**Master Degree in Specialized Economic Analysis**

# Money for Nothing: What can basic income achieve?

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## ABSTRACT IN ENGLISH:

Extending an Aiyagari-Huggett style model to include health-related produc-tivity shocks with wealth-dependent probability of occurrence, this paper sets out to assess the implications of introducing a guaranteed minimum income and con-trasts the ensuing general equilibrium outcome with the one obtained by imple-menting a targeted subsidy policy instead (which represents the welfare systems seen in many European countries). The calibration of the model incorporates our empirical finding that individuals in households with debt are more likely to suffer from poor health and have lower productivity than individuals in house-holds without debt. Adding this feature changes the predictions of the standard model by creating an incentive for agents to accumulate just enough assets to secure themselves better health prospects. In this context, the minimum income is welfare improving, but creates more wealth inequality.

## ABSTRACT IN CATALAN:

L'extensió d'un model d'estil Aiyagari-Huggett per incloure els xocs de productivitat relacionats amb la salut amb probabilitat d'aparició de la riquesa, es proposa avaluar les implicacions d'introduir un ingrés mínim garantit i confirmar el conseqüent resultat de l'equilibri general amb el obtingut mitjançant la implementació d'una política de subvencions específiques (que representa els sistemes de benestar que es veuen en molts països europeus). La calibració del model incorpora la nostra constatació empírica que els individus en les famílies amb deute tenen més probabilitats de patir una mala salut i tenen una menor productivitat que els individus a les cases sense deutes. Si afegiu aquesta característica, es modifiquen les prediccions del model estàndard creant un incentiu perquè els agents acumulin només béns suficients per assegurar-se millors perspectives de salut. En aquest context, l'ingrés mínim és millorar el benestar, però crea més desigualtat de riquesa.

# Money for Nothing: What can basic income achieve?

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**Abstract**

Extending an Aiyagari-Huggett style model to include health-related productivity shocks with wealth-dependent probability of occurrence, this paper sets out to assess the implications of introducing a guaranteed minimum income and contrasts the ensuing general equilibrium outcome with the one obtained by implementing a targeted subsidy policy instead (which represents the welfare systems seen in many European countries). The calibration of the model incorporates our empirical finding that individuals in households with debt are more likely to suffer from poor health and have lower productivity than individuals in households without debt. Adding this feature changes the predictions of the standard model by creating an incentive for agents to accumulate just enough assets to secure themselves better health prospects. In this context, the minimum income is welfare improving, but creates more wealth inequality.

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## Introduction

We set out to assess whether implementing a universal income will bring welfare improvements and reduce wealth inequalities arising from health shocks. We test this using a Aiyagari-Huggett style model with heterogenous agents. The agents are subject to productivity shocks (designed to mimic the impacts of health events on productivity), and the probability of receiving a positive or negative shock will depend on their financial position. This reflects the channel from financial means to productivity via health which exacerbates existing inequalities.

Using this model, we test two social policies: a targeted social policy (which is a simple version of the welfare systems seen in many European countries) and a guaranteed minimum income. This allows us to compare the economic costs and benefits of each policy in a simple theoretical setting.

A recent OECD report into health in Europe finds that per year chronic diseases such as heart attacks, strokes, diabetes and cancer, detract approximately 0.8 per cent of GDP from European countries, and this figure does not include the effects of lower employment rates and decreased productivity of people living with chronic health problems. The report identifies a need to reduce inequalities of access and quality of healthcare, and notes that there remains large gaps in life expectancies within countries, on the basis of education and income. In fact, 'poor people were ten times more likely to report unmet medical needs for financial reasons than rich people on average across EU countries' (OECD/EU, 2016, p. 10). This report also finds that poor health is associated with adverse labour market outcomes including employment status, productivity measures such as absence from work due to sickness and wages, and early exit from work.

One option for improving health outcomes for individuals could be the introduction of a guaranteed minimum income (or basic income, universal income etc.), which could allow individuals (and especially individuals in lower income households) to take preventative measures against adverse health shocks, or reduce their severity should they occur. It could also enable individuals to improve their health through lifestyle changes or proactive treatment of existing conditions. There are two interesting experiments (both in North America) that give an indication of how guaranteed basic income can impact on the health of recipients.

