Paying the Price: Accounting for Health Status and Expenditures across Country *

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Abstract

In this paper, we quantify the contributions of prices to explain cross-country differences in the health expenditure as a share of GDP and health status. To this end, we extend a general equilibrium framework *à la* Aiyagari (1994) by including health production Grossman (1972). The model relies on two wedges to explain health expenditures as a share of GDP and health status: *(i)* TFP wedge measuring the relative economic development, and *(ii)* health services wedge capturing the inefficiencies on the health service market. We estimate structural parameters as well as the country-specific structural wedges using a method of simulated moments approach on aggregate and micro data from eight countries. We find that dispersion in health prices seems to be the main cause for cross-country differences in health. These price differences come from inefficiencies in the health services sector and have sizable effect on welfare.

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1 Introduction

Large differences in health expenditures are observed across countries. In 2016, the U.S. spent 17.2% of its GDP on health while Germany spent 11.3% and Italy 8.9% (OECD Health Data, 2016). Yet, health expenditures do not appear to be strongly associated with health outcomes despite compelling evidence that health services improve health. For example, Americans have been repeatedly found to be in worse health than Europeans (Banks et al., 2006) and experiment higher incidence rates for various diseases (Solé-Auró et al., 2015). This has lead some to argue that the additional health expenditures is poorly productive and that the health production function is relatively flat (Fuchs, 2004). This paper presents an economic framework that can fit observed patterns in order to understand the role played by prices and quantity differences. The cross-country relationship between health expenditures and health status does identify the marginal productivity of health services given that price and quantity of health services vary across countries.

There is compelling evidence of substantial variation in **prices** for the same services: we refer to these distortions as **health services wedge**. For example, we report in Table 1 variation in costs for various products and services from the International Federation of Health Plans in 2013 (IFHP, 2013). The cost of an angiogram in the U.S. was 3.1 times that in Spain while 4.8 times for Bypass surgery. Similar evidence can be found for physician compensation and administrative costs (Anderson et al., 2003, Cutler and Ly, 2011). Cutler and Ly (2011) argue that much of these differences in costs come from the administrative burden of managing a complex reimbursement system while the relationship between providers and payers (insurers) may lead to important wedges due to asymmetric information. Hence, higher prices have the potential of leading to a higher share of income devoted to health.

The **quantity** of health services may also vary across countries. First, due to higher prices resulting from the health service wedge. Nevertheless, evidence on the price elasticity of health services suggest a relatively inelastic demand curve (Manning et al., 1987). Second, differences in TFP, what we call the **efficiency wedge**[1], may explain differences in quantity of health services. The earlier literature on differences in health expenditures has identified income as a key source of differences. Nevertheless, Gerdtham and Jonsson (2000) conclude that the income elasticity of health expenditures is close to one which

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[1]Chari et al. (2007) use a simple macroeconomic model to show that this *efficiency wedge* can be generated by frictions that cause factor inputs to be used inefficiently. This inefficient factor utilization maps into efficiency wedges and thus a lower TFP.

would suggest, as Newhouse (1992) points out, that income differences cannot explain large variation of the income share of health expenditures. However, Hall and Jones (2007) estimate a life-cycle model which generates much higher income elasticities capable of explaining the rise in health expenditures in the US which suggest that the income elasticity may have been underestimated in previous studies.

As far as we know, there is no general equilibrium model recognizing the endogeneity of health expenditures, health and economic resources that allows to quantify heterogenous wedges (health services or/and efficiency) in explaining price and quantity differences across countries. In a simple illustrative model, we show that the relative impacts of these various wedges depend in part on types of consumers preferences for consumption and health as well the shape of the health production function: the structural parameters of the economy determine the endogenous responses of health services to the efficiency wedges. Hence, if preferences and technologies are rather similar across countries, then what drives cross-country disparity in health would then be the size of the wedges (health services and efficiency). In order to solve this quantitative puzzle, we build on the framework developed by Aiyagari (1994), augmented to incorporate health production following Grossman (1972), to estimate structural parameters and the two wedges (the health services and efficiency wedges) using a Method of Simulated Moments (MSM) approach exploiting variation across country in economic resources, health expenditures and health outcomes.[2] This method allows us to identify both the size of the wedges and the elasticities of the aggregates to these wedges.[3] Our estimation is performed on 8 countries (the US, Sweden, Denmark, the Netherlands, Germany, France, Italy, and Spain). An advantage of our structural approach is to provide estimates of the elasticities of different aggregates to health service and efficiency wedges in both partial and general equilibrium: this allows us to estimate the magnitude of the feedback effect of all market adjustments.

Many others factor can explain cross country differences in health and health expenditures. First, the health insurance system can transfer some health services from the richest to the poorest, thus improving aggregate health status. We thus introduce in our estimation the observed heterogeneity across country of co-insurance rate. Second, while

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[2]A joint theory of health and economic resources must also be able to explain the fact that the distribution of health within country is very different, in particular across groups with different economic resources (see e.g. Avendano et al. (2009) and Smith (1999) for empirical evidences). Hence, beyond the aggregate economic indicators, our estimation also take as targeted moments the health gradient in each countries.

[3]Our approach is in the spirit of Chari et al. (2007)'s work. They estimate the standard RBC model in order to measure the contributions of various wedges (efficiency, labor, investment) on the variations across time of macroeconomic aggregates. This method is also used by Ohanian et al. (2008) to explain the cross-country differences in long-term changes in hours worked.

higher expenditures may lead to better health, the causality may also run in the opposite direction. The rapid growth of obesity in the U.S. relative to other countries may also explain part of the differences in health expenditures across countries (Thorpe et al., 2004, 2007). According to Cutler et al. (2003), part of the differences in obesity between the U.S. and Europe could originate from differences in food production technology and regulation which lead to higher relative price of less healthy food choices. We also take into account these heterogeneous risky behaviors. Third, we also introduce heterogeneity across country coming from labor market incomes. It is well known that US earning risks is larger in European labor markets. If we show that a large earning risk may evict health expenditure because agents need to insure themselves against consumption fluctuations (using precautionary savings), the effect at the aggregate level is ambiguous because capital accumulation increases output and thus average earnings, which affects the demand for health services and the health expenditures as a share of GDP. Hence, in order to purge our estimate of the health service and efficiency wedges from these observed cross country differences, our estimation takes these other sources of heterogeneity into account.

We find that the US are characterized by the highest health service wedge, while its efficiency wedge is one of the lowest, ie. the highest price of health services and a high TFP. Our estimation shows that The US prices of health services are approximatively two times larger than the average price in European countries. This measure is in accordance with evidences on drug prices, physician fees, diagnostic tests or hospital costs by day (see Tables 1, 2 and 3), showing that the US prices are between 1.3 and 8 times lager than in the European countries.[4] In addition, using counterfactuals, we find that in all countries inefficiencies on the health market dominate the efficiency wedge in explaining cross-country differences in health expenditure and health. Therefore, dispersion in health prices seems to be the main cause for cross-country differences in health expenditure as a share in GDP and percentage of population in good health. The welfare costs of this health service wedge is large for the US: while the health sector accounts for only 14% of GDP in the US, the welfare costs of the largest health service wedge (the highest price of health service for the US) is only twice lower than the welfare gains induced by the low efficiency wedge (the large TFP for the US). This underlines the strong distortions induced by inefficiencies on the US health market.

The paper is structured as follows. In section 2, we present a simple illustrative model to explain differences in health expenditures and health across countries. In section 3, we expose the general equilibrium model that will be used to fit the data. In section 4, we

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[4]Remark than the US prices are lower than those in the European countries for the generic drugs (see Table 2).

present the data and estimation method we use and report estimates of the model and its predictive performance. In section 5, counterfactual simulations allows us to decompose the cross-country differences in health indicators between the size of the wedges and the elasticities of aggregate to these wedges. We then explore welfare issues (Section 6). Finally, section 7 concludes.

2   Illustrative Model

In this section, we demonstrate that differences in the price of health services are necessary for a explanation of international stylized facts. First, because we observe that $p_{US} > p_g$ for $g \neq US$, where p_g is the price of health services relative to other goods in country g, suggesting that the inefficiencies are larger in US supply of health services. Second, because this health service wedge impacts the value (in consumption goods units) of the health expenditures directly through a price effect and indirectly through a demand effect. Indeed, agents choose m, the quantity of health services, to maximize expected utility, given an income y which decreases with efficiency wedge. This results in a demand function for medical services $m_g = \mathcal{M}(y_g, p_g)$ in country g with $\mathcal{M}'_y > 0$ and $\mathcal{M}'_p < 0$. We observe p_g, y_g and the health status $\pi(m_g)$, which is increasing in m. Differences in y are unlikely to explain the pattern of health status ($\pi(m_{US}) < \pi(m_g)$ for $g \neq US$) because income is higher in the US and the income elasticity is positive. Thus, we have to consider price differences. However, the extent of price differences will likely create a demand response which will lower demand for health services (m). Hence, for given *efficiency wedges*, theory needs these *health service wedge*, ie. price differences on the health market services, as well as restrictions on the demand for health services to yield both higher share of health expenditure in GDP ($s_g = \frac{p_g m_g}{y_g} < s_{US}$ for $g \neq US$) but lower fraction of population in good health ($\pi(m)$).

2.1   A Stylized Model

From the supply side, we focus on the inefficiency induced by the information gaps between providers and payers of health services, as well as the administrative costs induced by the size of the sector. These frictions induce a inefficient allocation of input specific to each country, generated by what we call the *health service wedge* which leads to country-specific price differences. Given these frictions, we then build the demand side using a two-period model of the demand for health services and investigate equilibrium properties

and restrictions on fundamentals allowing to match the share of the health expenditures in the total income and health levels across countries.

2.1.1 The Supply of Health Services: the health services wedge

We focus on two key differences across countries which may explain differences in prices as suggested by Cutler and Ly (2011).[5] First, we introduce informational frictions in the health service sector: the quality of services offered by all providers are not perfectly observed by the payers (the insurance system). We assume that the quality can take two values $q \in \{0, 1\}$. The organization cost allowing to provide $q = 1$ is $p_r > 0$. The payers can detect providers' shirking behavior with probability $\zeta \in [0; 1]$. Hence, the optimal contract for the payer is a price p_p for the quality of the service such that $p_p = \frac{p_r}{\zeta}$, which ensures that $q = 1$ at the equilibrium.[6,7] The production function of the provider is thus $m = zq(p_p)b$ where m denotes the quantity of health services supplied to the household, b is the quantity of services used by the providers, and z is the total factor productivity of the health sector. Using the equilibrium price contract implying $q(p_p) = 1$, we get $m = zq(p_p)b = zb$. Second, we allow for administrative cost in the health system. For simplicity, we assume that administrative costs are sunk costs and proportional to the size of the production sector (ιm). Health expenditures in units of consumption goods are pm, given that p is the relative price of health care services. These expenditures are also the resources for the health sector. The profit of the health sector is $\Pi_h = pm - C(m)$ with the cost function $C(m) = \left(\frac{p_p}{z} + \iota\right)m$.

Property 1. *The price gap of health services increases with informational frictions between providers and payers, as well as with the administrative costs.*

Proof. The zero profit condition leads to equilibrium prices as function of two parameters, informational friction ζ and administrative cost ι: $p = \frac{1}{z}\frac{p_r}{\zeta} + \iota \equiv \mathcal{P}(\zeta, \iota)$ with $\mathcal{P}'_\zeta(\zeta, \iota) > 0$

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[5]We use a highly stylized model in order to present the main arguments explaining why the price of health services is not a competitive price. For more detailed discussions on this point, see the surveys of Newhouse (1996), Dranove and Satterthwaite (2000) and Gaynor and Vogt (2000), or Gaynor and Town (2012).

[6]As usual in the contract theory, this equilibrium price p_p is deduced from the equalization of the value of the honest provider (here $p_p - p_r$ with $q = 1$) and the ones of the shirking provider (here $(1-\zeta)p_p + \zeta \times 0$ with $q = 0$).

[7]Another way to generate a gap between the effective price and the reservation price p_r (the production cost), is to introduce a bargaining between the payer and the provider. The Nash product is then given by $(p_p - p_r)^\zeta (\mathcal{R} - p_p)^{1-\zeta}$ where $\mathcal{R}$ is the marginal revenues of the payer. In this case, the equilibrium price is $\zeta \mathcal{R} + (1 - \zeta)p_r = p_p$. The larger the provider's bargaining power (ζ), the higher the price. See Gowrisankaran et al. (2015) or Ho and Lee (2017) for a detailed discussion on the bargaining between providers and payers, in a general framework where insurers bargain also with the consumers.

and $\mathcal{P}'_\iota(\zeta, \iota) > 0$. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ $\square$

Property 1 shows that the gap between US price p_{US} and the European p_E increases from $\zeta \approx 0$ (the extreme case with infinite informational fictions) to $\zeta \approx 1$: the larger the providers' informational rent, the higher the price in countries with informational frictions: the health wedge increases with frictions.[8,9] Moreover, when administrative cost increases, the price of the health services rise. This can be the case when the number of operators/intermediaries is uselessly large in the market, perhaps due to the administrative burden of handling the insurance reimbursement process. Frictions on the supply side of health services generate the health services wedge, implying a price differential.

2.1.2 Equilibrium: the impact of health and efficiency wedges on the Demand for Health Services

The household's behavior is summarized by a intertemporal choice of consumption (two-periods model with financial constraint), where the uncertainty come from both the income level[10] and the health status in the second period of life:

$$\mathcal{U} = \max_{m, a \geq 0} \{u(c) + \beta \mathbb{E}[u(d) + \pi(m)\phi]\}$$

$$\text{s.c.} \quad \begin{cases} c &= (1 - \tau)y + \mathcal{F} - a - \mu pm \\ d &= (1 + r)a + \widetilde{y} \end{cases}$$

where c and d are consumptions of the first and second period, μ is the co-insurance rate, r the interest rate, τ is the tax used to fund the health insurance system and $\pi(m)$ (with $\pi' > 0$ and $\pi'' < 0$) is the probability of being in good health, ϕ the utility benefit of good health is ϕ and $\mathcal{F}$ the dividend from the health sector.[11,12]

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[8]We interpret these informational frictions as the physicians' effort at work that is not perfectly observed by the hospital manager. Then, the larger the physicians' informational rent, the higher the price. This can be consistent with the findings of Cutler and Ly (2011) underlining that specialist U.S. physicians earn 5.8 times what the average worker does, compared to the non-U.S. average of 4.3 times.

[9]In the case where the markup price is determined by a bargaining between payers and providers, two cases can arise: the US system where the provider's bargaining power is large in a decentralized market, and the European case where, in all countries, a public system reduces the provider's bargaining power, by setting the price at its lowest level.

[10]The second-period income is drawn in the lotteries s.t. $\widetilde{y} \in \{0, \frac{y}{1-\varpi}\}$ with probabilities $(\varpi; 1 - \varpi)$, implying $\mathbb{E}[\widetilde{y}] = y$ and $\sigma_{\widetilde{y}}^2 = 2(\varpi y)^2$.

[11]Using the endowment y, each household produces input b used in the health sector. The production cost of b is given by $\mathcal{C}(b) = \frac{\varphi}{\vartheta}b^\vartheta$, with $\vartheta > 1$. This input is sold to the health sector at price p_p. The net cost from this activity is $\mathcal{F} = \max_b \{p_p b - \mathcal{C}(b)\}$. Hence, we have $\mathcal{F} = \frac{\vartheta - 1}{\vartheta}pm$ at the equilibrium.

[12]The FOC of the program are provided in Appendix B.

At the equilibrium, the budgetary constraint of the health insurance system $\tau y = (1 - \mu)pm$, the decision rules $m = \mathcal{M}(p, y, a)$ and $a = \mathcal{A}(p, m, y, \sigma_{\widetilde{y}})$ give the properties of the shares of health expenditure $s = \frac{pm}{y}$.

Property 2. *If $|\pi'' \frac{m}{\pi'}| > 1$, then, when $a > 0$, $\frac{\partial s}{\partial p} > 0$ and $\frac{\partial s}{\partial y} > 0$. Moreover, we always have $\frac{\partial s}{\partial \sigma_{\widetilde{y}}} < 0$.*

Proof. See Appendix B. □

Property 2 implies that the model can predict that s increases when efficiency wedge declines (y increases) or when health service wedge rises (p increases). The low efficiency wedge in the US ($y_{US} > y_E$) or/and large health services wedge ($p_{US} > p_E$) can explain $s_{US} > s_E$. But the model assumptions impose that $\pi' > 0$, with $\frac{\partial m}{\partial y} > 0$ and $\frac{\partial m}{\partial p} < 0$, underlining that the price of health services and the agent income have opposite impacts on the fraction of the population in good health. We deduce that the relative importance of these wedges can be identified through their impact on the health expenditures as a share of GDP (s) and on the fraction of the population in good health ($\pi(m)$): this is *a priori* indeterminate, even in this stylized model.[13]

Notice that s decreases with income risk. Hence, the impact of higher income ($y_{US} > y_E$ implies $s_{US} > s_E$) can also be compensated by higher income risk, as in the US economy, ($\sigma_{\widetilde{y},US}^2 > \sigma_{\widetilde{y},E}^2$ implies $s_{US} < s_E$). Nevertheless, if the efficiency in the health production function of a marginal unit of health expenditures is sufficiently high ($|\pi'' \frac{m}{\pi'}| > 1$), then Property 2 shows that high price (large health services wedge) can help match $s_{US} > s_E$. Indeed, the forces that drive the health expenditures as a share of GDP to be higher in the US than in Europe (a high average income, and high prices) must simply dominate the need for insurance coming from the precautionary saving motive, acting in opposite direction.[14] Given that Property 2 yields increasing demand for health services as income expands, a corollary is that rising income inequality inside a country (say a mean-preserving spread) will lead to rising health inequalities.

