepts, methods and applications. *Springer Science & Business Media*.
- [36] Vissing, Y.M., Akin, J.S., Guilkey, D.K., Griffin, C.C. and Popkin, B.M., 1986. Undefined. *Contemporary Sociology*, 15(3), pp.442. <https://doi.org/10.2307/2070071>.
- [37] Wagstaff, A., 1986. The demand for health. *Journal of Health Economics*, 5(3), pp.195-233. [https://doi.org/10.1016/0167-6296\(86\)90015-9](https://doi.org/10.1016/0167-6296(86)90015-9).
- [38] Wedig, G.J., 1988. Health status and the demand for health. *Journal of Health Economics*, 7(2), pp.151-163. [https://doi.org/10.1016/0167-6296\(88\)90013-6](https://doi.org/10.1016/0167-6296(88)90013-6).
- [39] Welch, J.E., 1970. Pioneering in health education at Amherst college. *School Health Review*, 1(2), pp.9-13. <https://doi.org/10.1080/00366579.1970.1061248>.