The first, in the 1970s, was in a small town named Dauphin in the Canadian province of Manitoba. All families in the town were eligible to participate, and those with no other source of income were given 60 per cent of Statistics Canada's Low Income Cut-

Off (LICO). This benefit was phased out at a 50 per cent rate for any income earned (i.e., every additional dollar earned reduced benefits by 50 cents). This had a big impact on the resources available to families who did not qualify for traditional forms of welfare, particularly the working poor, the elderly and single, employable males. Many families in the region relied on income from self-employment in agriculture, so the basic income reduced income insecurity and vulnerability to sudden illness, disability or adverse economic events. Within the period of this policy, there was a notable decline in mental health-related cases, as well as accident and injury-related hospital admissions. It is interesting to note that before the trail of a minimum income policy, universal health insurance was also introduced in Canada. However, when the experiment ended due to lack of funds, the apparent benefits on the residents' health appeared to end with it (Forget, 2011).

The second experiment, in the 1990s, was in North Carolina. A large casino was built on Cherokee Indian land, and a percentage of the profits from this casino was paid out to each resident of the community every six months (around $4,000 a year). The results showed that individuals who received this additional income had less depression, anxiety and alcohol dependence, and better overall health and fewer economic problems. Furthermore, there was no evidence that people worked fewer hours as a result of receiving the additional income (Costello, 2016).

A guaranteed minimum income has not yet been implemented in Europe. In a 2016 referendum Swiss voters overwhelmingly rejected a proposed basic income scheme. Critics warned of sky-high costs and people quitting their jobs in droves (France-Presse, 2016). However, Finland has recently launched a trial programme to pay unemployed citizens an unconditional monthly income. The payments of €560 replace existing social benefits and will continue to be paid even if the recipient finds a job (Henley, 2017). On a smaller scale, the local government of Utrecht in the Netherlands is planing to give 250 citizens currently receiving government benefits a flat €960 per month minimum income. They will compare outcomes for this group to people who continue receiving normal social benefits, and hope to test the impact of minimum income on the behaviour of recipients (Hamilton, 2016).

The remainder of the paper proceeds as follows. Section 1 discusses the concepts of basic income and inequality. Section 2 lays out the basic incomplete markets model including our extensions to it, while Section 3 describes how this model is calibrated. Section 4 introduces the implementation of our taxation and social policies. Section 5 presents the results of our extended model compared to the standard specification, as well as its predictions under minimum income and needs based social welfare policies, reporting changes in indicators like the Gini coefficient and welfare across the different scenarios as a basis for determining which of the two policies produces the better outcome. Section 6 concludes.

# 1 Literature review

The idea of switching to a welfare system based on guaranteed basic income has become more popular and more widely discussed over the past few years. Basic income proposals have recently been debated in publications such as the *Wall Street Journal* and *The Economist* and by well regarded research institutions such as the OECD and the Brookings Institute.[1]

This increased interest in basic income is partially due to the prolonged recessions in many OECD countries following the 2008 Financial Crisis, which have lead to job losses and rising unemployment rates as well as slowing income growth for those who are employed. Furthermore, as governments and institutions look to the future, they are aware that digital technology and automation may lead to a permanent decrease in labour demand, and could permanently sever the relationship between economic growth and employment. If this does occur, there may be no policy levers available to the government to increase employment and reduce reliance on unemployment benefits (Arthur, 2016).

Most OECD countries currently provide a combination of targeted and means tested welfare payments, tax credits and unemployment insurance. These are generally contingent on economic participation - working, looking for work or providing unpaid work (such as providing care for a relative). Guaranteed basic income however would be a regular transfer that is paid to all adult citizens of a country without conditionality, means testing or unemployment requirements (Van Parijs, 2004).

The argument generally made for replacing contingent welfare with basic income is threefold: it provides a social safety net to all adult citizens (and, by extension, their children and dependants), it gives people autonomy in how they choose to spend the money, and it reduces red tape and streamlines the social payments bureaucracy (Dervis, 2017). However, as a policy basic income remains politically unpopular, due to its high costs and concerns about the possibility of removing the incentive to work. There is also the political reality that some voters will resent the idea of paying higher taxes to support able-bodied citizens who choose not to work (Arthur, 2016).

We wish to focus on the potential health benefits of basic income - by providing

[1] See for example OECD (2017), Ip (2016), Economist (2016) and Dervis (2017).

individuals with income security and financial reserves, they can choose to invest in, for example, lifestyle improvements and education, but can also use this money to deal with negative shocks such as adverse health events. We want to assess whether basic income policies may have macroeconomic benefits through this health channel by increasing the productivity of workers and thereby reducing inequality in a society.

This theory will be tested in an Aiyagari-Hugget style model. This class of models was introduced by Bewley (1986) and was further developed by Huggett (1993) for the case of an asset in zero net supply. Aiyagari (1994)) adds an aggregate production function in this framework, where the capital input factor is the aggregate amount of risk-free assets accumulated by individuals. We will extend this version by specifying the likelihood of receiving favourable health-related productivity shocks as being dependent on agents' wealth level. To the best of our knowledge, imposing this type of relationship has not yet been explored in the literature, although there have been some similar experiments carried out.