This equilibrium analysis without aggregate macro effects shows that more savings can lead to less health expenditures at the individual level. Nevertheless, we need to look at general equilibrium effects because this additional saving leads to more capital, and thus, more aggregate production, leading to higher incomes. This feedback effect of the general equilibrium framework can then reinforce the demand for health. The crowding

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[13]The estimation of the model will remove this indeterminacy.

[14]Earning risk leads to a positive precautionary saving: savings ($a > 0$) then crowds out health expenditures.

out effect, driven by the precautionary saving, can be compensated by an income effect driven by a more capital-intensive economy. The general equilibrium analysis can also highlight feedback effects from tax endogenous changes.

3 General Equilibrium Model

3.1 Households

Agents are heterogeneous with respect to their productivity level e, health status h and asset holding a. The productivity levels e are determined by an exogenous stochastic process. In contrast, health status and asset are endogenous outcomes of the model.

Preferences. Households value both their consumption and their health status. Households' preferences can be described by the following standard expected discounted utility

$$\sum_{t=0}^{\infty} \beta^t \sum_{e'} \sum_{h'} p(e'|e)p(h'|h,m)u(c,h) \tag{1}$$

where $0 < \beta < 1$ is the time discount factor, $c \geq 0$ is consumption and h current health status. Next period's variables are denoted with a prime. As in DeNardi et al. (2010), health can be either good ($h = 1$) or bad ($h = 0$). The object $p(h'|h,m)$ denotes the probability of being in health status h' next period, given the current health status h and health services m. This transition is determined by a health production function that depends on health services m. The exogenous transition probability from the current productivity level e to next period's level e' is denoted $p(e'|e)$. In contrast, $p(h'|h,m)$ is endogenous in the model. We assume that the instantaneous utility is additive in consumption c and health h:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + \phi h. \tag{2}$$

with $\phi > 0$ the utility benefit of good health. Hence, the rate at which the marginal value of health increases with income depends on how fast the marginal utility of consumption is declining.

Health Production. Each agent can spend his resources on consumption c and health services m. Health services m improve the probability of being in good health next period.

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In addition, we assume that the function that maps health services in health status is

$$p(h' = 1|h, m) = 1 - \exp(-(\alpha_0 m + \alpha_{1h} + \eta r_b)) \tag{3}$$

with $\alpha_0 > 0$, $\alpha_{1h} > 0$. With $\alpha_{11} > \alpha_{10}$, the probability to be in good health next period is higher for agents who are currently in good health. We assume that the individual probability to be in good heath depends on the country specific baseline health, denoted r_b for "risky behaviors", for example obesity or other environmental factors that may affect the transition rates.

Resource Constraint. Labor income is affected by an idiosyncratic stochastic process e that determines the value of efficient labor. e is the sum of an AR(1) permanent shock with parameters (ρ_e, σ_e) and a transitory shock with standard deviation σ_v. Market incompleteness prevents agents from insuring against the idiosyncratic risk. In addition to labor income, agents collect capital income from asset holding a, with risk-free return r rate. Next period's asset a' is then

$$a' = a(1 + r) + we(1 - \tau) - c - \mu p m \tag{4}$$

Income is spent on labor income taxes (with flat-tax rate τ), consumption c and health services m. The variable p refers to the relative price of health services with respect to consumption good. μ refers to the co-insurance rate. This captures the fraction of out-of-pocket expenditures in total health expenditures. In addition, assets have to satisfy a borrowing constraint

$$a \geq 0. \tag{5}$$

Endogenous Demand for Health Services and Savings. As far as each agent is concerned, the state variables are the realizations of the household-specific shock, e, the stock of wealth, a, and health status h. The dynamic program solved by an individual whose state is (a, h, e) is

$$V(a, h, e) = \max_{m,c} \left\{ \frac{c^{1-\sigma}}{1 - \sigma} + \phi h + \beta \sum_{e'} \sum_{h'} p(e'|e) p(h'|h, m) V(a', h', e') \right\} \tag{6}$$

subject to equations (4) and (5). V denotes the individual's value function. The solution that solve this problem is a set of decision rules that map the individual state into choices for consumption and health services. We denote these rules by $\{c(a, h, e), m(a, h, e)\}$.

3.2 Good-Producing Firm

Production Y is characterized by constant returns to scale using aggregate capital K and labor N as inputs:[15]

$$Y = AK^{\alpha}N^{1-\alpha} \tag{7}$$

A captures technological factor productivity and $0 < \alpha < 1$ the capital share in GDP. The representative firm operates under perfect competition such that profit maximization leads to

$$r = \alpha A \left(\frac{N}{K}\right)^{1-\alpha} - \delta_k \tag{8}$$

$$w = (1-\alpha) A \left(\frac{K}{N}\right)^{\alpha} \tag{9}$$

with w the wage rate, and δ_k capital annual depreciation rate.[16]

3.3 Health Insurance System

The government provides health insurance. Health insurance reimburses medical expenditures using proportional taxes on labor income:

$$\tau w N = (1-\mu)p \sum_e \sum_h \sum_a m(a,h,e)\lambda(a,h,e) \tag{10}$$

where $\lambda(a,h,e)$ is the stationary distribution of individuals across individual states (a,h,e). Given the co-insurance rate μ, the tax rate τ must finance expenditures. Equation (9) leads to $wN = (1-\alpha)Y$: the tax rate is proportional to the GDP share of health expenditures.

The supply of health services is the same as in section 2.1. Hence, households transform a part of their consumption goods in inputs supplied to the health sector.[17] This sector

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[15]Aggregate employment is exogenous and result from the Markovian representation of the AR(1) process on productivity e.

[16]In the model, household's utility is not a function of leisure. As a result, employment level is independent of factor prices w and r, distribution of health and asset and the aggregate capital stock. Aggregate employment can be directly computed from the Markov process governing the evolution of labor productivity e.

[17]In Equation (4), the dividends from the health service sector do not appear (see footnote 10 in section 2.1). Indeed, without any information on the costs supported by the household for providing input to the health service sector, we assume that the households do not perceived dividends from this sector. This is possible when $\vartheta \to 1$ for the estimation procedure of the model.

does not generate profit. The price of health services depends on physicians' informational rent, given the administrative costs.

3.4 Definition of Equilibrium

A steady-state equilibrium for this economy is a household value function, $V(a, h, e)$; a household policy, $\{c(a, h, e), m(a, h, e)\}$; a health insurance system, τ; a stationary probability measure of households, λ; factor prices, (r, w); and macroeconomic aggregates, K, N, such that the following conditions hold:

(a.) Factor inputs, tax revenues, and transfers are obtained aggregating over households:

$$K = \sum_e \sum_h \sum_a a\lambda(a, h, e), \quad N = \sum_j e_j N_j$$

(b). Given K and N, factor prices r and w are factor marginal productivities (Equations (8) and (9)).

(c.) Given r, w, τ, the household policy solves the households' decision problem described in (6).

(d.) Tax rate τ adjusts such that health insurance budget constraint (10) is satisfied.

(e.) The goods market clears : $Y = \sum_e \sum_h \sum_a c(a, h, e) + pm(a, h, e)\lambda(a, h, e) + \delta_k K$.

(f.) The measure of households $\lambda(a, h, e)$ is stationary.

This equilibrium depends on both health services and efficiency wedges (A, p). The numerical method used to solve it are described in the appendix C.

4 Data and Estimation

We estimate the model on eight countries: the US, Sweden, Denmark, the Netherlands, Germany, France, Italy, and Spain. We chose these countries because both OECD data and comparable longitudinal micro data was sufficiently available to estimate structural parameters. There is considerable heterogeneity in both outcomes and institutions across these countries. We will assume that the preferences and the health production function parameters are the same across countries. Hence, we estimate simultaneously all countries.

We use a two-step strategy to estimate/calibrate parameters of the model for $g = 1, ..., G$ countries. Firstly, we describe how the auxiliary parameters are set using external information (Micro and Macro datasets). In a second step, we use a method of simulated moments approach to estimate remaining parameters.

4.1 Auxiliary Parameters

We use different sources of data to obtain auxiliary parameters.[18]

Income Risk. Estimating income processes requires panel data. For the United States, we use eight years of the Panel Study of Income Dynamics (PSID) data (1990 to 1997). Data after 1997 is collected every two years, complicating the estimation of the income process. For European countries, we use eight years of the European Community Household Panel (ECHP) from 1994 to 2001. We first net out the effect of age from income by regressing an household's total net income on a flexible age polynomial and obtain residuals. We use after-tax household income as it allows for differences across countries in social programs that may mitigate income risk. For the error component, we assume the following process

$$\eta_t = e_t + u_t \quad \text{with} \quad e_t = \rho_e e_{t-1} + \nu_t$$

where ν_t is the innovation to the persistent component, distributed $N(0, \sigma_e^2)$, whereas the transitory component u_t is distributed $N(0, \sigma_u^2)$. Table 4 shows the estimates of the income process. Overall, the variances of the transitory components are similar. The estimates of the stationary variance of the permanent component are larger in the US than in European countries. We find considerable persistence in income, with autocorrelation coefficients ranging from 0.9697 (the Netherland) to 0.9798 (Spain). The main source of the difference in income risk is the scale of the innovation to permanent income in the U.S. The variance of the permanent shock is twice as large in the U.S. compared to Europe.

Risky Health Behaviors. To calibrate the variable $r_{b,g}$ for the selected countries g, we use the Study of Health, Ageing and Retirement in Europe (SHARE) and the Health and Retirement Study (HRS) for the US for the year 2004. We use an indicator of obesity for a body mass index larger than 30 and compute the average obesity rate of those between the ages of 50 and 75. Obesity is a good summary measure of past physical activity as well as eating habits. It is unlikely to be the result of past health services or depend on

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[18]Details on data sources to construct variables can be found in Appendix A.

parameters of the health insurance system. Body mass peaks around those ages which justifies looking at this age range as a summary measure. In Figure 1, we can observe that Americans have the largest share of the population which are obese: more than 30% of this population has a BMI over 30, followed of Spain, with 25%, while other European countries tend to have less than 20% of their population with a BMI over 30.

Co-insurance Rates. We use aggregate data from OECD Health Data to compute the co-insurance rate μ across countries for 2005. We define the co-insurance rate as private out-of-pocket household expenses as percentage of health expenditures. This data is not available for Italy. We use the World Bank data for this country with a similar definition. Figure 2 shows the differences across countries. Spain and Italy have large share of out-of pockets over total health expenditures, while France and the Netherlands have the smallest shares. The US ranks in the middle.

Other Parameters. We use Penn World Table (Feenstra et al. (2015)) in order to calibrate the country-specific shares of capital (α) and the depreciation rates (δ_k). The values reported in Table 5 give the estimates for the period 1990-2005. The share of capital in production (α) is between 0.3399 (Deutschland) to 0.4379 (Italy), the value for the US being 0.3553. In the case of the depreciation rate (δ_k), the estimates range between 0.0346 (France) to 0.0483 (Sweden), with a value of 0.0401 for the US.

4.2 Method of Simulated Moments

We have three groups of structural parameters to estimate. The vector of preference parameters is given by $\{\beta, \sigma, \phi\}$. Preference parameters are identical across countries. The second group consist of parameters of the health production function $\{\alpha_0, \alpha_1, \psi, \eta\}$, also constant across countries. Finally, we have two country specific parameters, $\{A_g, p_g\}$, capturing *efficiency wedges*, measured by TFP gaps in producing goods (A_g) and *health services wedges*, measured by price gaps of health services (p_g). These wedges are estimated by taking the US as the reference country: we thus normalize $A_{US} = 1$ and $p_{US} = 1$. Hence, the estimation provide measures of the wedges across economies. Notice that only cross-country differences can be identified using our data. The structural parameter vector to estimate is given by

$$\Theta = \{\beta, \sigma, \phi, \alpha_0, \alpha_1, \psi, \eta, \{A_g\}_{g \neq US}, \{p_g\}_{g \neq US}\}$$

The structural estimation of the model allows to quantify the mechanisms of propagation of the revealed country-specific wedges (health services and efficiency).

Denote the set of country specific auxiliary parameter χ_g and $\chi = \{\chi_1, ..., \chi_G\}$. For each country, consider a set of M_g moments (or targets) denoted

$$m_g(\Theta, \chi_g) = \left\{ m_{g,1}(\Theta, \chi_g), ..., m_{g,M_g}(\Theta, \chi_g) \right\}. \tag{11}$$

The moment vector over all countries is given by

$$m(\Theta, \chi) = \{ m_g(\Theta, \chi_g), ..., m_G(\Theta, \chi_G) \}'. \tag{12}$$

The total number of moments is $M = \sum_g M_g$. Given Θ and χ, we can simulate these moments from the model using S draws for income and health. Denote the simulated moment vector, $\tilde{m}_S(\Theta, \chi)$.

We combine a set of aggregate moments and moments derived from micro data. We convert all monetary amounts to US dollars PPP adjusted. In order to partially pin down risk aversion, we use the ratio of capital to GDP, K/Y from Penn World Table (Feenstra et al. (2015)) over the years 1990 to 2005. We also use GDP per capita relative to US, $\tilde{Y}_g = Y_g/Y_{US}$ to identify efficiency wedges (TFP differences). A third set of moments involves the share of health expenditures as a fraction of GDP, $s = \frac{pm}{Y}$. We use information from the OECD Health data from 2003-2007.[19] The sample for the estimation of s is shorter than the one used to measure K/Y and Y_g/Y_{US}. Beyond the constraint on data availability, the non-stationarity of s leads us to favor a measure that account for the current situation in each country, whereas a more longer sample for K/Y and Y_g/Y_{US} allows us to smooth the cyclical components of these stationary statistics.

Moments involving micro data help estimate the health production function. We use SHARE and HRS data for 2004 and 2006 to estimate health state transitions. We also use those data to estimate the gradient of health status by levels of wealth (capital). This further strengthens the identification of the health production function. Health transition probabilities depend only on wealth trough the choice of medical consumption. Hence, the variation in observed health status by wealth level helps identify the productivity of medical consumption, α_0. We use self-reported health which is asked in both surveys. Of course, one could be interested in considering multiple dimensions of health but the computational burden of doing this prohibits this possibility. Self-reported health is reliable

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[19]The OECD health data does not include data for Italy. We use the corresponding value from the IMF.

overall health measure predictive of mortality and use of physician services (Miilunpalo et al., 1997). Respondents are asked to rate their health from poor to excellent using 5 levels. We convert this measure to a binary indicator where 1 denotes very good or excellent health and zero other cases. It is well-known that self-reported health varies across countries in part due to differences in reporting scales (Jurges, 2007, Kapteyn et al., 2007). We correct for reporting scales by following the strategy proposed by Jurges (2007).

We estimate a logit model relating self-reported health to more objective measures of health and country fixed effects. The country fixed effects reflect different reporting styles. The average predicted probabilities of being in good health is given by $\tilde{p}(X_g, g)$ where argument g denotes that the fixed effect of country g is used in predicting good health in that country and X_g denote a set of objective health conditions. In order to correct for reporting styles, we set the fixed effect to a base country, say 1, which is Germany in our analysis, and use $\tilde{p}(X_g, 1)$. We can do something similar for transition rates. Denote by $\tilde{p}_{jk}(X_g, g)$ the joint probability of being in state j at time t and k at time $t+1$. We can predict those probabilities using a logit where the dependent variable equals one when states j and k are observed over the two waves and use both set of observed health conditions at t and $t+1$. Using Bayes rule, the transition rate can be computed as $\tilde{p}_{k|j}(X_g, g) = \frac{\tilde{p}_{jk}(X_g,g)}{\tilde{p}(X_g,g)}$. Hence, the corrected transition rate is given by $\tilde{p}_{k|j}(X_g, 1)$. Since transition probabilities sum to one conditional on state j, we use $\tilde{p}_{1|0}(X_g, 1)$ and $\tilde{p}_{1|1}(X_g, 1)$ as moments.[20]

To compute the health gradient, we first create bins based on the distribution of net wealth in 2005 PPP adjusted US dollars. We use the bins $[0-100k, 100k-250k, 250k-450k, 450k+]$. We compute the average adjusted predicted probability of being in good health within each bin, $\tilde{p}_{q,g}(X_g, 1)$ for $q = 1, 2, 3, 4$. We use as moments the relative probability using the first bin as a base: $\overline{p}_{q,g}(X_g, 1) = \tilde{p}_{q,g}(X_g, 1)/\tilde{p}_{1,g}(X_g, 1)$ for $q = 2, 3, 4$.

The vector of moments for each country is given by

$$m_g = \left\{ K_g/Y_g, \tilde{Y}_g, s_g, \tilde{p}_{1|0}(X_g, 1), \tilde{p}_{1|1}(X_g, 1), \overline{p}_2(X_g, 1), \overline{p}_3(X_g, 1), \overline{p}_4(X_g, 1) \right\} \tag{13}$$

where $\tilde{Y}_g$ is not included for the U.S.

We report in Figure 3 the computed moments from the data. In terms of capital-output ratio, Italy, Spain and the US have the highest capital to GDP ratio while Sweden has the lowest.[21] GDP per capita is in general 40 to 20% lower in European countries relative to

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[20]Given that surveys measure health every two years, we recompute annual transition rates, solving $\tilde{\Pi}_2 = \tilde{\Pi}_1^2$ for $\tilde{\Pi}_1$ where Π_q is the markov transition matrix for q year transitions.

[21]Overall, the shares of housing capital are larger in European countries than in the US (more than

the U.S. The U.S. spends 14% of GDP on health while only three countries rise above 10% in Europe (France, the Netherlands and Germany). In terms of transition rates into good health, the U.S. ranks 6 out of 8 countries for transition rates conditional on being healthy and third for transition rates from bad health to good health. Finally, the health gradient by wealth level is much steeper in the U.S. than in any European country. For example, those in the highest wealth level (more than 450,000$ US PPP) had a probability of being in good health 34% higher than those in the lowest wealth group (less than 100,000$ US PPP). Denote by $m_D(\Theta_0, \chi_0)$ the vector of moments computed from the data, where Θ_0 and χ_0 are the true values of the structural and auxiliary parameters.

The difference between simulated moments and moments from the data is given by $\tilde{g}_S(\Theta, \chi) = [\tilde{m}_S(\Theta, \chi) - m_D(\Theta_0, \chi_0)]$. The MSM estimator $\hat{\Theta}$ is the solution to the minimization problem

$$\min_{\Theta} \tilde{g}_S(\Theta, \chi)' W_N \tilde{g}_S(\Theta, \chi) \tag{14}$$

where W_N is a positive definite weighting matrix which depends on the data. We choose a diagonal matrix with elements equal to the inverse of the variance of each moment as a weighting matrix. For moments involving microdata, we use the bootstrap to find the variance while we use the time-series variation to compute the variance for aggregate moments.

Because the function is not a smooth function of the parameters we follow the method proposed by Chernozhukov and Hong (2003). Instead of minimizing directly the objective function, we construct a Monte Carlo Markov Chain which converges to a stationary process with a distribution whose mode is equivalent to the MSM estimator.[22]

4.3 Estimation Results

4.3.1 Structural Parameters

Estimation results are reported in Tables 6 and 7. There are parameters common to all countries $\{\sigma, \beta, \phi, \psi, \delta_{h1}, \delta_{h2}, \eta\}$ that summarize the preferences and health technology (Table 6). The other set of parameters such as price and TFP gaps are country specific (Table 7).

45% in European countries vs. 39% in the US). These shares of housing capital are especially high in Italy and Spain (48% and 46.5% respectively). See Kamps (2006) and Backus et al. (2008) for more details on this decomposition of capital.

[22]See Appendix D for more details.

The coefficient of relative risk aversion, σ, is estimated at 3.158 which is within the range of estimates found in the literature for precautionary saving models. The discount factor β is estimated to be 0.832 which implies an annual discount rate of 20.2%.[23] This level of impatience is large compared to existing estimates. Such a high discount rate is needed in order to match simultaneously the capital-to-GDP ratio and the health gradient. With risk aversion at 3, the capital-to-GDP ratio would have been too large for standard discount rates (above 5). Similarly, the health gradient with wealth would not be steep enough at values of risk aversion below 2 as the curvature of the utility function has a positive effect on how much health spending is responsive to income/wealth (see Hall and Jones (2007)). The marginal utility of being in good health is found to be 0.079 which is large, given that the curvature of the utility function implies low values of utility from consumption. The consumption value of being in good health is equal to 78% of the US average consumption.[24] The marginal productivity of health investment α_0 is found to be large, at 2.088. This value is reminiscent of Property 2: large marginal benefits from investing in health is necessary to allow the model to replicate a data-consistent GDP share of health expenditures.[25] In order to gauge the plausibility of our parameter estimates, we compute elasticity of health expenditures pm to the co-insurance μ generated by the model. This elasticity is 0.4 without any adjustments in tax and interest rate, but 0.29 when tax rate adjusts and 0.31 when both tax and interest rates adjust. These estimates are in the range of the RAND Health Insurance Experiment (at 0.2). If one considers that the RAND experiment is more close to a partial equilibrium analysis, the gap between our estimate and the RAND one can come from the scope of the experiment: in the RAND experiment, out-of-pocket expenditures were subject to a limit, which is not the case in our coinsurance rate counterfactual. Our US income elasticity of pm is 1.97 (in general equilibrium), which lie between the macro estimates (close to 1) and Hall and Jones (2007)'s findings (higher than 2).[26] Hence, we do not require an impossible income elasticity in order to match data.

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[23]In heterogeneous agent model with financial constraint, the model can be far from the steady state restriction of representative agent model $1 = \beta(1+r)$, because financial constraints implies $1 < \beta(1+r)$ at the equilibrium.

[24]We deduce this number by computing ϱ defined as follows: $\frac{(c(1+\varrho))^{1-\sigma}}{1-\sigma} = \frac{c^{1-\sigma}}{1-\sigma} + \pi\phi$, where π is the share of individual in good health in the economy.

[25]In addition, the stylized model (equation (21) in Appendix B) suggests that, in simple framework without savings, the model would replicate a data-consistent GDP share of health expenditures with a price elasticity lower than 1 in absolute value and an income elasticity larger than 1. Interestingly, we will show in Section 5 that these conditions also hold in our model.

[26]We compute this income elasticity using the TFP counterfactual in Section 5 and make sure to compute the average response of pm to a 1% increase in total income (including labor earnings and financial income).

We estimate strong state-dependence in health transition probabilities with the probability of being in good health next period being much larger if one is already in good health than if it is not ($\alpha_{11} > \alpha_{10}$). Finally, we estimate a negative effect of the obesity rate on the probability of being in good health: the elasticity of this probability to BMI is 0.77% in the US.

4.3.2 Estimated wedges across countries

The estimation procedure allows to measure the cross-country inefficiencies in terms of health prices and TFP (see Table 7): the health service and the efficiency wedges.

As for the price of health, the differences across countries of the health services wedges are large. All countries are characterized by lower values than the US economy (normalized to one): the estimation reveals an inefficiency gap for the US. France, the Netherlands and Denmark display the cheapest health prices relative to the US (around .3 - .4). Germany and Sweden constitute a second group with health prices hovering around .6 relative to the US, whereas the third group is composed by Italy and Spain with health prices hovering around .7-.8 relative to the US. Our results are consistent with the health price dispersion in Tables 1, 2 and 3. The remarkable result is that this simple model makes it possible to find the ranking of countries in terms of price of health services. The most surprising result comes from Spain. In the Tables 1, this country seems to have the lowest prices in Europe, but a more detailed data show that the physician fees in Spain can be very high for a European country: 2.5 times higher than in France for an appendectomy, 1.14 for a cataract surgery and 12.33 for a hip replacement.[27]

As for efficiency wedge, it captures the heterogeneity in economic development across countries. The US, Denmark and Sweden appear as the most productive economies while Spain and Italy lie at the other end of the TFP distribution. The estimated inefficiencies suggest that countries such as the US, with high price of health services and high TFP, could use their advanced technological development (TFP efficiency) to pay for expensive price services (health market inefficiency). Other countries have high TFP and cheap price of health, such as Denmark. Estimated gaps show that price dispersion appear very large, even larger than gaps in TFP, thereby suggesting that our focus on cross-country differences in inefficiency of the health sector is supported by the data.

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[27]See the data provided by the IFHP (2009) for more details.

4.3.3 Model fit

Figure 7 shows that the model succeeds in fitting the share of health expenditures ($p_g m_g/y_g$, the Spearman correlation is 0.95). The model slightly overestimates the transition rate from good to good health but the ranking of the countries is well reproduced (the Spearman correlation is 0.63 for $p_{1|1}(X_g, 1)$). The model fit is worse for the transition from bad to good health (the Spearman correlations are -0.83 for $p_{1|0}(X_g, 1)$). Nevertheless, the model reproduces the empirical evidence that the share of health expenditures is the highest in the US but with a low percentage of people in good health (only Italy and Spain perform worse) as well as in terms of health inequalities, measured by the health gradient (the highest in the US). At the opposite, Denmark performs much better: for the low share of health expenditures (only Italy and Spain have lower s), the percentage of people in good health is the largest, and the health inequalities are the lowest. Italy and Spain seems to be the worse country, with high health inequality in Spain. Finally, Germany, France, the Netherland and Sweden have similar outcomes, with higher shares of health expenditure in Germany and France: the model fits this feature. Figure 7 shows that the simulated moments are very close to their empirical counterparts: the capital/output ratio and the GDP differences are well reproduced (the Spearman correlations are respectively 0.48 and 0.76). Finally, health inequalities, measured by the health gradient are in accordance with the main features of the data (even if the Spearman correlation are low, respectively 0.25, 0.33 and 0.4 but always positive), showing than the US is the country where inequalities are the largest, whereas Nordic countries are those where they are the lowest.

5 Paying More for Less: The Leading Role of Health Services Wedge

The main challenge of this paper is to evaluate the respective contributions of wedges on health services market and on technological efficiency on cross-country health performance. The analysis of the stylized model presented in the section 2 has shown that high health services prices can reduce the fraction of population in good health, but at the same time increase the health expenditures as a fraction of the GDP. At the opposite, it shows that high incomes increase both the fraction of population in good health and the health expenditures as a fraction of the GDP. These mechanisms are at the heart of our identifying strategy for estimating the model. Now, using the estimation results, we

go beyond by quantifying the respective impacts of differences in health services price and TFP on both the fraction of population in good health ($p(H = 1)$) and the health expenditures as a fraction of the GDP (s). To this end, we perform counterfactual experiments in which the model predicts what would have happened in one country when faced with the health service price (p) or TFP (A) from another country. These counterfactual experiments will be also the opportunity to quantify the impact of interest rate adjustments: we then distinguish counterfactuals at the general equilibrium (adjustment of the interest rate) from counterfactuals at partial equilibrium (interest rate fixed at it initial value).

5.1 The US with European wedges.

For the purpose of clarity, we focus first on the case in which the US is characterized by average European health services prices (p_{EU}) or TFP (A_{EU}). These different experiences mean that the US experience *(i)* a decline in health service wedge when the price is set to the one of European market ($p_{US} > p_{EU}$), or *(ii)* a increase in the efficiency wedge when TFP is set to European level ($A_{US} > A_{EU}$). Figure 8 reports the model predictions dy/y for $y = \{s, p(H = 1)\}$ in response to the change $dx/x < 0$ for $x \in \{p, A\}$.

In response to a lower health service price, the model generates a decline in health expenditures as a share of GDP (panel (a) of Figure 8 where dy/y is negative), and an increase in the fraction of the population in good health (panel (b) of Figure 8 where dy/y is positive). This suggests that the health services wedge (price difference) can explain the US specificities with respect to the health expenditures as a share of GDP *and* the fraction of the population in good health. In contrast, by switching to the European TFP, the model predicts that both the health expenditures as a share of GDP and the the fraction of the population in good health declines. Hence, without price differences, it is not possible to explain cross country differences in heath and health expenditures.

What do we learn from quantitative analysis? The quantitative analysis allows to decompose the model prediction dy/y between the estimated size of the shock (the change in the wedge size dx/x) and the sensitivity of behaviors to this change in the market inefficiency, basically defined by the elasticity of y to x and measured by the estimated model.[28] Figure 8 recalls (see the estimated parameters in Table **??**) that the health services wedge

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[28]We report below results under general equilibrium: individual behaviors adjust to the counterfactual economic environment, as well as input prices (wage rate w and interest rate r) and tax rate (τ). We report arc-elasticity defined by $\varepsilon_{y|x} = \frac{\frac{y_1 - y_0}{(y_1 + y_0)/2}}{\frac{x_1 - x_0}{(x_1 + x_0)/2}}$, and we denote abusively $dy/y = \frac{y_1 - y_0}{(y_1 + y_0)/2}$ and $dx/x = \frac{x_1 - x_0}{(x_1 + x_0)/2}$.

(price difference) is larger than the efficiency wedge (TFP difference): inefficiencies in the health services market are larger than the technological gaps across countries. The new information provided by Figure 8 is that the elasticities of health and health expenditures to the health services price or to the TFP are of rather similar magnitude, underlying that the sensitivity of the behaviors to these two wedges is large. Given that the health services wedge (price difference) is larger than the efficiency wedge (TFP difference), these similar elasticities suggest that the primary driver for US specific performances on the health service market lies in the large size of the health services wedge. What are the economic mechanisms that generate these elasticities?

The elasticity to the health services wedge. The reactions of the US economy to a decline in the health services wedge are displayed in Figure 9 (US price elasticities). At the *partial equilibrium*, a reduction of health services wedge leads health services m to increase, which rises the percentage of the population in good health.[29] The reduction of the health services wedge leaves more resources for individual savings. Aggregate capital stock rises, thereby increasing production.[30] The health expenditures as a share of GDP declines as the changes in health price dominates the fall in the demand for health services[31], whereas public health and GDP improve.[32] At the *general equilibrium*, the tax rate adjusts to balance the health insurance system: with lower inefficiency on the health service market, the US tax rate is reduced by 4.5 points in percentage (from 20.10% to 15.43%). The variations in the tax rate are proportional to changes in GDP share of health expenditures (see Equation (10)). This additional reduction of distortions in the US leads households to save more, which increases the capital stock in the economy, therefore shifts wages upward and reduces the interest rate. Hence, this tax reduction, accompanied by a wage increase thereby amplify the effect of reduction in the price of health services on all variables: general equilibrium magnifies all the price elasticities (Figure 9).[33] The

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[29] A 1% reduction of the price of health services increases health expenditures by 0.55%, whereas the percentage of the population in good health is reduced by -0.054%.

[30] The price elasticity of the stock of capital is -0.11, and the price elasticity of GDP is -0.04.

[31] The health expenditures as a share in GDP falls by 0.51% for 1% price gap reduction.

[32] Beyond these aggregate performances, a decrease in the health services wedge modifies health inequalities, summarized by the health gradient. At the bottom of the wealth distribution, the health wedge reduction allows the poorest to access more easily to the health system. At the top of the wealth distribution, the impact of the price variation is negligible on behaviors: rich groups were already healthy prior to the switch to a more efficient health services market. Hence, p_4/p_1 largely declines (Figure 9). For the middle class, the reduction of the health services wedge is accompanied with a wealth increase allowing these agents to deviate from the health conditions of the poorest: this explains the increases in p_2/p_1 and p_3/p_1 (Figure 9).

[33] The wealth effects induced by health services wedge variations, and specific to general equilibrium, are stronger at the bottom of the wealth distribution, such that, *(i)* the gap between the poorest and the

gaps between the measures of the elasticities at partial vs. general equilibrium are small because the changes in the price of health services have only indirect impacts on wages and interest rates: the price elasticities of the health expenditure as a share of GDP is -0.49% at partial equilibrium vs. -0.51% at general equilibrium.

The elasticity to the efficiency wedge.   The US TFP elasticities (Figure 9) give the reaction of the US economy to an increase of the efficiency wedge, ie. a reduction of the TFP in US.[34] At the *partial equilibrium*, this TFP variation changes only wages.[35] This negative income shock leads to a reduction in health expenditures and thus reduces the percentage of the population in good health[36] It also reduces households' savings and thus the stock of productive capital, thereby magnifying the negative impact of TFP on GDP.[37] These large negative income effects lead the health expenditure as a share of GDP to be reduced.[38][39]   At the *general equilibrium*, the tax rate declines as the health expenditures as a share of GDP goes down. This creates a positive wealth effect, which tends to dampen the initial fall in TFP. As a result, effects on macroeconomic aggregates at the general equilibrium tend to be dampened with respect to the partial equilibrium.[40]

5.2   Robustness: the European countries with the US wedges.

In this section, we present the health expenditures as a share of GDP and the fraction of the population in good health predicted by the model when European economies are faced with US wedges on health services or efficiency. Obviously, the induced changes in wedges are not identical across European countries. This exercise allows us to test the robustness of our conclusions with respect to various estimations of the *size* of wedges and of the model's *elasticities* that are both country-specific. We then show that the

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richest (p_4/p_1) is smaller (larger) than at partial equilibrium, and *(ii)* the differences between the middle class and the poorest (p_2/p_1 and p_3/p_1) tend to increase (to reduce).

[34]In our simulations, the TFP is set to its estimated level for the average European economy.

[35]They fall by -1.55% for 1% TFP decrease.

[36]The reduction in m and $p(H=1)$ are respectively 1.98% and 0.19% for 1% TFP decrease.

[37]The elasticity is equal to 1.50%.

[38]The elasticity of s to A is 0.625.

[39]As the increase of efficiency wedge (a TFP decline) reduces all wages, this particularly affects total incomes of the 75% poorest agents who reduce their health expenditures: health inequalities decrease across all households, but less with the top 25% richest (p_4/p_1 declines by only 0.009% for 1% TFP decrease, whereas p_2/p_1 and p_3/p_1 are reduced by respectively 0.09% and 0.125% for 1% TFP decrease), who are less sensitive to wage changes thanks to their financial incomes.

[40]This is not the case for the health gradient, as the richest individuals benefit more from the decline in taxation (see Figure 9). The same damping effects related to general equilibrium adjustments are observed in the European countries (see Figure 11).

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differences in the health service price play a leading role in the explanation for the cross country differences in health.

We present in Table 8 the predicted health expenditures as a share of GDP (s, columns (2)-(5) in panels (a) & (b)) and fraction of the population in good health ($p(H = 1)$, columns (6)-(9) in panels (a) & (b)) when European economies are faced with US price (panel (a)) or TFP (panel (b)). As in Figure 8, we decompose the total effect on health expenditures as a share of GDP and on fraction of population in good health (columns (4) for the evaluation at partial equilibrium (eqp), (5) for the evaluation at general equilibrium (eqg)) between the size of the change in wedges (health service wedge in column (1)-panel (a) and efficiency in column (1)-panel (b)) and the elasticities (ε, columns (2) for eqp, (3) for (eqg)).