For example, Matsuyama (2004) investigates the effects of the international financial market on inequality between nations by implementing wealth-dependent borrowing constraints in a standard neoclassical overlapping generations model. In a cohort of otherwise identical countries, those with low capital stock are restricted by borrowing constraints, whereas for rich countries, these constraints are not binding. This leads to 'poverty traps' and polarisation between rich and poor countries.

Another example is Livshits et al. (2007), who incorporate idiosyncratic uncertainty about households' net asset holdings and labour income into a life-cycle model with incomplete markets. They use this to test the impact of two bankruptcy policies: the US policy of allowing for a 'fresh start' whereby household are forgiven their debt, and the European policy of lifelong liability for debt. Their model generates interest rates that differ across types of agents and are endogenous to each agents debt level.

# 2 The incomplete markets model

## 2.1 The consumer's problem: Idiosyncratic health-related productivity shocks with wealth-dependent frequency of occurence

The model developed in this paper follows the lines of an Aiyagari (1994) style model, so the agents face uncertainty regarding the income they receive (in our case, health-related productivity shocks) and can only partially insure against unfavourable shocks by accumulating assets (with a risk-free, non-state contingent rate of return). There is a precautionary reason for saving: the agents try to avoid the situation of adjusting consumption downwards by using the stock of assets as a buffer: whenever they face negative shocks, they deplete assets in order to smooth consumption. Financially-constrained agents are those that have no other alternative than to decrease consumption when detrimental shocks are realized.

The Bellman's equation that summarizes the infinite-horizon problem faced by the individual is:

$$V(a,l) = \underset{(c,a')\in\Gamma(a,l)}{\text{Max}} \Big\{ u(c) + \beta E^{Good} V(a',l') I_{\{a \geq a^{threshold}\}} + \beta E^{Bad} V(a',l')(1 - I_{\{a \geq a^{threshold}\}}) \Big\} \tag{1}$$

where:

$$\Gamma(a,l) = \Big\{ (c,a') \in \mathbb{R}_+ \times [\underline{b}, \bar{a}] : c + a' \leq w \cdot l + a \cdot (1+r), \underline{b} < 0, \bar{a} > 0 \Big\} \tag{2}$$

$V(a,l)$ is the optimal value function for the individual owning the asset level $a$ and being faced with the productivity shock $l$; these represent the state variables, the endogenous and the exogenous one, respectively. $\beta$ is the discount factor and $I_{\{a>a^{threshold}\}}$ is an indicator function taking the value of 1 if the capital level is above the specified threshold $a^{threshold}$, which we set to zero, the same for all agents.[2] $\Gamma(a,l)$ is the choice correspondence at the current level of capital $a$ and health-related productivity shock $l$: taking these into account, the agent has to choose how much to consume and what level of assets to hold for the next period. Borrowing is allowed up to a certain amount $\underline{b}$ and $\bar{a}$ is the maximum asset holding in the economy. The decision rules for consumption and asset holdings, respectively, are given by:

$$c = g^c(a,l) \tag{3}$$

$$a' = g^a(a,l) \tag{4}$$

Labour is not a choice variable for the agent and is exogenous at the individual level, as if it is supplied inelastically by each individual. Nonetheless, by being on one side or the other of the capital threshold, the agent can expect different frequencies of occurrence of health-related productivity shocks.

The health-related productivity shock $l$ is discretised by allowing three states $l^{low}$, $l^{medium}$ and $l^{high}$, corresponding to a low, medium and high health status respectively.

[2]This calibration aims to differentiate between indebted and debt-free individuals, and is further discussed in Section 3.

The expected realization of these shocks for individuals below the threshold capital level ($E^{Bad}(l)$) is different from that of individuals above it ($E^{Good}(l)$).

The existence of a positive relationship between income and health has been well documented in the literature. However, because health status can affect income and income can affect health status, it is often difficult to disentangle the direction of causality in this relationship. We focus on the impact of debt on health, and subsequently the impact of health on productivity as the motivators for our modifications to the standard incomplete markets model.

With regards to the former, the Absolute Income Hypothesis, which postulates a positive and concave relationship between income and health (Preston, 1975), has been studied by various authors, including Adeline and Delattre (2017). They utilise the fifth wave[3] of the Survey of Health, Ageing, and Retirement in Europe (SHARE) to conclude that income has a positive and concave effect on self-perceived health status. Furthermore, they find evidence that also confirm the weak version of the Income Inequality Hypothesis,[4] i.e., people at the bottom of the income distribution are more likely to experience bad health shocks. Adapting this, we test whether there is a negative impact on health for individuals in households in a net debt position, and use these results to calibrate the probability transition matrices that govern the idiosyncratic shocks in our model.