The changes in the health services wedges (change in the price of health services) reveal that there are three groups: the first composed of Spain and Italy where the changes in the price of health services are between 0.25 and 0.45, the second composed by Deutschland and Sweden where the changes in the price of health services are 0.45, and the second composed of Denmark, France and the Netherland where the changes in the price of health services are larger (between 0.73, 0.75 and 0.81 respectively). Price elasticities of the health expenditures as a share of GDP lie between 0.077 and 0.52, which is lower than in US (0.55). They are larger for France and the Netherland where they are equal to 0.48 and 0.52 respectively. These results underline the large heterogeneity of market adjustment across countries, despite the common structural parameters. The combination of these large price elasticities with the large changes in health services prices lead France and the Netherland to be the countries where the shift to the US price increases the share of health expenditure the most. At the opposite, Italy and Spain combine low price elasticities with small price gaps leading to the smallest changes in the share of health expenditure. Except for the Italy where the elasticities are very small, the general equilibrium adjustments lead to dampen the impact of a health service wedge change on the health expenditures as a share of GDP.

If we compare these results with those obtained for a change in the efficiency wedge (a change in TFP), the main difference lies in the sizes of the changes in wedges: they are smaller than for the health services wedges. Moreover, the magnitudes of the country-specific elasticities of the health expenditures as a share of GDP at health service wedge are larger than the elasticity at the efficiency wedge. Thus, the combination between smaller changes in the efficiency wedge and the smaller elasticities explains the smaller variations in the health expenditures as a share of GDP. Even if the small changes in the

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efficiency wedge lead to small variations in the health expenditures as a share of GDP, the differences between an evaluation at partial or at the general equilibrium are larger than for a change in the health service wedge due to the direct impact of TFP variations on the prices $\{w, r\}$. Moreover, the general equilibrium magnifies the elasticities because the increase of tax induced by the rise in s is overcompensated by the direct impact of the TFP increase on the prices ($\{w, r\}$), generating a wealth effect specific tho the general equilibrium adjustments.

Table 8 also allows to assess the impact of change in the two wedges (health services and efficiency) on the percentage of people in good health. We observe then that for 2 out of 7 countries the changes in health services wedge dominates the change in efficiency wedge. For this group of country (France and the Netherland), the result comes again from the large size of the estimated health services wedges.

Hence, the conclusion based on the US economy and showing that the health prices lie at the heart of the cross country differences seems to be robust: it is not dependent of the country chosen as the reference, even if the order of magnitude changes because the elasticities are country-specific.[41]

6 Welfare

Our counterfactual experiments show that large health wedge (high price of health services) tends to lower the utilization of health services, thereby the fraction of people in good health, hence welfare. In contrast, small efficiency wedge (high TFP) increases income, which allows individuals to spend more on health and reach a higher probability of good health, thereby increasing welfare. The US is characterized by a high health wedge and a small efficiency wedge. With respect to the health indicators, we have shown that the negative impacts of the price gaps are not compensated by those induced by the TFP gaps. Is this conclusion also relevant when we consider welfare? Indeed, the weight of health in welfare can be small and thus dominated by other components highly linked to the TFP gap. Which gap is quantitatively more important on the US welfare?

We aim at answering this question by looking at welfare implications of changes in US health services and efficiency. In these counterfactual experiments, US price (TFP) is replaced by the average of the estimated values of the European countries. Table 9

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[41]The introduction of the US health services wedge in European countries would lead to increases of the tax rates from 0.9pp (Spain) to 9.47pp (the Netherland). Hence, the increase of the health services wedge is magnified by the rise in distortions induced by the tax rate increases (Figure 10).

reports the model's predictions under general equilibrium. Welfare changes are computed as γ % change in permanent consumption that US individuals would willing to pay to switch to the European value. The formula is the following. We compute the fictitious consumption level $\bar{c}_0$ corresponding to the benchmark welfare such that

$$\sum_t \sum_e \sum_a \sum_h \beta^t \left(\frac{\bar{c}_0^{1-\sigma}}{1-\sigma} + \phi h \right) \lambda_0(a,h,e) = \sum_e \sum_a \sum_h v(a,h,e) \lambda_0(a,h,e)$$

We repeat the same calculation in order to get $\bar{c}_1$ in the counterfactual experiment. The welfare change is measured as $\gamma = \frac{\bar{c}_1 - \bar{c}_0}{(\bar{c}_1 + \bar{c}_0)/2}$ which can be decomposed as follow: $\gamma = \varepsilon_{\bar{c}|x} \frac{x_1 - x_0}{(x_1 + x_0)/2}$ where $\varepsilon_{\bar{c}|x} = \frac{\frac{\bar{c}_1 - \bar{c}_0}{(\bar{c}_1 + \bar{c}_0)/2}}{\frac{x_1 - x_0}{(x_1 + x_0)/2}}$, for $x = p, A$.

Table 9 suggests that welfare consequences of health services wedge are large. A switch to European health price increases US welfare by approximatively 6% in terms of permanent consumption. This result comes from the large price gap between US and Europe. Table 9 also suggests that efficiency wedge matters more than health wedge. Indeed, Americans would need to be compensated by 13% of permanent consumption to switch to the European TFP. This result is mainly due to the large impact of the TFP on all the economic mechanism (larger elasticity $\varepsilon_{\bar{c}|x}$), but not from the estimated size of the TFP gap. Interestingly, even though the GDP share of health spending amounts to 14% of GDP, changes in health service wedge have large welfare consequences: it represents a half of the impact of the efficiency wedge.

Figure 12 reports welfare changes across the distribution of labor earnings. A large part of the cross individual differences with a country come from the health expenditures. The poorest people spend a modest part of their income on health care costs: they are not very sensitive to price variations in health services and thus benefit from the most modest welfare gains when health market inefficiencies are reduced. The same reasoning applies for a reduction in TFP: a decrease in their incomes (almost only wages) only reduces their consumption, whereas the "quality" margin of their welfare (ie, the state of health) does not change as much, as it was already low before the TFP decline. For the middle class, the impact of a wedge variation is, on the contrary, very important. In fact, these agents, with modest financial wealth, had begun to taste the well-being of their health. Reducing the price of health brings them great welfare gains, while reducing their income through a reduction of the TFP, thereby leading them to give up health expenses. TFP changes tend to affect all income levels equally (due to the direct effect of TFP on the wage rate that applies to all productivity levels). As a result, welfare impact of lower TFP negatively affects US workers in the same way along the income distribution. In

contrast, Figure 12 confirms that changes in prices affect more high-income groups than low income groups. Indeed, with lower price of health services, GDP-share of health spending declines, hence the tax rate falls. All income group benefit from lower taxation, especially the high-income group. The richest, meanwhile, are characterized by a high share of health expenditure in their total expenditure, and by a large share of financial income in their total income. It is clear then that they are the primary winners of the reduction of inefficiencies in the health market. For high-income individuals, the welfare decline induced by the decline in TFP, which is largely explained by the renunciation of health, is negligible because the increase in health expenditure has a marginal return.

7   Conclusion

Health expenditures as a share of GDP and health status vary significantly across countries. While some have argued that the lack of a strong link between the two at the aggregate level is evidence that the marginal returns of health expenditures paid by richest individuals are very small, others have argued that prices and inefficiencies blur the link between health consumption and health. In this paper, we evaluate the contributions of two gaps on the cross-country differences in the GDP share of health expenditures and health status: *(i)* the TFP gaps measuring the relative economic development (called efficiency wedge), and *(ii)* the price gaps capturing the inefficiencies on the health service market (called the health service wedge). To this end, we extend a general equilibrium framework *à la* Aiyagari (1994) by including health production (Grossman, 1972). Using a method of moments approach, we estimate its structural parameters using macro and micro data from the US and seven European countries. Our estimation reveals not only deep parameter values related to preferences and health production but also country-specific structural price and TFP gaps. We perform counterfactual experiments to quantify the relative role of price, TFP and coinsurance rates in explaining observed cross-country heterogeneity in health expenditures and health status.

We find that the US are characterized by the highest health service wedge (health price) of our sample and lies among the lowest efficiency wedge countries (highest-TFP). In addition, using counterfactuals, we find that inefficiencies on the health market dominate the high technological efficiency when we focus on health indicators. It is also the case for European countries. Therefore, dispersion in health price seems to be the main cause for cross-country differences in GDP share of health expenditure and percentage of population in good health. When we consider welfare, rather than health indicators, the conclusion

is reversed (as the utility gain from good health can be low compared to consumption utility): efficiency wedge matter more than health service wedge. Health price gap (the health service wedge) is more than compensated by TFP gap (the efficiency wedge) in the US. Nevertheless, the welfare costs of the price gap are found to be large : while the health sector accounts for only 14% of GDP in the US, the welfare costs of the health service wedge is only twice lower than the welfare gains induced by the efficiency wedge. This underlines the strong distortions induced by inefficiencies on the US health market.

References

S Rao Aiyagari. Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics*, 109(3):659–84, August 1994. URL `http://ideas.repec.org/a/tpr/qjecon/v109y1994i3p659-84.html`.

Gerard F. Anderson, Uwe E. Reinhardt, Peter S. Hussey, and Varduhi Petrosyan. It's The Prices, Stupid: Why The United States Is So Different From Other Countries. *Health Affairs*, 22(3):89–105, May 2003. ISSN 0278-2715, 1544-5208. doi: 10.1377/hlthaff.22. 3.89. URL `http://content.healthaffairs.org/content/22/3/89`.

Mauricio Avendano, M. Maria Glymour, James Banks, and Johan P. Mackenbach. Health Disadvantage in US Adults Aged 50 to 74 Years: A Comparison of the Health of Rich and Poor Americans With That of Europeans. *American Journal of Public Health*, 99 (3):540–548, March 2009. ISSN 0090-0036. doi: 10.2105/AJPH.2008.139469.

David Backus, Espen Henriksen, and Kjetil Storeslettenb. Taxes and the global allocation of capital. *Journal of Monetary Econmics*, 55:48–61, 2008. URL `https://doi.org/10.1016/j.jmoneco.2007.11.008`.

James Banks, Michael Marmot, Zoe Oldfield, and James P. Smith. Disease and Disadvantage in the United States and in England. *JAMA*, 295(17):2037–2045, May 2006. ISSN 0098-7484. doi: 10.1001/jama.295.17.2037.

Ana Castaneda, Javier Diaz-Gimenez, and Jose-Victor Rios-Rull. Accounting for the U.S. Earnings and Wealth Inequality. *Journal of Political Economy*, 111(4):818–857, 2003. ISSN 0022-3808. doi: 10.1086/375382. URL `http://www.jstor.org/stable/10.1086/375382`.

Varadarajan V. Chari, Patrick J. Kehoe, and Ellen R. McGrattan. Business cycle accounting. *Econometrica*, 75(3):pp. 781–836, 2007.

Victor Chernozhukov and Han Hong. An MCMC approach to classical estimation. *Journal of Econometrics*, 115(2):293–346, August 2003. ISSN 0304-4076. doi: 10.1016/S0304-4076(03)00100-3. URL `http://www.sciencedirect.com/science/article/pii/S0304407603001003`.

David Cutler and Dan Ly. The (Paper) Work of Medicine: Understanding International Medical Costs. *Journal of Economic Perspectives*, 30(6):1174–1187, 2011.

David M Cutler, Edward L. Glaeser, and Jesse M. Shapiro. Why Have Americans Become More Obese? *The Journal of Economic Perspectives*, 17(3):pp. 93–118, 2003.

Mariacristina DeNardi, Eric French, and John B. Jones. Why Do the Elderly Save? The Role of Medical Expenses. *Journal of Political Economy*, 118(1):pp. 39–75, 2010.

D.D. Dranove and M.A. Satterthwaite. Chapter 20 - the industrial organization of health care markets. In Joseph P. Newhouse and Anthony J. Culyer, editors, *Handbook of Health Economics*, Handbook of Health Economics, pages 1094–1139. Elsevier, 2000.

Robert C. Feenstra, Robert Inklaar, and Marcel P. Timmer. The next generation of the penn world table. *America Economic Review*, 105(19):3150–3182, 2015. doi: 10.1257/aer.20130954. URL `https://www.aeaweb.org/articles?id=10.1257/aer.20130954`.

Victor R. Fuchs. More variation in use of care, more flat-of-the-curve medicine. *Health Affairs (Project Hope)*, Suppl Variation:VAR104–107, 2004. ISSN 0278-2715. doi: 10.1377/hlthaff.var.104.

M. Gaynor and W.B. Vogt. Chapter 27 - antitrust and competition in health care markets. In Joseph P. Newhouse and Anthony J. Culyer, editors, *Handbook of Health Economics*, Handbook of Health Economics, pages 1405–1487. Elsevier, 2000.

Martin Gaynor and Robert J. Town. Chapter 9 - competition in health care markets. In Anthony J. Culyer Newhouse and Joseph P., editors, *Handbook of Health Economics*, volume 2 of *Handbook of Health Economics*, pages 499–637. Elsevier, 2012.

Ulf-G. Gerdtham and Bengt Jonsson. Chapter 1 - International Comparisons of Health Expenditure: Theory, Data and Econometric Analysis*. In Anthony J. Culyer Newhouse and Joseph P., editors, *Handbook of Health Economics*, volume 1, Part A of *Handbook of Health Economics*, pages 11–53. Elsevier, 2000. doi: 10.1016/S1574-0064(00)80160-2.

Gowrisankaran Gowrisankaran, Aviv Nevo, and Robert Town. Mergers when prices are negotiated: Evidence from the hospital industry. *American Economic Review*, 175:pp. 172–203, 2015.

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

Heikki Haario, Eero Saksman, and Johanna Tamminen. An adaptive Metropolis algorithm. *Bernoulli*, 7(2):223–242, April 2001. ISSN 1350-7265. URL `https://projecteuclid.org/euclid.bj/1080222083`.

Robert E. Hall and Charles I. Jones. The Value of Life and the Rise in Health Spending. *The Quarterly Journal of Economics*, 122(1):pp. 39–72, 2007.

Kate Ho and Robin S. Lee. Insurer competition in health care markets". *Econometrica*, 85(2):379–417, 2017.

IFHP. Comparative Price Report: Variation in Medical and Hospital Prices by Country. Technical report, International Federation of Health Plans, 2013.

Hendrik Jurges. True health vs response styles: exploring cross-country differences in self-reported health. *Health Economics*, 16(2):163–178, February 2007. ISSN 1057-9230. doi: 10.1002/hec.1134. bibtex: jurges_true_2007.

C Kamps. New estimates of government net capital stocks for 22 oecd countries, 1960-2001. IMF Staff Papers 53, IMF, February 2006. URL `http://www.uni-kiel.de/ifw/forschung/netcap/netcap.htm`.

Arie Kapteyn, James P. Smith, and Arthur van Soest. Vignettes and Self-Reports of Work Disability in the United States and the Netherlands. *American Economic Review*, 97(1):461–473, March 2007. ISSN 0002-8282. doi: 10.1257/aer.97.1.461. URL `https://www.aeaweb.org/articles?id=10.1257/aer.97.1.461`. bibtex: kapteyn_vignettes_2007.

Willard G. Manning, Joseph P. Newhouse, Naihua Duan, Emmett B. Keeler, and Arleen Leibowitz. Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment. *The American Economic Review*, 77(3):pp. 251–277, 1987.

Seppo Miilunpalo, Ilkka Vuori, Pekka Oja, Matti Pasanen, and Helka Urponen. Self-rated health status as a health measure: The predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. *Journal of Clinical Epidemiology*, 50(5):517 – 528, 1997. ISSN 0895-4356. doi: http://dx.doi.org/10.1016/S0895-4356(97)00045-0. URL `http://www.sciencedirect.com/science/article/pii/S0895435697000450`.

Joseph P. Newhouse. Medical Care Costs: How Much Welfare Loss? *The Journal of Economic Perspectives*, 6(3):pp. 3–21, 1992.

Joseph P. Newhouse. Reimbursing health plans and health providers: Efficiency in production versus selection. *Journal of Economic Literature*, 35:pp. 1236–1263, September 1996.

Lee E. Ohanian, Andrea Raffo, and Richard Rogerson. Long-term changes in labor supply and taxes: Evidence from oecd countries, 1956-2004. *Journal of Monetary Economics*, 55(8):pp. 1353–1362, 2008.

James P. Smith. Healthy Bodies and Thick Wallets: The Dual Relation between Health and Economic Status. *Journal of Economic Perspectives*, 13(2):145–166, June 1999. ISSN 0895-3309. doi: 10.1257/jep.13.2.145.

Aïda Solé-Auró, Pierre-Carl Michaud, Michael Hurd, and Eileen Crimmins. Disease incidence and mortality among older Americans and Europeans. *Demography*, 52(2): 593–611, April 2015. ISSN 0070-3370. doi: 10.1007/s13524-015-0372-7.

Kenneth E. Thorpe, Curtis S. Florence, David H. Howard, and Peter Joski. Trends: The Impact Of Obesity On Rising Medical Spending. *Health Affairs*, October 2004. ISSN 0278-2715, 1544-5208. doi: 10.1377/hlthaff.w4.480. URL http://content.healthaffairs.org/content/early/2004/10/20/hlthaff.w4.480.

Kenneth E. Thorpe, David H. Howard, and Katya Galactionova. Differences In Disease Prevalence As A Source Of The U.S.-European Health Care Spending Gap. *Health Affairs*, 26(6):w678–w686, November 2007. ISSN 0278-2715, 1544-5208. doi: 10.1377/hlthaff.26.6.w678. URL http://content.healthaffairs.org/content/26/6/w678.

A   Data Sources

We use four longitudinal surveys to construct our auxiliary estimations and the distribution of some moments. Our main data sources are the Health and Retirement Study (HRS) for the U.S., the Study of Health, Ageing and Retirement in Europe (SHARE), the Panel Study of Income Dynamics (PSID) for the U.S, and the European Community Household Panel (ECHP) for Europe.

We first use the two aging surveys to construct estimates of health status and health tansitions. HRS and SHARE are longitudinal surveys of the over-50 population and conducted every two years surveys. The HRS, and SHARE cover an equally broad range of topics, including demographics (age, gender and education), labor supply, income, pension benefits, wealth, and health, and they contain identical question wording wherever possible. We use data from 2004. In particular the demographic variables that we use in HRS and SHARE for the health transitions rates are age, gender and education. The education variable is college versus non college. The chronic variables used are hypertension, stroke, diabetes, lunge problems and cancer. We also build two limited physical indicators,the first is defined as self-reported difficulties with activities of daily living (ADLs) as well as instrumental ADLs (IADLs). For limitations in ADLs, questions were asked in all surveys about difficulties in five basic activities: bathing, dressing, eating, getting in and out of bed, and walking across a room. Individuals were classified as having any ADL limitation if they reported limitations with one or more of the five activities. Limitations in IADLs were measured by questions about difficulties in the following five activities: making meals, shopping, making phone calls, taking medications and managing money. Those who reported having some difficulty with any of the five activities were classified as having any IADL limitation. For the quintiles of wealth variables across countries, we use the net assets variable (all assets minus debt including housing). Finally, we use self-reported height and weight to construct our measure of obesity. Survey weights are used when computing statistics.

To estimate income processes, we use the PSID and ECHP. We use the PSID data, years 1990 till 1997, for the U.S., and ECHP, years 1994 till 2001. Both data sets have extensive information of income variables. We define income as total household income minus taxes and tansfers and restrict the age range between 21 and 85 years old for estimating income processes.

B   Basic two-periods model analysis

The assumptions are

- **Assumption 1.** The probability of being in good health is $\pi(m)$, with $\pi' > 0$ and $\pi'' < 0$. The utility benefit of good health is ϕ.

- **Assumption 2.**   Risk: the second-period income is drawn in the lotteries s.t. $\widetilde{y} \in \{0, \frac{y}{1-\varpi}\}$ with probabilities $(\varpi; 1 - \varpi) \Rightarrow \mathbb{E}[\widetilde{y}] = y$ and $\sigma_{\widetilde{y}}^2 = 2(\varpi y)^2$.

- **Assumption 3.** Using the endowment y, each household produces inputs b used in the health sector. The production cost of b is given by $\mathcal{C}(b) = \frac{\varphi}{\vartheta} b^\vartheta$, with $\vartheta > 1$. This inputs is sold to the health sector at price p_p. The net cost from this activity is $\mathcal{F} = \max_b \{p_p b - \mathcal{C}(b)\}$. Hence, we have $\mathcal{F} = \frac{\vartheta-1}{\vartheta} pm$ at the equilibrium.

- **Assumption 4.** Financial arrangements: One risk-free asset a, yielding the interest rate r. Financial constraint holds: $a \geq 0$.

B.1   The FOC of the household program

The FOC are

$$u'\left((1 - \tau)y - a - \left(\mu - \frac{\vartheta - 1}{\vartheta}\right) pm\right) = \beta(1 + r)\mathbb{E}\left[u'((1 + r)a + \widetilde{y})\right] \tag{15}$$

$$\left(\mu - \frac{\vartheta - 1}{\vartheta}\right) pu'\left((1 - \tau)y - a - \left(\mu - \frac{\vartheta - 1}{\vartheta}\right) pm\right) = \beta\pi'(m)\phi \tag{16}$$

$$\left(\mu - \frac{\vartheta - 1}{\vartheta}\right) pu'\left((1 - \tau)y - \left(\mu - \frac{\vartheta - 1}{\vartheta}\right) pm\right) = \beta\pi'(m)\phi \tag{17}$$

where (15) and (16) are the FOC w.r.t. a and m if $a > 0$, whereas (17) is the FOC w.r.t. m when $a = 0$.

B.2 Equilibrium

Using the budgetary constraint of the Health insurance system, $\tau y = (1 - \mu)pm$, the equilibrium is defined by

$$u'\left(y - a - \frac{1}{\vartheta}pm\right) = \beta(1 + r)\mathbb{E}\left[u'((1 + r)a + \widetilde{y})\right] \tag{18}$$

$$\left(\mu - \frac{\vartheta - 1}{\vartheta}\right)pu'\left(y - a - \frac{1}{\vartheta}pm\right) = \beta\pi'(m)\phi \tag{19}$$

$$\left(\mu - \frac{\vartheta - 1}{\vartheta}\right)pu'\left(y - \frac{1}{\vartheta}pm\right) = \beta\pi'(m)\phi \tag{20}$$

where (18) and (19) are the FOC w.r.t. a and m for the households having $a > 0$, whereas (20) is the FOC w.r.t. m for the households having $a = 0$.

B.3 Proof of Property 2

The elasticities of s when $a > 0$. The properties of $\mathcal{M}$ and $\mathcal{A}$ are determined using the log-linearization of equations (18) and (19). We first Log-linearize equation (18), leading to

$$\widehat{a} = \frac{1}{2}\underbrace{\frac{(\nu_1 + \nu_2)\nu_5\nu_3}{-\nu_4[\nu_1 + (1 + r)(\nu_1 + \nu_2)]}}_{=\Gamma_1 > 0}\sigma_{\widetilde{y}}^2 + \underbrace{\frac{-\nu_1\nu_3}{-\nu_4[\nu_1 + (1 + r)(\nu_1 + \nu_2)]}}_{=\Gamma_2 > 0}\widehat{y} + \underbrace{\frac{\nu_2(\nu_1 + 1)}{-\nu_4[\nu_1 + (1 + r)(\nu_1 + \nu_2)]}}_{=\Gamma_3 \gtrless 0}\widehat{p}$$

where $\nu_1 = \pi''\frac{m}{\pi'} < 0$, $\nu_2 = \frac{1}{\vartheta}u''\frac{pm}{u'} < 0$, $\nu_3 = u''\frac{y}{u'} < 0$, $\nu_4 = u''\frac{a}{u'} < 0$ and $\nu_5 = \frac{u'''y}{u''}$. We assume that $u''' > 0$ in order to have precautionary saving, leading to $\nu_5 < 0$. Moreover, we consider the case where $\beta R \to 1$ in order to have $a = 0$ in an hypothetical economy without risk. If $|\varepsilon_{\pi'}| > 1$, then $\Gamma_3 < 0$ because this leads to $\nu_1 + 1 < 0$.

Secondly, we Log-linearize equation (19), leading to

$$\widehat{m} = \underbrace{\frac{1 - \nu_2}{\nu_1 + \nu_2}}_{=\varepsilon_p < 0}\widehat{p} + \underbrace{\frac{\nu_3}{\nu_1 + \nu_2}}_{=\varepsilon_y >}\widehat{y} - \underbrace{\frac{\nu_4}{\nu_1 + \nu_2}}_{=\varepsilon_a > 0}\widehat{a}$$

Hence, we deduce

$$\widehat{m} = \varepsilon_y\widehat{y} - \varepsilon_a\widehat{a} + \varepsilon_p\widehat{p}$$
$$\widehat{a} = \Gamma_1\sigma_{\widetilde{y}}^2 + \Gamma_2\widehat{y} + \Gamma_3\widehat{p}$$

Given this solution for $\widehat{a}$, we obtain:

$$\widehat{m} \;=\; (\varepsilon_y - \varepsilon_a\Gamma_2)\widehat{y} + (\varepsilon_p - \varepsilon_a\Gamma_3)\widehat{p} - \varepsilon_a\Gamma_1\sigma_{\widehat{y}}^2$$

and, using $\widehat{s} = \widehat{p} + \widehat{m} - \widehat{y}$, we deduce that

$$\widehat{s} \;=\; (\varepsilon_y - 1 - \varepsilon_a\Gamma_2)\widehat{y} + (1 + \varepsilon_p - \varepsilon_a\Gamma_3)\widehat{p} - \varepsilon_a\Gamma_1\sigma_{\widehat{y}}^2$$

If $|\varepsilon_{\pi'}| > 1$, then we have $\frac{\partial s}{\partial y} > 0$ and $\frac{\partial s}{\partial p} > 0$. Indeed, the elasticities of s w.r.t. y and p satisfy the following properties.

- For the elasticity w.r.t y, we have:

$$
\begin{aligned}
\varepsilon_a\Gamma_2 &= \frac{-\nu_1\nu_3\nu_4}{-\nu_4(\nu_1 + \nu_2)[\nu_1 + (1+r)(\nu_1 + \nu_2)]} \\[2mm]
&= \frac{\pi''\frac{m}{\pi'}u''\frac{y}{u'}}{\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\left[\pi''\frac{m}{\pi'} + (1+r)\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]} \\[2mm]
\varepsilon_y - 1 &= \frac{\nu_3}{\nu_1 + \nu_2} - 1 = \frac{u''\frac{y}{u'} - \pi''\frac{m}{\pi'} - \frac{1}{\vartheta}u''\frac{pm}{u'}}{\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}} \\[2mm]
\varepsilon_y - 1 - \varepsilon_a\Gamma_2 &= \frac{1}{\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}}\left[u''\frac{y}{u'} - \pi''\frac{m}{\pi'} - \frac{1}{\vartheta}u''\frac{pm}{u'} - \frac{\pi''\frac{m}{\pi'}u''\frac{y}{u'}}{\left[\pi''\frac{m}{\pi'} + (1+r)\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]}\right]
\end{aligned}
$$

Hence, we have $\varepsilon_y - 1 - \varepsilon_a\Gamma_2 > 0$ iff

$$
\begin{aligned}
u''\frac{y}{u'} - \pi''\frac{m}{\pi'} - \frac{1}{\vartheta}u''\frac{pm}{u'} - \frac{\pi''\frac{m}{\pi'}u''\frac{y}{u'}}{\left[\pi''\frac{m}{\pi'} + (1+r)\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]} &< 0 \\[2mm]
\Leftrightarrow u''\frac{y - \frac{1}{\vartheta}pm}{u'} - \pi''\frac{m}{\pi'}\left(1 + \frac{u''\frac{y}{u'}}{\left[\pi''\frac{m}{\pi'} + (1+r)\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]}\right) &< 0
\end{aligned}
$$

A sufficient condition is:

$$1 + \frac{u''\frac{y}{u'}}{\left[\pi''\frac{m}{\pi'} + (1+r)\left(\pi''\frac{m}{\pi'} + \frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]} < 0 \;\;\Leftrightarrow\;\; \frac{1}{1 + (1+r)}u''\frac{y - \frac{1}{\vartheta}pm}{u'} < -\pi''\frac{m}{\pi'} - \frac{1}{\vartheta}u''\frac{pm}{u'}$$

which is always satisfied because the LHS is negative ($u'' < 0$) whereas the RHS is positive ($-\pi''\frac{m}{\pi'} - \frac{1}{\vartheta}u''\frac{pm}{u'} > 0$).

- For the elasticity w.r.t p, we have:

$$\varepsilon_a\Gamma_3 = \frac{\nu_4\nu_2(\nu_1+1)}{-\nu_4(\nu_1+\nu_2)[\nu_1+(1+r)(\nu_1+\nu_2)]}$$

$$= \frac{\frac{1}{\vartheta}u''\frac{pm}{u'}\left(\pi''\frac{m}{\pi'}+1\right)}{-\left(\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}\right)\left[\pi''\frac{m}{\pi'}+(1+r)\left(\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}\right)\right]}$$

$$1+\epsilon_p = 1+\frac{1-\nu_2}{\nu_1+\nu_2} = \frac{1+\pi''\frac{m}{\pi'}}{\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}}$$

$$1+\epsilon_p-\varepsilon_a\Gamma_3 = \frac{\pi''\frac{m}{\pi'}+1}{\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}}\left[1+\frac{\frac{1}{\vartheta}u''\frac{pm}{u'}}{\pi''\frac{m}{\pi'}+(1+r)\left(\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}\right)}\right]$$

where $\frac{\pi''\frac{m}{\pi'}+1}{\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}} > 0$ if $\pi''\frac{m}{\pi'}+1 < 0$, ie. $|\varepsilon_{\pi'}| > 1$. We assume that this last restriction is satisfied. Hence, $|\varepsilon_{\pi'}| > 1$ is a sufficient condition for $1+\epsilon_p-\varepsilon_a\Gamma_3 > 0$ because

$$\frac{\frac{1}{\vartheta}u''\frac{pm}{u'}}{\pi''\frac{m}{\pi'}+(1+r)\left(\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}\right)} > 0 \iff 1+\frac{\frac{1}{\vartheta}u''\frac{pm}{u'}}{\pi''\frac{m}{\pi'}+(1+r)\left(\pi''\frac{m}{\pi'}+\frac{1}{\vartheta}u''\frac{pm}{u'}\right)} > 0$$

The elasticities of s when $a = 0$. Without risk, the agent problem becomes static: the optimal choice is reduced to the optimal health expenditures. We have $a = 0$, $c = y - pm$ and $d = y$. In order to analyze the other properties of the model, we log-linearize the equation (20):

$$\nu_1\widehat{m} = \widehat{p}-\nu_2\left(\widehat{m}+\widehat{p}\right)+\nu_3\widehat{y} \implies \widehat{m} = \underbrace{\frac{\nu_3}{\nu_1+\nu_2}}_{=\varepsilon_y>0}\widehat{y}+\underbrace{\frac{1-\nu_2}{\nu_1+\nu_2}}_{=\varepsilon_p<0}\widehat{p}$$

where $\nu_1 = \pi''\frac{m}{\pi'} < 0$, $\nu_2 = \frac{1}{\vartheta}u''\frac{pm}{u'} < 0$ and $\nu_3 = u''\frac{y}{u'} < 0$, implying that $\frac{\nu_3}{\nu_1+\nu_2} > 0$ and $1-\nu_2 > 0$. For all functional forms, ie. $\forall\{\pi(\cdot), u(\cdot)\}$, the equilibrium health expenditures $(m^\star)$ behave as a normal goods, ie. $\frac{\partial m^\star}{\partial p} < 0$ (because $\frac{1-\nu_2}{\nu_1+\nu_2} < 0$), and increase with the income, ie. $\frac{\partial m^\star}{\partial y} > 0$ (because $\frac{\nu_3}{\nu_1+\nu_2} > 0$). This implies that $\varepsilon_p < 0$ and $\varepsilon_y > 0$.

Given that $\widehat{s} = \widehat{p}+\widehat{m}-\widehat{y}$, we deduce that

$$\widehat{s} = \frac{\nu_3-(\nu_1+\nu_2)}{\nu_1+\nu_2}\widehat{y}+\frac{1+\nu_1}{\nu_1+\nu_2}\widehat{p}$$

$$\widehat{s} = (\varepsilon_y-1)\widehat{y}+(\varepsilon_p+1)\widehat{p} \tag{21}$$

with $\frac{1+\nu_1}{\nu_1+\nu_2} \gtrless 0$ and $\frac{\nu_3-(\nu_1+\nu_2)}{\nu_1+\nu_2} \gtrless 0$. Lets us denote $\varepsilon_{\pi'} = \pi''\frac{x}{\pi'} < 0$ and $\varepsilon_{u'} = u''\frac{c}{u'} < 0$.

Using these notations, we have *(i)* $\frac{1+\nu_1}{\nu_1+\nu_2} > 0$ iff $1 + \nu_1 < 0$. This leads to $|\varepsilon_{\pi'}| > 1$. *(ii)* the restriction $\frac{\eta[\nu_3-(\nu_1+\nu_2)]+(1+\nu_1)}{\nu_1+\nu_2} > 0$ is equivalent to

$$\eta u'' \frac{y}{u'} + 1 + \pi'' \frac{m}{\pi'} < \eta \pi'' \frac{m}{\pi'} + \eta u'' \frac{pm}{u'} \quad \Leftrightarrow \quad \varepsilon_{u'} < \varepsilon_{\pi'} \left(1 - \frac{pm}{y}\right) + \varepsilon_{u'} \frac{pm}{y} - \frac{1}{\eta}(1 + \varepsilon_{\pi'}) \frac{c}{y}$$

For *(i)* satisfied, ie. $|\varepsilon_{\pi'}| > 1$, we have $1 + \varepsilon_{\pi'} < 0$. Hence, a sufficient condition on elasticities ensuring that the previous inequality is satisfied is $\varepsilon_{u'} < \varepsilon_{\pi'} \left(1 - \frac{pm}{y}\right) + \varepsilon_{u'} \frac{pm}{y}$. Given that $\frac{pm}{y} \in (0,1)$, this is true iff $\varepsilon_{u'} < \varepsilon_{\pi'}$. Hence, the share of health expenditures in the total income

(i) can be increasing with the price of the health sector if $|\varepsilon_{\pi'}| > 1$,

(ii) can be increasing with the total income if $\varepsilon_{u'} < \varepsilon_{\pi'}$.