With regards to the latter, Smith (2004) looks at the impact of exogenous health events on labour supply, and finds that the onset of a new severe health shock has the immediate and large impact of reducing an individual's probability of working. We note that this paper uses the US Health and Retirement Survey (which is harmonised with the European SHARE). There are significant differences between the health systems in the United State and Europe. The US health system is private, with individuals funding their health expenses out of pocket or through insurance policies. In contrast, many European countries have public health systems or public insurance schemes. We will therefore test whether a similar health-productivity relation holds when using the SHARE data set; the results will substantiate the manner in which the productivity levels across different health states are calibrated in our model.

By incorporating the positive and concave relationship between wealth and the likelihood of receiving positive health shocks, our specification is able to include an additional mechanism to explain the saving behaviour in an incomplete markets model: a low net wealth individual has more incentive to save, in order to escape from the

[3] A pooled version of the data is used for robustness checks, and found to give similar results.

[4] The strong version holds that inequality in itself is equally damaging for the health of all members of society.

disadvantageous expected distribution of health shocks, whereas a relatively higher net wealth individual, when hit by a bad idiosyncratic shock, would not necessarily deplete assets if that would mean ending up with a significantly worse distribution of shocks in the future.[5]

In practice, this is done by specifying as a function of assets the transition probability matrix associated to the Markov process followed by the health-related productivity shock. More specifically, our model features a discrete approximation of this relation, differentiating between the expected idiosyncratic shocks faced by indebted versus positive net wealth consumers. As it is also argued in Section 3, a net wealth level of zero seems a natural choice for this analysis, although one can also think about a continuous dependence between these two variables. For the particular data set used in this paper, this formalisation seems to do a satisfactory job. Specifying a more parsimonious functional form is left for future research. The extension of the classical Aiyagari (1994) model along these lines (i.e., identifying a relationship between the distribution of idiosyncratic shocks faced by agents and other modelled individual characteristics) can be useful in many other applications, aside from the connection between health and wealth (e.g., instead of individuals, countries of a currency union experiencing different exposures to shocks that affect the national income, function of their debt relative to a threshold).

The individual takes the wage $w$ and return on assets $r$ as given. These will result from a general equilibrium framework. In particular, from the first order conditions (FOC) of a profit-maximising representative firm with a neoclassical production function, after imposing the market clearing condition for capital and labour. In this sense, the individual asset holdings depend on the aggregate level of capital.

The agent's problem is solved numerically by value function iterations. This requires specifying a grid for capital and maximizing the value function over all the possible combinations of current period capital, next period capital and health-related productivity shocks. Our problem is further complicated by the need to take into account two separate transition probabilities depending on the position of the current level of capital relative to the specified threshold. This procedure is repeated until convergence is achieved.

[5]This result is specific to this setting, where the positive effect of wealth on productivity kicks in at low levels of wealth (consistent with the concave relation assumed between the two), providing an extra motive for poor people to save; if this effect were to become manifest at a higher level of wealth, polarization would emerge, as individuals exactly below that level will struggle to save more, whereas the saving behaviour of poor consumers, which are bundled at the bottom end of the wealth distribution, will not be influenced.

## 2.2 The firm's problem

There is a representative firm in perfectly competitive goods, capital and labour markets (i.e., the firm is a price-taker). The firm maximises profits (sales less the cost of production, equation 5) and has access to a constant returns to scale technology (equation 6 specifies a Cobb-Douglas production function):

$$\underset{(L,K)}{\text{Max}}\Big\{Y - w \cdot L - (r+\delta)\cdot K\Big\} \tag{5}$$

subject to:

$$Y = K^{\alpha} \cdot L^{1-\alpha} \tag{6}$$

The FOC take the following form:

$$r = \alpha\left(\frac{K}{L}\right)^{\alpha-1} - \delta \tag{7}$$

$$w = (1-\alpha)\left(\frac{K}{L}\right)^{\alpha} \tag{8}$$

The return on assets (i.e., the interest rate) is given by the marginal productivity of capital (equation 7), net of the depreciation rate $\delta$. This equation already implies no arbitrage between capital and borrowing or lending. Wage is the marginal productivity of labour (equation 8).