C Solving the General Equilibrium Model

Step 1: Households' decision rules. In step 1, we compute the household policy. Given r, w, τ, μ, p, we determine, for each state (a, h, e), consumption, savings and medical expenditures $\{c(a, h, e), a'(a, h, e), m(a, h, e)\}$ that solve the households' decision problem described in (6). We rely on a discrete approximation of the state space. h takes 2 values (good or bad), the number of e ability level is N_e and the asset grid is captured by a discrete set of points N_k. We then compute $2 \times N_e \times N_k$ value functions. Let us make several comments on the asset grid. First, we use piecewise linear interpolation, so that next period's asset choice can lie outside the initial grid on asset. Secondly, as it is standard in the literature (Castaneda et al. (2003)), the asset grid is not equally spaced. For very low values of asset holdings, the distance between grid points is small. This is done to allow financially constrained individuals to increase their savings by small increments.

With respect to Aiyagari (1994)'s model, the complexity lies in the computation of two optimal choices c and m (a' being determined by the household's budget constraint) that are related through a dynamic first-order condition. We rely on value function iteration. Starting from a guess on optimal choices of c and m, for a given state (a, h, e), using Nelder-Mead method, we compute values of c and m that maximize the value function (6), using a guess on next period's value function. The new values for V, c and m are compared to the initial guess. If they are not close, replace the guess by the new values of c, m, V and repeat the optimization procedure. If they are close enough, the household's policy was found for the given state (a, h, e). We then repeat the whole process for all possible values of state (a, h, e).

Step 2: Stationary distribution. We compute the invariant wealth and health distribution by Monte Carlo simulations. We use simulated paths to generate an approximation of the distribution. We start with an individual agent to whom we assign an asset level, labor efficiency and health status. Using the policy rule computed in step 1, we can infer the individual optimal choices, then the probability of future health status. We draw a new productivity level and repeat the procedure next period. We track the individual's choices and realization of idiosyncratic shock over a very large number of periods. The stationary distribution is obtained by counting the number of times the individual happens to be in each state of the space (a, h, e). We check that the Monte Carlo distribution converges to the stationary distribution.

Step 3: General Equilibrium. We compute the general equilibrium factor prices (r mentioned in (b.) in Section 3.4) then w is inferred from equation (9)) and the equilibrium tax rate τ (mentioned in (d.) in Section 3.4). As a result, Steps 1 and 2 must be repeated until the interest rate r clears the asset market and the tax rate τ ensures that health insurance budget constraint is satisfied.

The steps of the algorithm are then

i. Compute the stationary level of employment N

ii. Make an initial guess of the interest rate r and tax rate τ

iii. Compute the wage rate w using equation (9)

iv. Compute the household's decision rules (Step 1)

v. Compute the invariant distribution (Step 2)

vi. Calculate aggregate variables using the agents distribution. Check market clearance on the asset market. Check that health budget constraint is satisfied. If these conditions do not hold, update the guess of the interest rate r and tax rate τ. If not, go back to ii.

vii. Check for convergence and update the guess

D MCMC Algorithm for MSM estimator

Denote by $Q(\Theta) = -\tilde{g}_S(\Theta, \chi)' W_N \tilde{g}_S(\Theta, \chi)$ the objective function of the MSM estimator. We use the adaptive Metropolis-Hastings algorithm proposed by Haario et al. (2001). The algorithm uses a Gaussian proposal distribution with a covariance matrix which depends on the entire markov chain and shrinks slowly.

A Metropolis-Hastings algorithm is used to simulate a chain that converges to the quasi-posterior distribution. For the initialization of the algorithm, we compute an initial chain where $\Theta \sim N(\overline{\Theta}_0, \Omega_O)$. We use $n_0 = 100$ draws as a burn-in period with a fixed (and large) covariance matrix Ω_0 (we choose $\Sigma_0 = I_d$). The first element of the chain is drawn in this initial chain. It is denoted Θ_0. Afterwards, we process as follow, for $n = 1, ..., N_c$:

- **Step 1.** Start with an evaluation of the objective function Q with a value Θ_n.

- **Step 2.** Draw a proposal $\Theta_{n+1}^\star$ in the normal law $N(\theta_n, \Omega_n)$.

- **Step 3.** Compute the acceptance probability $\alpha(\Theta_{n+1}^\star | \Theta_n) = \min\{\exp(Q(\Theta_{n+1}^\star) - Q(\Theta_n)); 1\}$.

- **Step 4.** Draw a value $\widetilde{\eta}$ in the uniform distribution over $[0; 1]$. The new value for the chain is thus

$$\Theta_{n+1} = \begin{cases} \Theta_{n+1}^\star & \text{if} \quad \widetilde{\eta} < \alpha(\Theta_{n+1}^\star | \Theta_n) \\ \Theta_n & \text{otherwises} \end{cases}$$

- **Step 5.** Update the covariance matrix Ω_{n+1} for the next draw:

$$\Omega_{n+1} = \frac{n}{n+n_0} \left(\frac{n-1}{n} \Omega_n + \frac{n \overline{\Theta}_{n-1} \overline{\Theta}'_{n-1} - (n+1) \overline{\Theta}_n \overline{\Theta}'_n + \overline{\Theta}_n \overline{\Theta}'_n}{n} \right) + \frac{n_0}{n+n_0} \Omega_0$$

where
$$\overline{\Theta}_n = \frac{n+1}{n+1+n_0} \left(\frac{n}{n+1} \overline{\Theta}_{n-1} + \frac{1}{n+1} \overline{\Theta}_{n-1} \right) + \frac{n_0}{n+1+n_0} \overline{\Theta}_0$$

- **Step 6.** come back to step 1 to compute Θ_{n+2}.

Estimates can be obtained from the chain of length N_c using averages and confidence intervals using empirical quantiles. We use chain of length 10,000 and keep the last 1000 draws to compute estimates. We varied the length of the Markov Chain and found little change in the estimates.
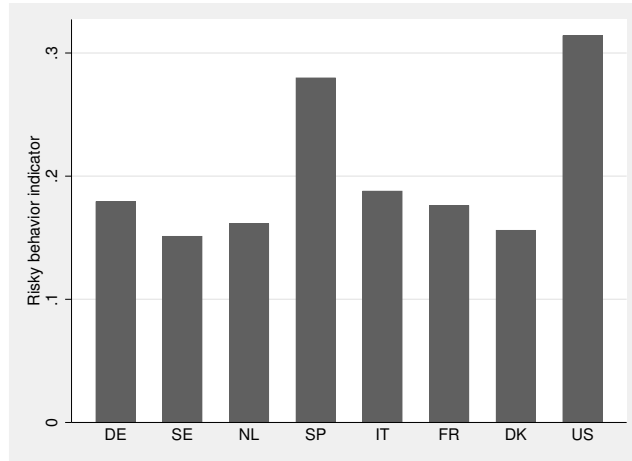
Figures

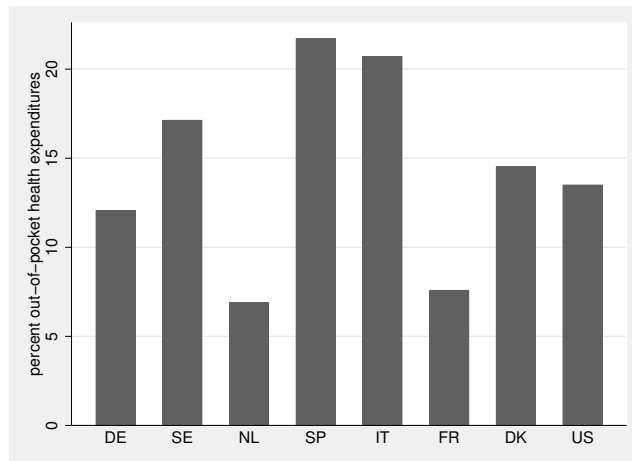Figure 1: Obesity Rates in HRS and SHARE

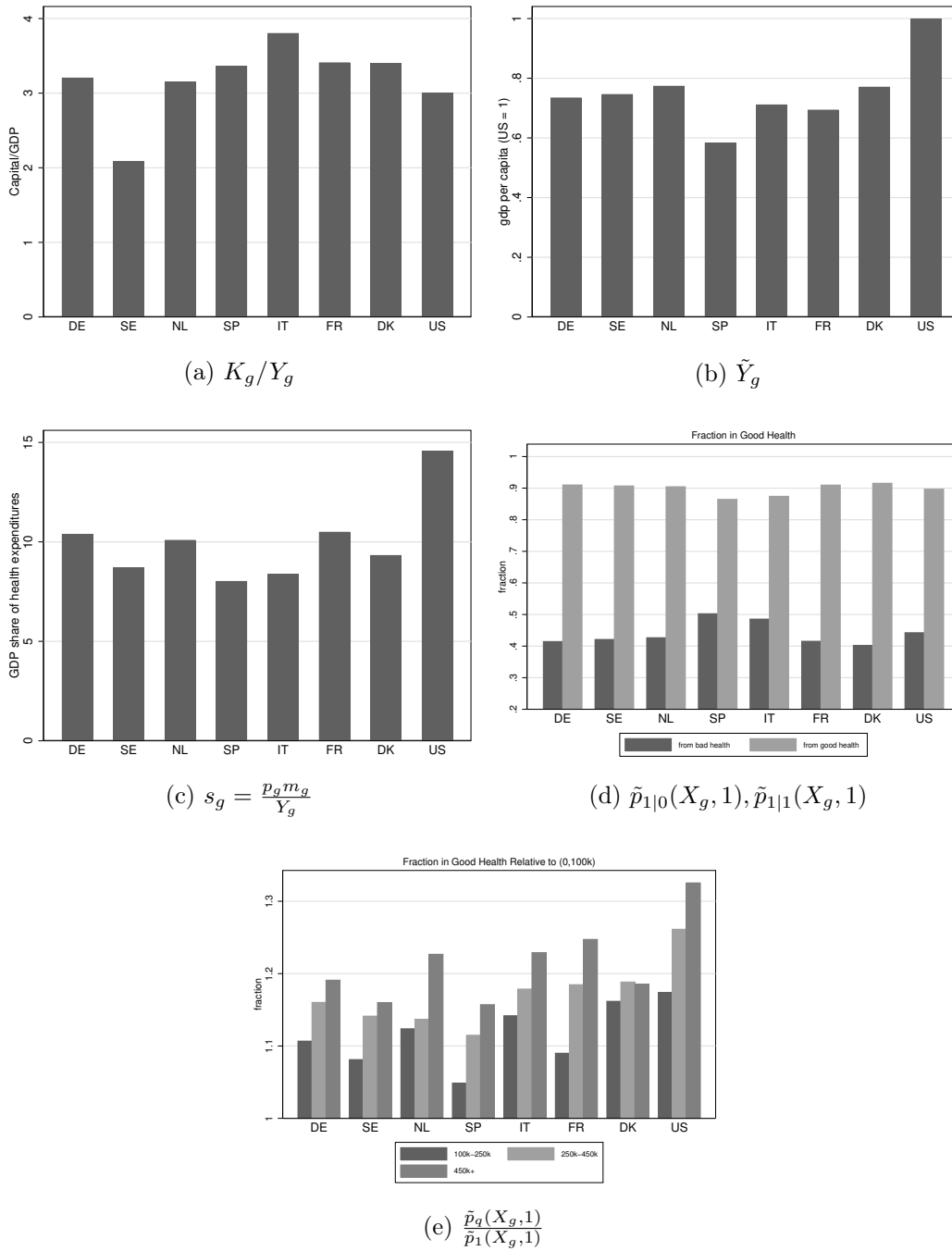Figure 2: Out-of-pocket as % Health Expenditures

(a) K_g/Y_g

(b) $\tilde{Y}_g$

(c) $s_g = \frac{p_g m_g}{Y_g}$

(d) $\tilde{p}_{1|0}(X_g, 1), \tilde{p}_{1|1}(X_g, 1)$

(e) $\frac{\tilde{p}_q(X_g, 1)}{\tilde{p}_1(X_g, 1)}$
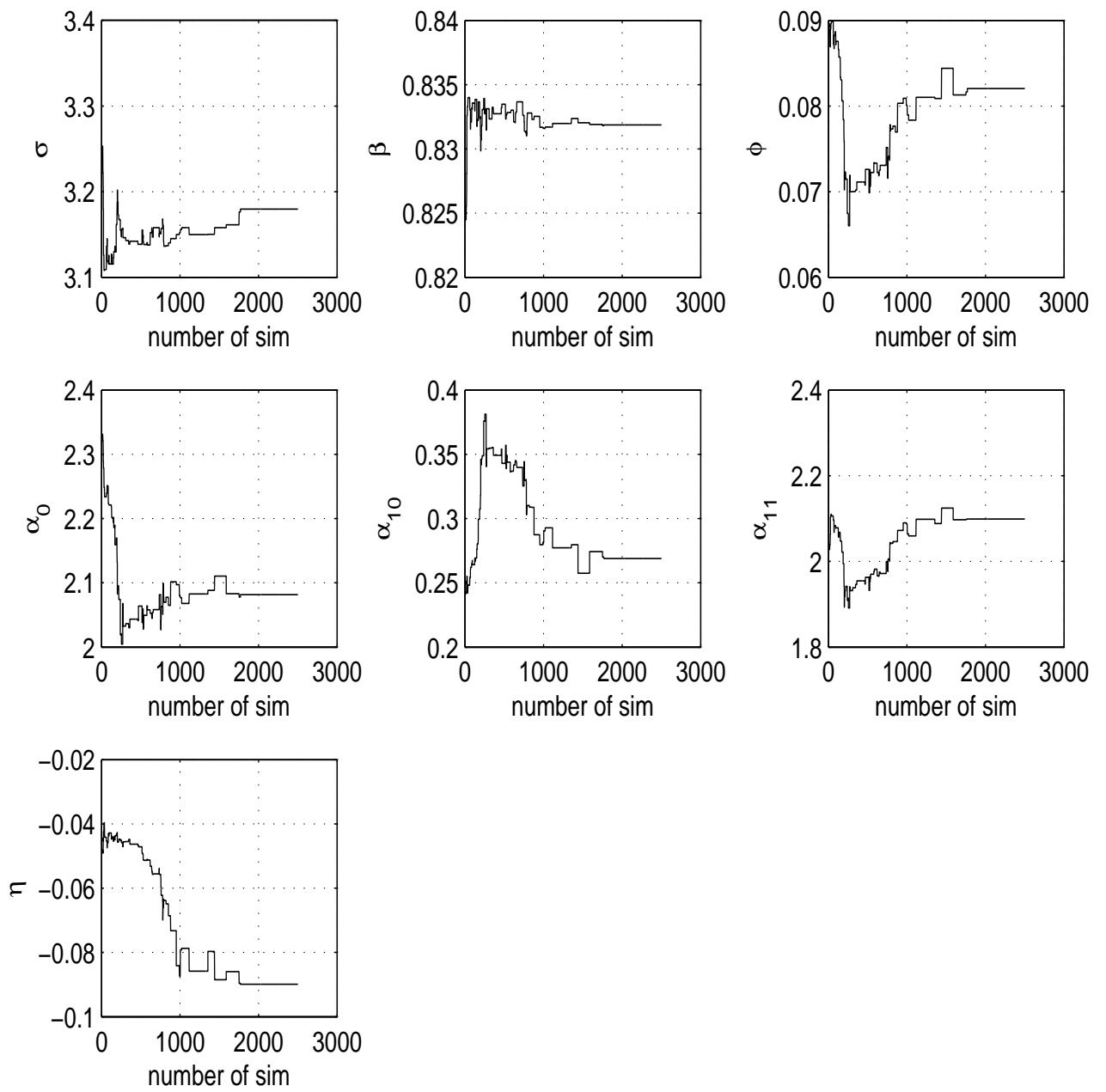
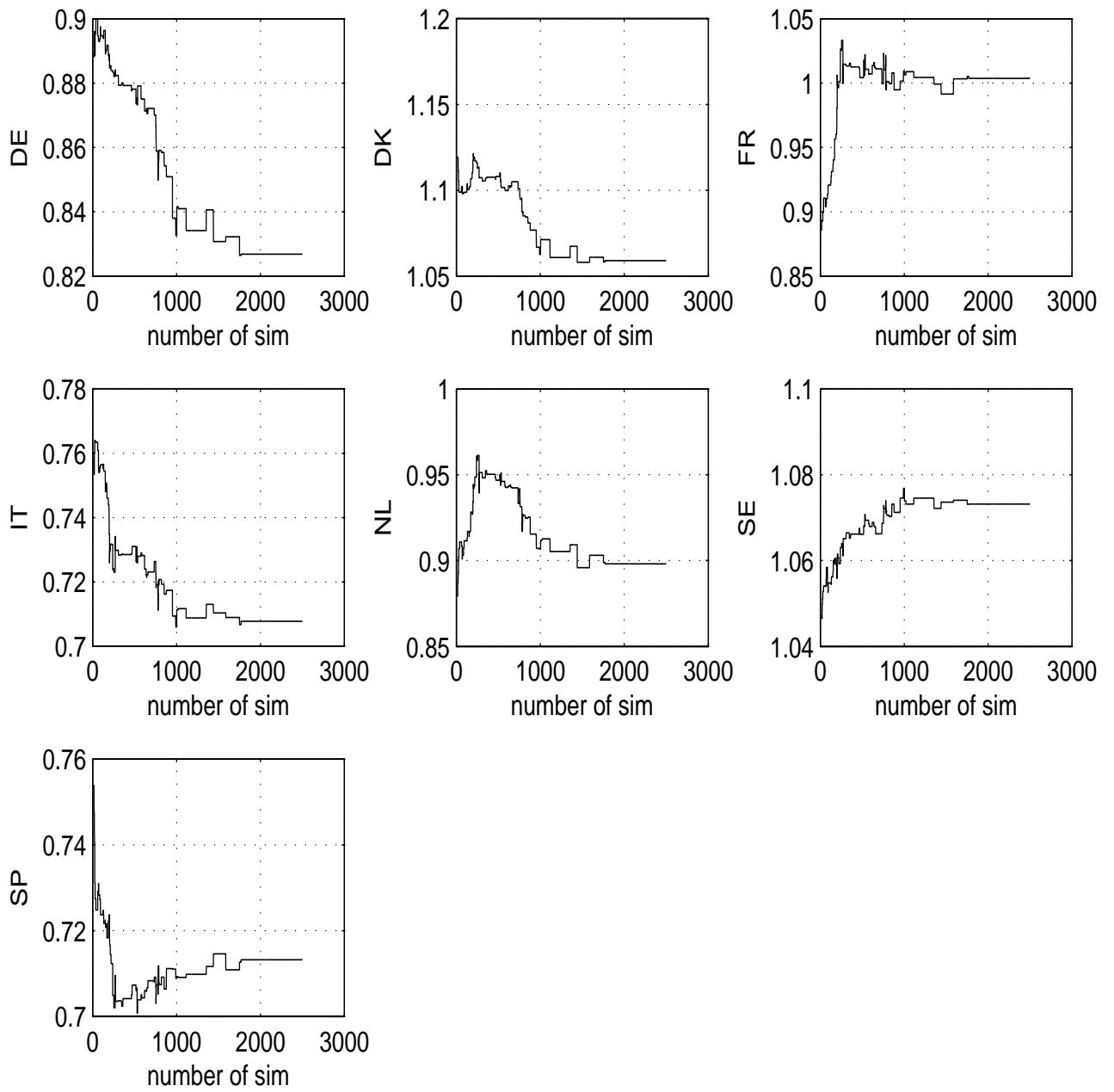Figure 3: Moments used in Estimation