## 2.3 The stationary recursive competitive equilibrium

Let $S$ represent the state space, i.e., the Cartesian product $[\underline{b}, \bar{a}] \times \{l^{low}, l^{medium}, l^{high}\}$. The stationary recursive competitive equilibrium is given by the value function $V(a,l) : S \to \mathbb{R}$, the policy functions for the household $g^a : S \to [\underline{b}, \bar{a}]$ and $g^c : S \to \mathbb{R}$, firm's choices $L$ and $K$, prices $r$ and $w$ and the stationary cross-sectional distribution of agents over the state space that associates an invariant probability $p^*_{a,l}$ for each pair $(a,l) \in S$ and $\sum_S p^*_{a,l} = 1$. These must satisfy the following (Ljungqvist and Sargent, 2004):

- given prices $r$ and $w$, the policy functions $g^k$ and $g^c$ solve the agent's problem (equation 1) and $V(a,l)$ is the corresponding value function;

- given prices, the capital $K$ and labour $L$ represent the solutions of the optimising firm (equations 7 and 8);

- the labour market clears:

$$L = \sum_S p^*_{a,l} \cdot l \tag{9}$$

- the asset market clears (the capital demanded by the producer ($K$)is equal to the aggregate level of assets accumulated by the consumers):

$$K = \sum_S p^*_{a,l} \cdot g^a(a,l) \tag{10}$$

Equation 9 is important in our model (as opposed to standard models of this type, where there is no aggregate uncertainty and aggregate labour is exogenous) because individual choices will lead to an endogenous capital distribution that will imply a particular distribution of health-related productivity shocks (interpreted as efficient units of labour). The aggregate level of labour $L(p)$ is, therefore, endogenous, depending on the proportion of agents that accumulate assets above $a^{threshold}$, and can vary over time (this last property is redundant in a stationary equilibrium).

The steady state equilibrium is computed using the bisection method, i.e., after providing an initial guess for the interest rate, the corresponding competitive wage is calculated using the capital to labour ratio from the firm's problem; following that, the algorithm proceeds by computing the optimal decision rules for the individuals given these prices (calculated using dynamic programming, as specified in Subsection 2.1). The ensuing invariant distribution of capital[6] $p^*(a^{threshold})$ is used to obtain the aggregate level of capital (which, in our case, is the same as per capita level of capital due to the assumption that there is a continuum of economic agents of unit mass). If this is consistent with the initial guess (i.e., if the initial guess for the interest rate is equal to the marginal productivity of the aggregate capital level, taking also into account the change in the aggregate level of efficient units of labour), the algorithm stops. If not, it computes the arithmetic average between the initial guess and the newly found interest rate and repeats all the previous steps for this value. Finally, the resulting interest rate has to be smaller than the discount rate embedded in the discount factor, or else the capital stock goes to infinity.

[6]Computed by assuming that each agent can be in one of the states defined by the capital grid. The conditions for the existence of the stationary distribution are mentioned in the appendix of Huggett (1993)

# 3 Model calibration

## 3.1 Data

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a biennial survey producing multi-national panel data on the health, wealth and income of more than 100,000 individuals aged 50 or over in many European countries and Israel. As explained by Börsch-Supan et al. (2013), survey participation rates fell in the aftermath of the Global Financial Crisis, so we are therefore going to focus on the sixth wave (2014-2015) rather than use the pooled database.

In this paper, all data used are from the sixth wave of the SHARE survey.[7] This wave includes responses from 68,231 individuals from 17 European countries and Israel.

A key variable of interest is health, for which we use the qualitative proxy self-perceived health status. In the survey, individuals are asked to describe their health as 'poor', 'fair', 'good', 'very good' or 'excellent'. In our model, we have three possible states of health, which we have defined as low health ('poor' or 'fair'), medium health ('good') or high health ('very good' or 'excellent'). The distribution of these states is shown in Table 1.

Table 1: Health distribution

| Health | Freq. | Percent |
|---|---|---|
| High | 84,408 | 24.7 |
| Medium | 121,345 | 35.6 |
| Low | 135,402 | 39.7 |

Although many papers investigate the link between income and health, what we are interested in is the 'means' available to individuals should they be hit by a negative health shock. The 'stock' measure of this is net household worth, which indicates the pool of resources or assets available to all members of the household which could be drawn on in the instance of an adverse health shock. We define a household that is

[7]This paper uses data from SHARE Wave 6 (DOI: 10.6103/SHARE.w6.600), see Börsch-Supan et al. (2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N°211909, SHARE-LEAP: N°227822, SHARE M4: N°261982). Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Ageing (U01-AG09740-13S2, P01-AG005842, P01-AG08291, P30-AG12815, R21-AG025169, Y1-AG-4553-01, IAG-BSR06-11, OGHA-04-064, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

in 'debt' as one with negative net household wealth. A 'flow' measure of this is total household income, which is reported as a monthly figure.

The distribution of household net worth (Figure 1) shows that most individuals are bunched close to the median, and there are long tails, with an especially long right-hand tail. We have chosen to trim the top percentile from this data, so that the maximum household net worth in our sample is €2.13 million. Total household income (Figure 2) has a similar distribution, although it is obviously zero-bounded while net worth is not. We did not trim income, but it is logged for the regressions.

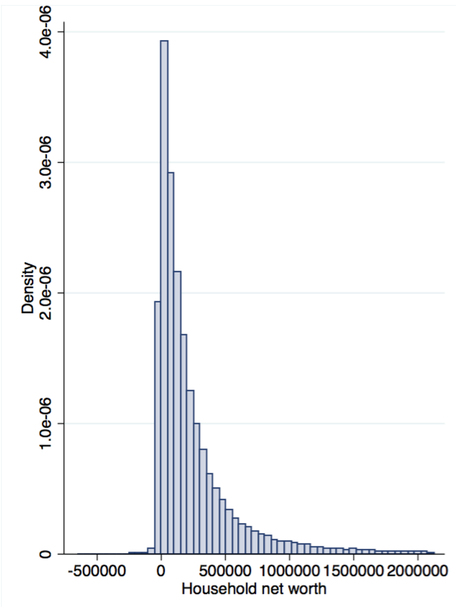



Figure 1: Wealth distribution

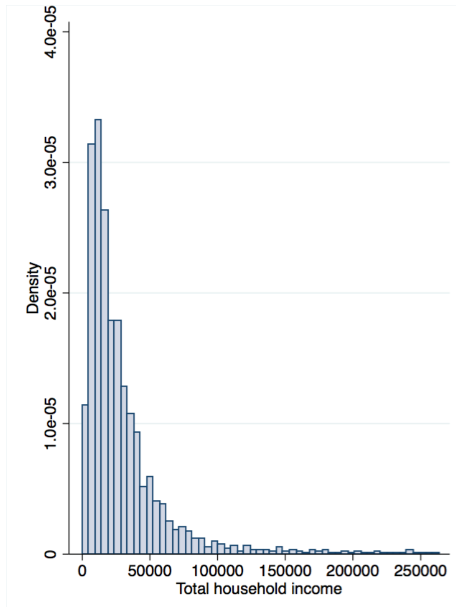



Figure 2: Income distribution

Finally, we are also interested in the productivity of individuals. Productivity is notoriously hard to measure, and is normally a residual statistic rather than an observed one. We therefore use total labour income (employed and self-employed) as a proxy for productivity.

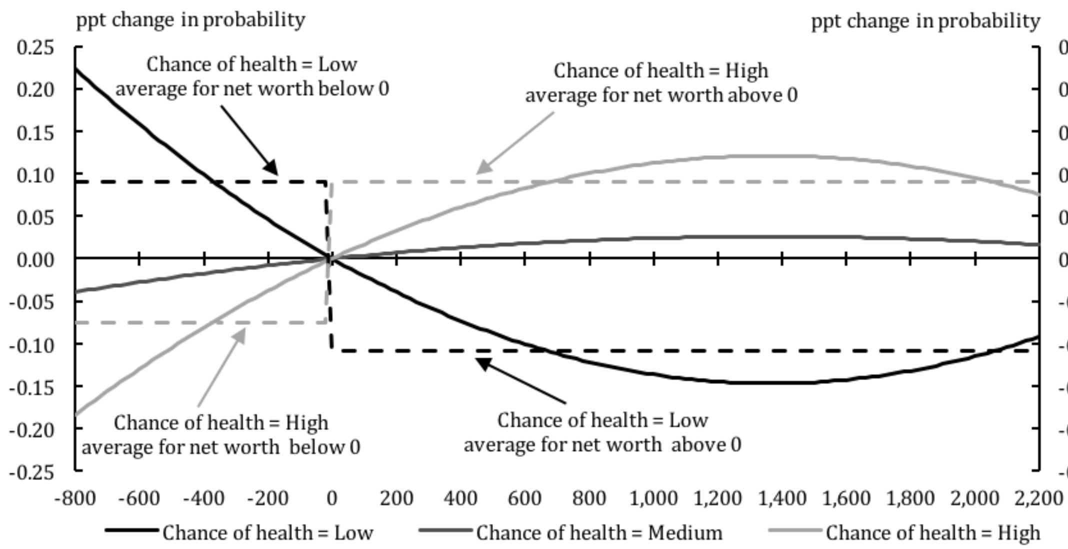
## 3.2 Empirical analysis

To test the Absolute Income Hypothesis using household net worth we estimate an ordered probit model with self-perceived health status as the dependent variable.

This model controls for age, years of education, gender, relationship status, employment status and country (results are shown in the first column of Table A1, Appendix A). The coefficients on household net worth and its square confirm the positive and concave relationship between asset levels and health.