Figure 4: MCMC: structural parameters
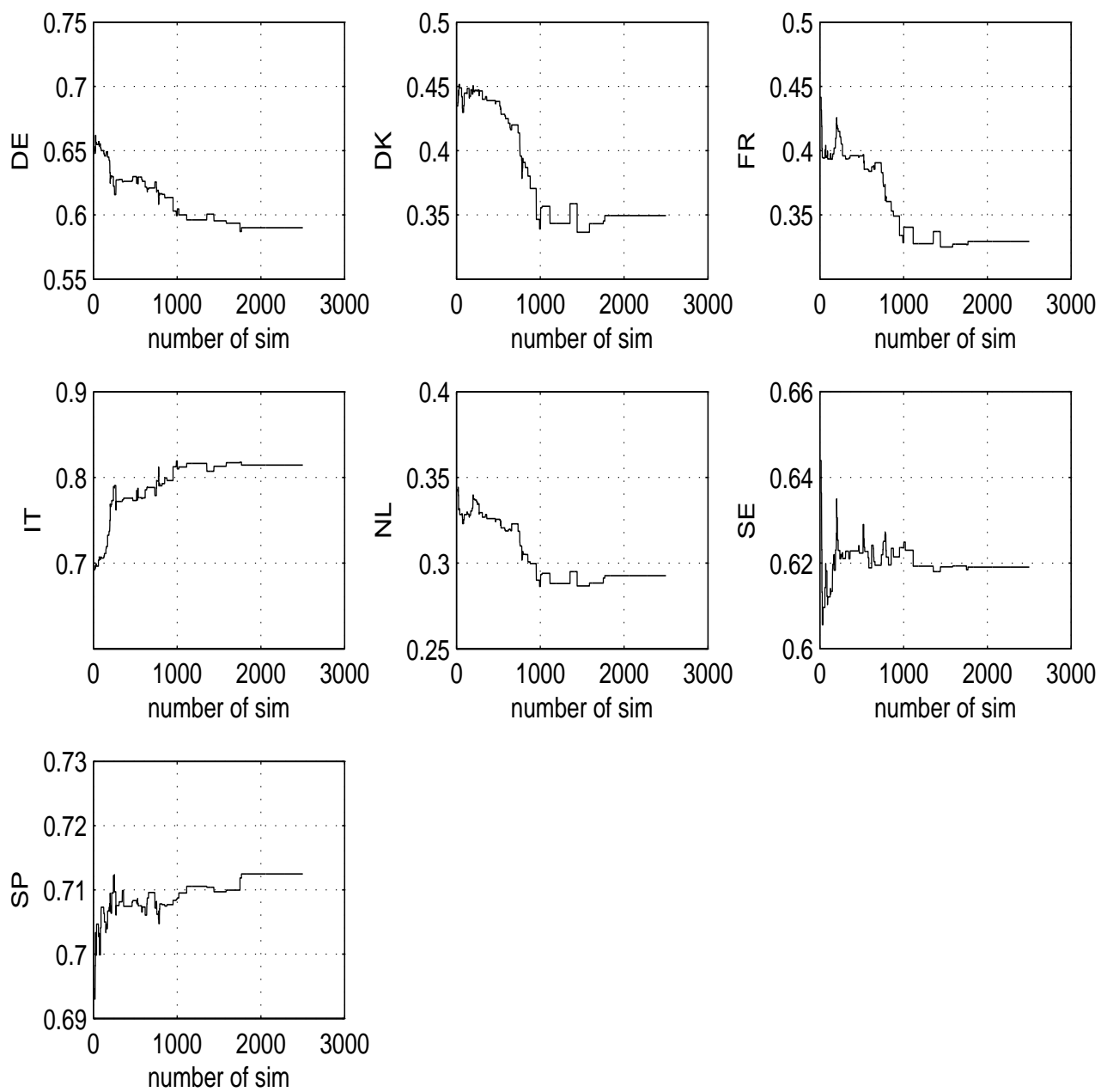
Figure 5: MCMC: efficiency wedges (A/A_{US})
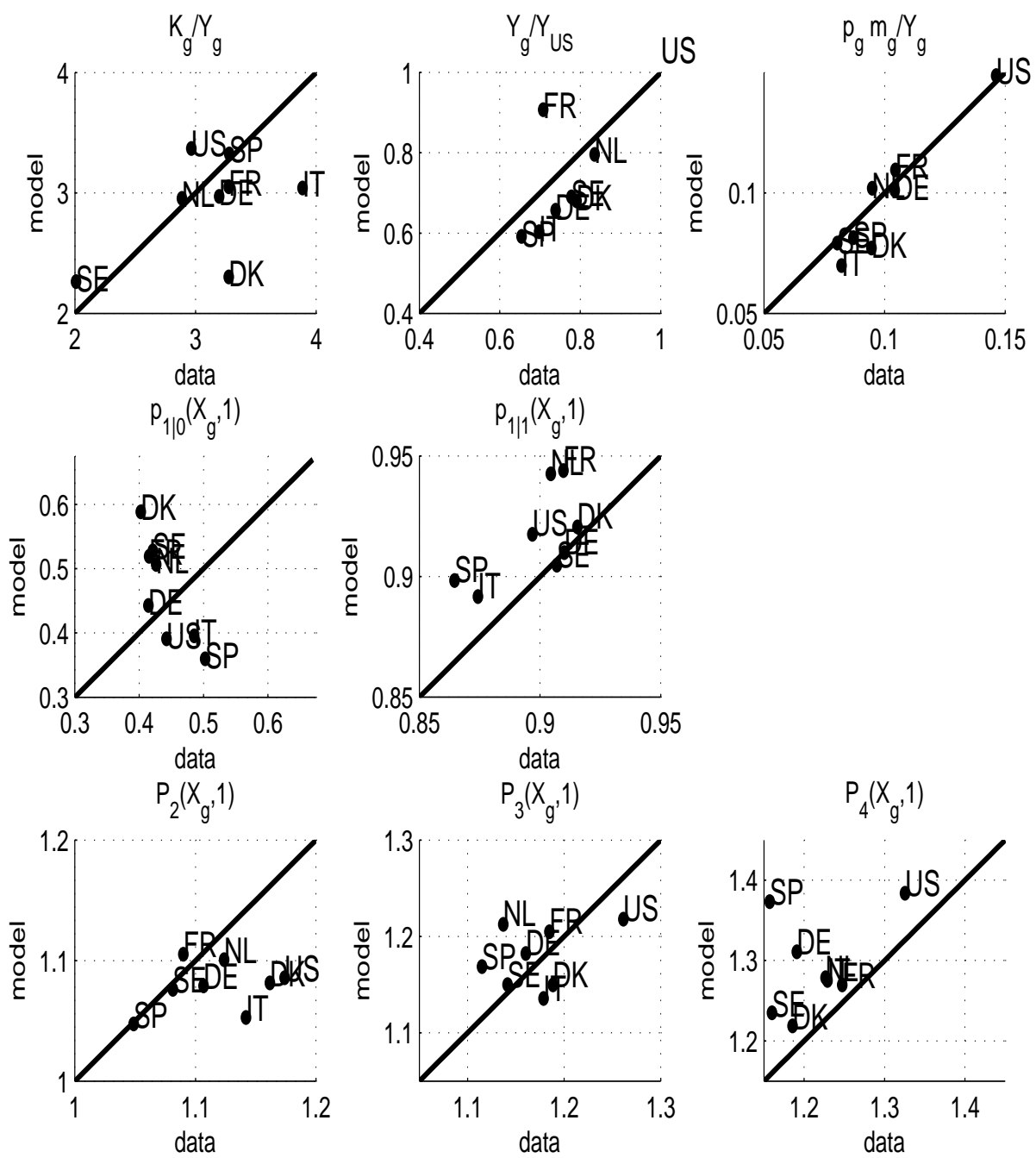
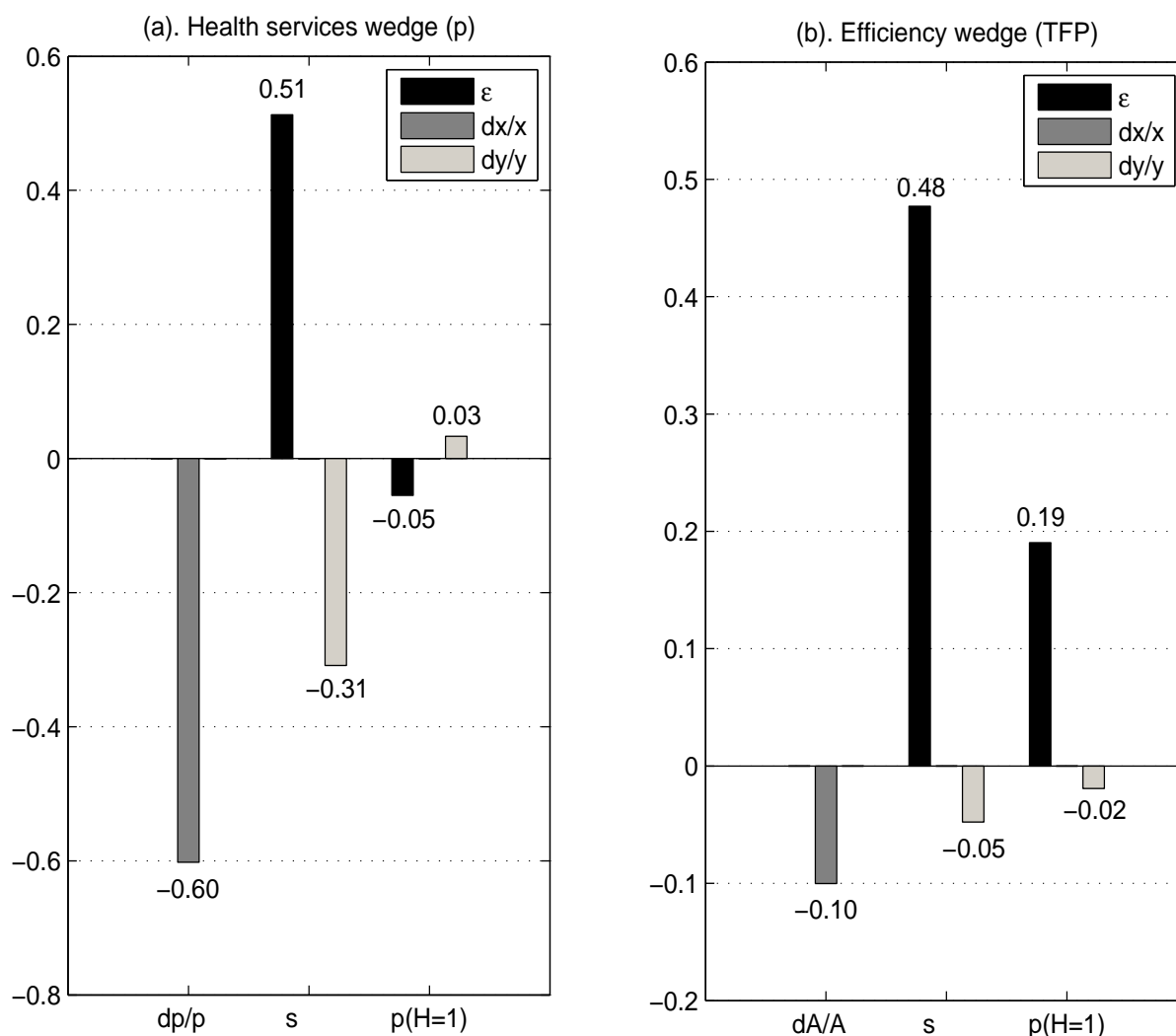Figure 6: MCMC: health services wedges (p/p_{US})

Figure 7: Model fit

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Figure 8: US economy with average European price of health (p) or TFP (A). Each counterfactual x is decomposed into elasticity ϵ, the ratio of change in exogenous variable dx/x and change in variable of interest dy/y with $y = s, p(H = 1)$. For instance, in panel (a), in the "heath services wedge" counterfactual, dx/x is the % change in price, ds/s % change in share of health expenditure. General equilibrium results.
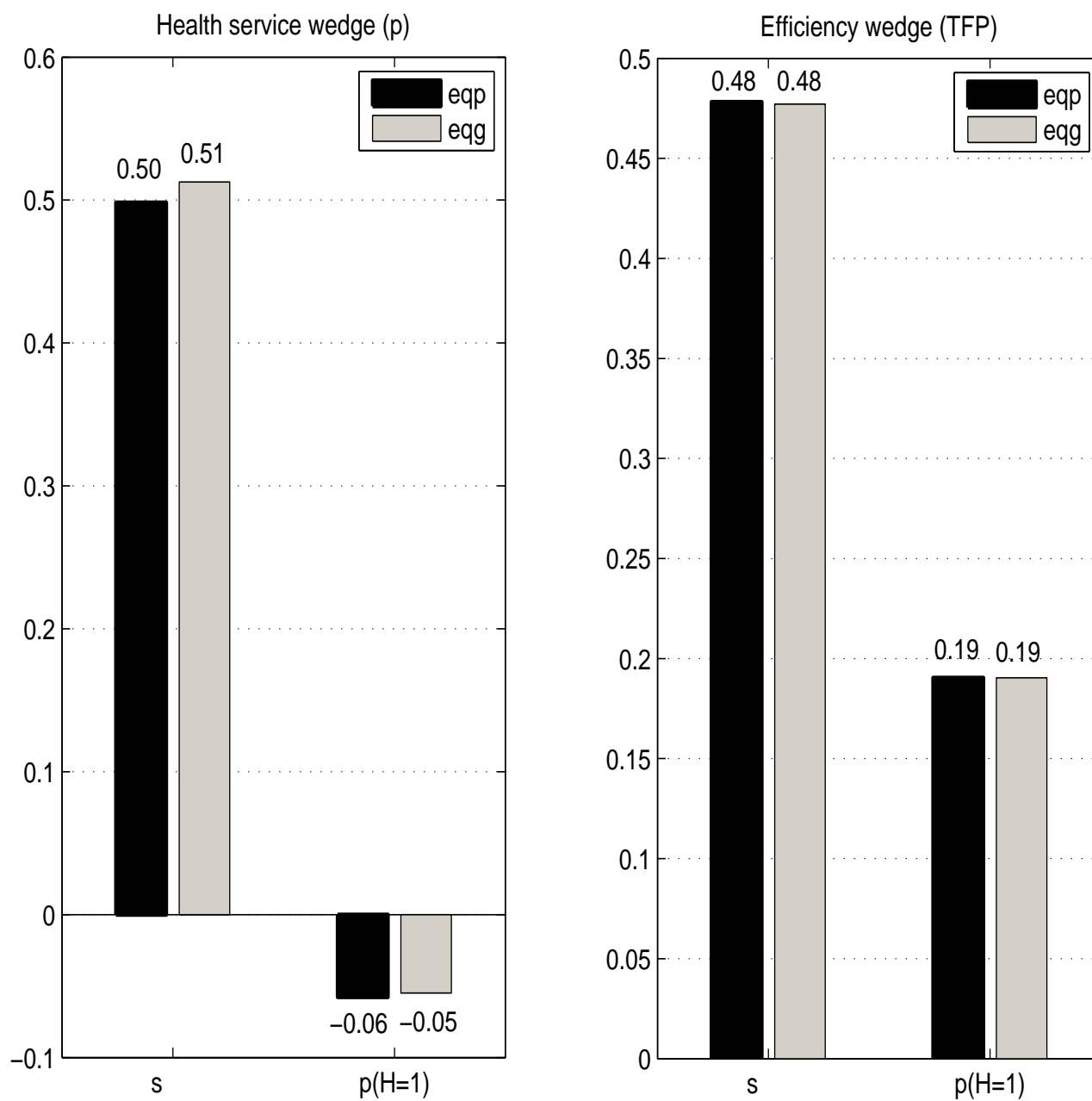
Figure 9: US economy with average European characteristics. Arc-elasticities - Partial vs. general equilibrium.

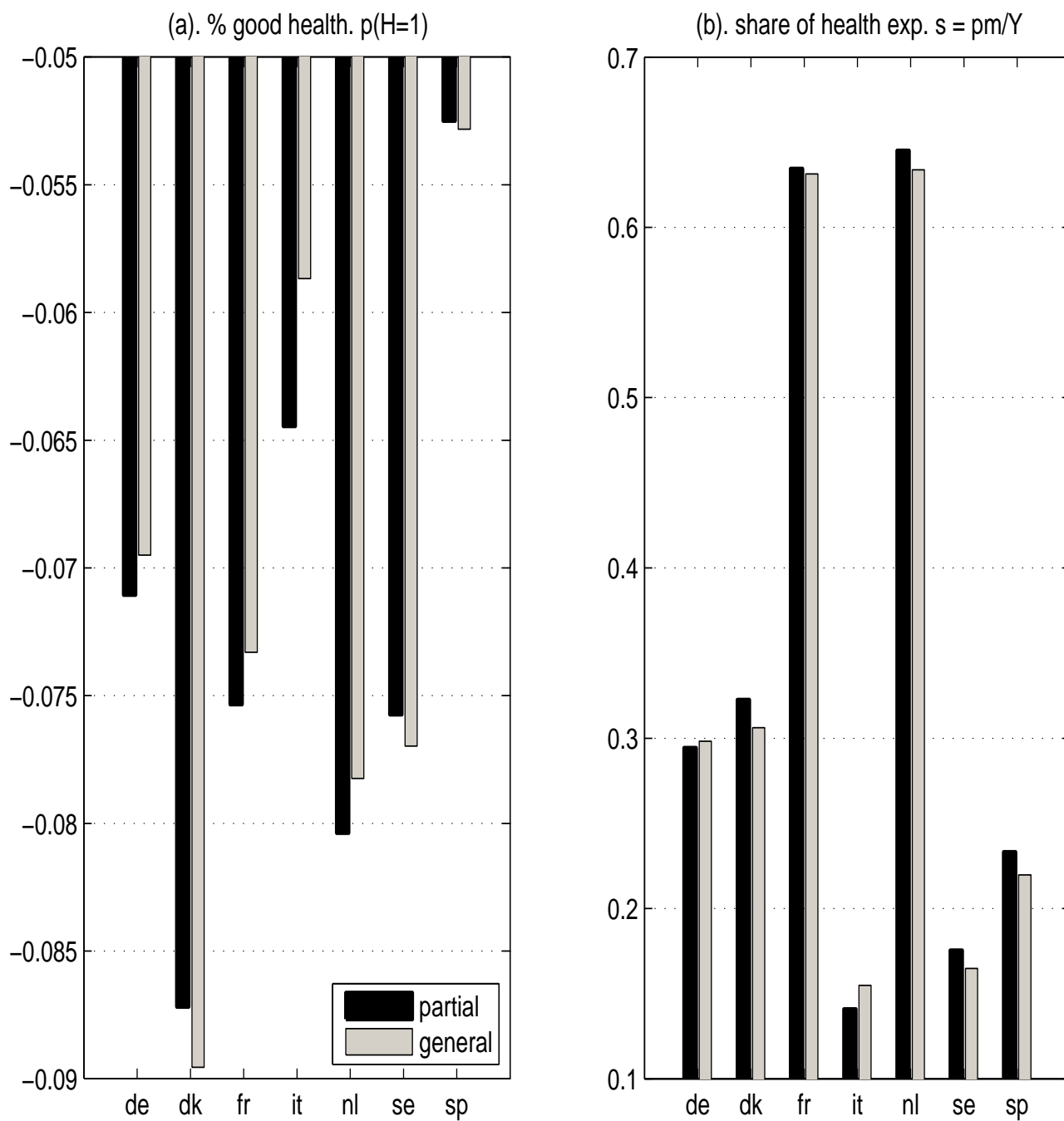Figure 10: European countries with US health price. Arc-elasticities - Partial vs. general equilibrium.
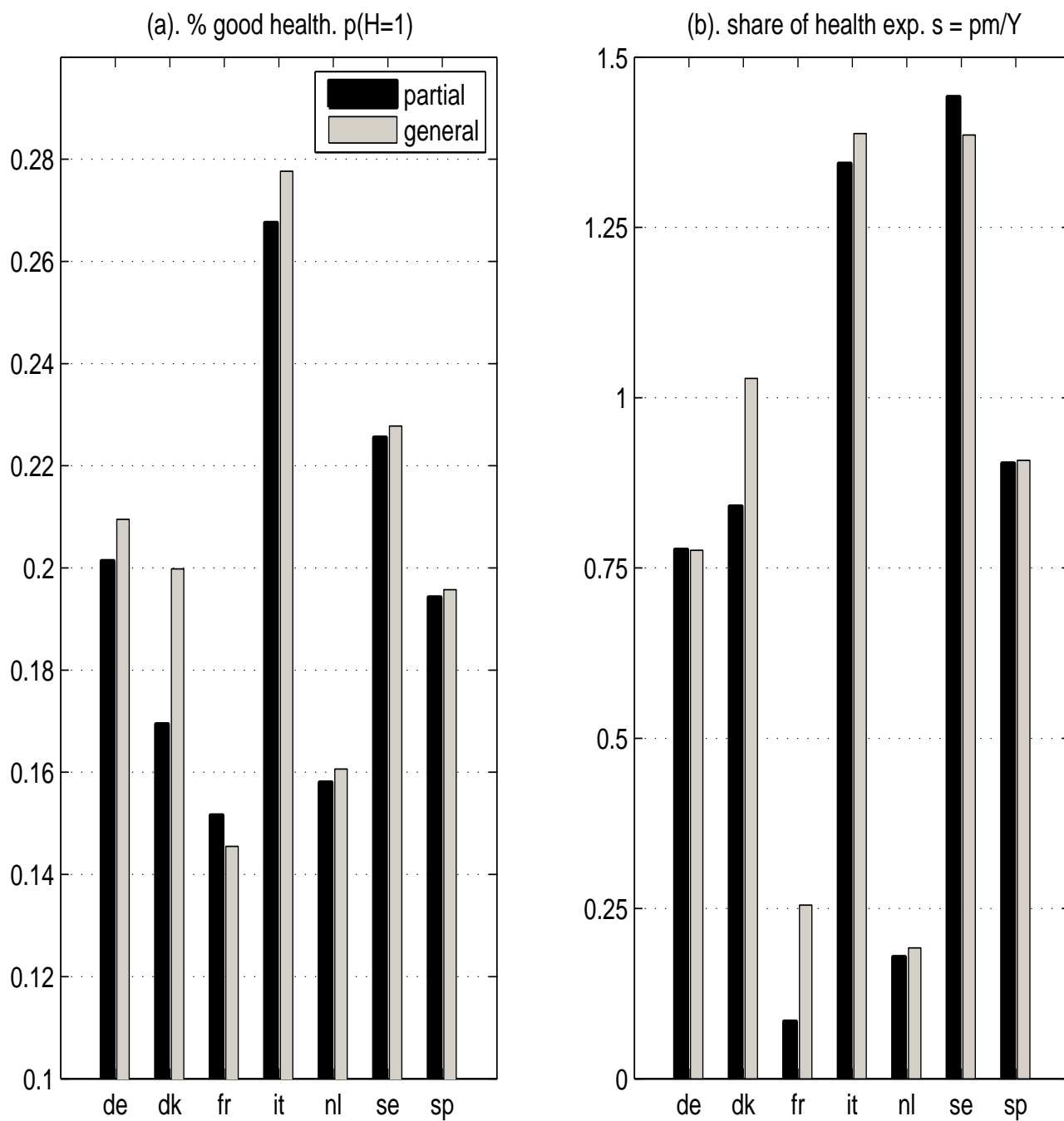
Figure 11: European countries with US TFP. Arc-elasticities - Partial vs. general equilibrium.
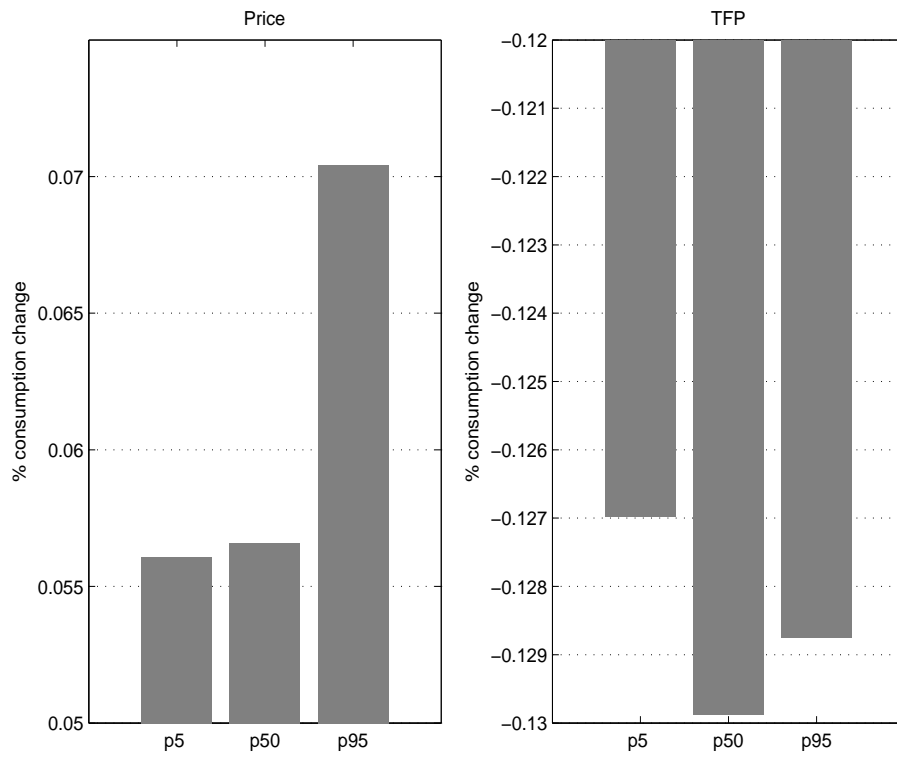
Figure 12: Welfare changes if the US economy were to switch to French values. % change in permanent consumption with respect to benchmark."p5" 5% percentile on labor earnings, "p50" median labor earnings, "p95" top 5% labor earnings.

Tables

	Diagnostics Angiogram	Drugs Gleevec (Cancer)	Scan Abdomen	Surgery Bypass surgery
US	914$ (1)	6,214$ (1)	750$ (1)	73,420$ (1)
DE	—	—	319$ (0.425)	—-
FR	264$ (0.288)	—	248$ (0.330)	22,344$ (0.304)
NL	—	3,321$ (0.534)	258$ (0.344)	14,061$ (0.191)
SP	125$ (0.136)	3,348$ (0.538)	161$ (0.214)	17,437$ (0.237)

Table 1: Comparison of Prices (IFHP, 2013)

	Prices for 30 most commonly prescribed drugs, 2006-07 (US set at 1.00)[a]			Primary care physician fee for office visits, 2008 [b][c]		Orthopedic physician fee for hip replacements, 2008 [b][c]	
	Brand name	Generic	Overall	Public payer	Private payer	Public payer	Private payer
FR	0.32	2.85	0.44	$32 (0.53)	$34 (0.25)	$674 (0.41)	$1,340 (0.33)
DE	0.43	3.99	0.76	$46 (0.76)	$104 (0.78)	$1,251 (0.76)	–
NL	0.39	1.96	0.45	–	–	–	–
US	1.00	1.00	1.00	$60 (1)	$133 (1)	$1,634 (1)	$3,996 (1)

[a] Source: Analysis by G. Anderson of IMS Health data.
[b] Adjusted for differences in cost of living.
[c] Source: M.J. Laugesen and S.A. Glied

Table 2: Drug Prices and Physician Fees: US vs. European Countries

	US	NL	DK	SE	FR	DE
$	18,142	13,244	11,112	9,870	5,2014	5,072
US=1	1	0.73	0.61	0.54	0.28	0.27

Source: OECD Health Data 2011

Table 3: Hospital Spending per Discharge (2009): US vs. European Countries

	Country							
	DE	DK	FR	IT	NL	SE	SP	US
ρ_e	0.9436	0.9182	0.9588	0.9433	0.9697	0.9182	0.9798	0.959
σ_e^2	0.0285	0.0150	0.0191	0.0303	0.0108	0.0150	0.0111	0.0396
σ_u^2	0.0967	0.0751	0.1143	0.0806	0.1192	0.0751	0.1364	0.1257
$\sigma_u^2 + \frac{\sigma_e^2}{1-\rho_e^2}$	0.3567	0.1707	0.3510	0.3556	0.3002	0.1707	0.4140	0.6187

Table 4: Estimates of Income Process

	Country							
	DE	DK	FR	IT	NL	SE	SP	US
α	0.373	0.338	0.373	0.456	0.383	0.353	0.348	0.358
δ	0.037	0.041	0.035	0.041	0.038	0.048	0.034	0.040

Table 5: Calibration

	Common Parameters		
Parameter	Estimates	Low CI (95%)	High CI (95%)
σ	3.158	3.115	3.179
β	0.832	0.831	0.833
ϕ	0.079	0.069	0.088
α_0	2.088	2.032	2.233
α_{10}	0.291	0.254	0.354
α_{11}	2.059	1.931	2.124
η	-0.073	-0.089	-0.043

Table 6: Estimated Parameters: preferences and health production function

	Country Specific Parameters					
	Efficiency wedges (A/A_{US})			Health service wedges (p/p_{US})		
	Est.	L. CI (95%)	L. CI (95%)	Est.	L. CI (95%)	H. CI (95%)
DE	0.848	0.826	0.894	0.606	0.590	0.652
DK	1.076	1.058	1.117	0.376	0.336	0.447
FR	0.997	0.910	1.015	0.352	0.324	0.414
IT	0.717	0.707	0.757	0.796	0.703	0.817
NL	0.913	0.895	0.951	0.302	0.286	0.336
SE	1.070	1.054	1.074	0.620	0.612	0.625
SP	0.711	0.703	0.727	0.709	0.703	0.712
US	1.000	1.000	1.000	1.000	1.000	1.000

Table 7: Estimated Parameters: wedges

	(a). Health services wedge $\frac{dp}{p}$								
		Share of health expenditures (s)				% of population in good health ($p(H=1)$)			
	$\frac{dp}{p}$	$\varepsilon|_{eqp}$	$\varepsilon|_{eqg}$	$\frac{ds}{s}|_{eqp}$	$\frac{ds}{s}|_{eqg}$	$\varepsilon|_{eqp}$	$\varepsilon|_{eqg}$	$\frac{dp(H=1)}{p(H=1)}|_{eqp}$	$\frac{dp(H=1)}{p(H=1)}|_{eqg}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DE	0.4610	0.2942	0.2982	0.1356	0.1374	-0.0710	-0.0694	-0.0327	-0.0320
DK	0.7302	0.3225	0.3061	0.2355	0.2235	-0.0871	-0.0895	-0.0636	-0.0653
FR	0.7583	0.6342	0.6313	0.4809	0.4787	-0.0753	-0.0733	-0.0571	-0.0555
IT	0.2387	0.1407	0.1548	0.0336	0.0369	-0.0644	-0.0586	-0.0153	-0.0140
NL	0.8168	0.6450	0.6337	0.5269	0.5177	-0.0803	-0.0782	-0.0656	-0.0639
SE	0.4447	0.1753	0.1647	0.0779	0.0732	-0.0757	-0.0769	-0.0336	-0.0342
SP	0.3405	0.2331	0.2197	0.0793	0.0748	-0.0524	-0.0528	-0.0178	-0.0179
	(b). Efficiency wedge $\frac{dA}{A}$								
		Share of health expenditures (s)				% of population in good health ($p(H=1)$)			
	$\frac{dA}{A}$	$\varepsilon|_{eqp}$	$\varepsilon|_{eqg}$	$\frac{ds}{s}|_{eqp}$	$\frac{ds}{s}|_{eqg}$	$\varepsilon|_{eqp}$	$\varepsilon|_{eqg}$	$\frac{dp(H=1)}{p(H=1)}|_{eqp}$	$\frac{dp(H=1)}{p(H=1)}|_{eqg}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DE	0.1776	0.2013	0.2095	0.0357	0.0372	0.7767	0.7759	0.1380	0.1378
DK	-0.0888	0.1694	0.1997	-0.0150	-0.0177	0.8402	1.0280	-0.0746	-0.0913
FR	0.0035	0.1515	0.1454	0.0005	0.0005	0.0840	0.2550	0.0002	0.0008
IT	0.3308	0.2675	0.2776	0.0884	0.0918	1.3434	1.3877	0.4444	0.4590
NL	0.1016	0.1579	0.1606	0.0160	0.0163	0.1785	0.1923	0.0181	0.0195
SE	-0.0818	0.2254	0.2277	-0.0184	-0.0186	1.4414	1.3855	-0.1179	-0.1133
SP	0.3378	0.1942	0.1957	0.0656	0.0661	0.9032	0.9080	0.3051	0.3067

Table 8: Europe with US price or TFP.

	Price	TFP
γ	0.0568	-0.1281
$\varepsilon_{\overline{c}|x}$	-0.0943	1.2783
$\frac{x_1-x_0}{(x_1+x_0)/2}$	-0.6019	-0.1002
$\Delta\tau$	-0.0466	-0.0127
$\Delta p(H=1)$	0.0277	-0.0156
$\Delta K/Y$	0.1490	0.0310
Δr	-0.0040	0

Table 9: Welfare gains ($\gamma > 0$)/losses ($\gamma < 0$) if the US were to switch to average European wedges