This is extended by computing the marginal effects within our ordered probit model (see Table A2 in Appendix A). These marginal effects are graphically depicted in Figure 3, and show that an individual living in a household with higher assets enjoys a higher probability of being in the high health state, and a lower probability of being in the low health state, compared to if, *ceteris paribus*, that individual lived in a household with zero net worth. Furthermore, the improvements in probability of having a high health status diminish with the level of wealth, and the deterioration in probability of having a low health status also diminishes with the level of wealth.

Figure 3: Impact of wealth on probability of individual health state



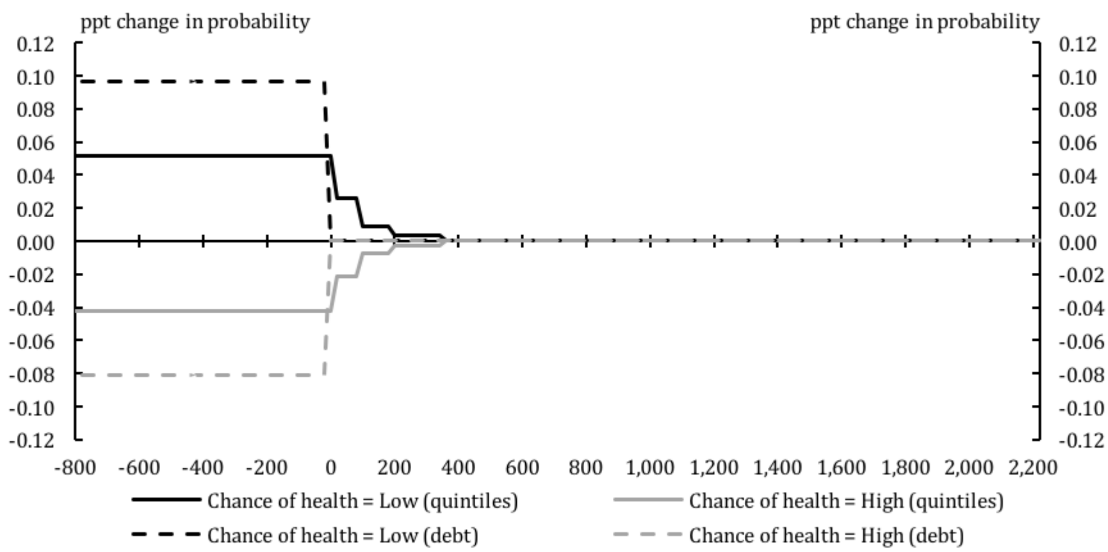

Note: Horizontal axis shows household net worth in €'000. Each solid line shows an individual's relative probability of being in the specified health category compared to their probability given household net worth of zero. The dashed lines show the average relative probabilities of an individual having low and high health status above and below a zero threshold (again, this is relative to the case of household net worth of zero).

The average relative probabilities for low and high health below the capital threshold (household net worth of zero) show that an individual in a household with debts is around 9 percentage points more likely on average to be in the low health state and around 7 percentage points less likely on average to be in the high health state compared to an individual in a household with net worth of zero.

Furthermore, the coefficients on the wealth quintiles show that an individual in the lowest wealth quintile is significantly less likely to move from low to medium health or from medium to high health. This confirms the weak version of the Income Inequality Hypothesis - that the least well off in a society are more likely to experience unfavourable health states. Again, this is specified through marginal effects analysis

(Table A3 in Appendix A), with the results shown diagrammatically in Figure 4. The solid lines show an individual's relative probability of being in a low or high health state if they are in the lowest to second highest quintile, compared to if they were in the top quintile. Note that the middle three quintiles cover narrow ranges of household net worth, while the top and bottom quintiles cover wide ranges, reflecting long tails on the household net worth distribution.

Figure 4: Impact of wealth quintile and debt status on probability of individual health state




Note: Horizontal axis shows household net worth in €'000. The solid lines show an individual's relative probability of having low and high health status given their household net worth quintile. This is relative to the case of being in the top quintile. The dashed lines show the relative probabilities of an individual having low and high health status if they are in an indebted household (this is relative to the case of being in a household without debt).

The greatest impact on an individual's relative chance of having good health comes from being in a household in the lowest net worth quintile. This quintile spans assets levels of –€655,000 to €25,000. Individuals in this range are 4.2 percentage points less likely to be in a high health state than individuals in the highest wealth quintile, and 5.2 per cent more likely to be in a low health state.

We estimate a second ordered probit to evaluate the impact of household debt on health, controlling for total household income and the variables mentioned in the first model. The results are shown in the second column of Table A1 (Appendix A).

Given the negative coefficient for the debt dummy, we further investigate the relationship between debt and health by looking at the margins - that is, the relative probability of being in each health state for an individual in an indebted household, compared to an individual with the same characteristics who lives in a debt-free household (Table A4, Appendix A). These relative probabilities are the dashed lines in Table 4. Having debt raises the probability of having low health by 9.7 percentage points, and decreases the probability of having high health by 8.1 percentage points. This is a much stronger result than the relative health probabilities of individuals in the poorest quintile compared to the richest quintile, because the poorest quintile includes many individuals with some household net worth (between €0 and €25,000), while all these individuals are excluded from the indebted cohort. The effect on the probability of having medium health is less strong (i.e., it is only moderately impacted by the debt status of an individual's household).

We use these relative probabilities to define our transition probability matrices in the model, as shown in Table 2 and Table 3. The descriptive statistics of our three health states from SHARE, as shown in Table 1, form the basis for the 'above the capital threshold' transition matrix, since the bulk of the population has positive net wealth. We then subtract 10 percentage points from the probability of having high health and add 10 percentage points to the probability of having low health to form the transition probability matrix for agents below the capital threshold. A slight reduction to the probability of remaining in medium health for agents with medium health in time $t$ is also incorporated to reflect the moderate impact of indebtedness on an individual's probability of having medium health.

Table 2: Transition probability matrix - above capital threshold

| t+1: | High | Medium | Low |
|---|---|---|---|
| t: High | 0.35 | 0.65 | 0 |
| t: Medium | 0.25 | 0.35 | 0.4 |
| t: Low | 0 | 0.45 | 0.55 |

Table 3: Transition probability matrix - below capital threshold

| t+1: | High | Medium | Low |
|---|---|---|---|
| t: High | 0.25 | 0.75 | 0 |
| t: Medium | 0.15 | 0.3 | 0.55 |
| t: Low | 0 | 0.35 | 0.65 |

To calibrate the impact of a change in health state on productivity, we estimate a simple OLS regression with labour income as the dependant variable to check the relationship between self perceived health status and productivity, again using the control variables mentioned in the probit models estimation. The results of this estimation show that moving from low to medium health or from medium to high health is correlated with a 10 per cent increase in labour income in each instance (Table A5, Appendix A).

Knowing this, we calculate the ratio of labour income between low and medium health individuals and between high and medium health individuals, with the results shown in Table 4. These values are used to specify the magnitude of $l^{low}$ and $l^{high}$ shocks in our model, $l^{medium}$ denoting the normalizing shock (i.e., it is set to 1).

Table 4: Labour income ratios

| | |
|---|---|
| Low to medium health | 0.70 |
| High to medium health | 1.35 |

# 4 Taxation and social policy

After validating our model by showing that it is able to reproduce characteristics of our data set, we can proceed to use its general equilibrium framework to assess two competing social policies: the guaranteed minimum income versus a targeted social policy. The former one is implemented by assuming that all agents receive the same lump sum transfer, regardless of their wealth or labour income. The latter is meant to provide support only for those who are vulnerable to adverse circumstances, i.e., indebted and also more susceptible of being exposed to unfavourable health shocks. Both policies are financed by a government that raises revenue through taxes on capital income. There is no government consumption and we don't allow for government debt. The tax levied on capital income is introduced as a proportional tax rate. Those that have negative net wealth receive a tax deduction for their interest-related expenditure. Therefore, the tax itself redistributes from those with positive wealth levels to those with negative ones. The choice of taxing capital income is motivated by the fact that it is expected to distort the saving decisions of households, as opposed to, for example, taxing labour income, which in our case would be equivalent to a non-distortionary lump sum tax since labour is exogenous at the individual level. Furthermore, the fact that the capital level also influences the likelihood of receiving 'good' and 'bad' health-related productivity shocks is bound to provide rich dynamics to the whole system.

These policies affect both the optimisation problem faced by the individual and the aggregate level of variables. Under the minimum income policy, the consumer budget constraint becomes:

$$c + a' = wl + a(1 + r(1 - \tau^{mi})) + sub \tag{11}$$

where $\tau^{mi}$ is the proportional capital income tax rate and $sub$ denotes the amount of social transfers received by the individual.

The government budget constraint completes the market clearing conditions for capital and labour; this has to hold in each period, since there is no government debt:

$$\tau^{mi} \cdot r \cdot K = sub \tag{12}$$

In the targeted subsidy policy, there are two types of budget constraints, depending on the individual's net wealth. For those indebted:

$$c + a' = wl + a(1 + r(1 - \tau^{ts})) + sub \tag{13}$$

And for those with positive net wealth:

$$c + a' = wl + a(1 + r(1 - \tau^{ts})) \tag{14}$$

In this case, the government budget constraint becomes:

$$\tau^{ts} \cdot r \cdot K = sub \cdot wd \tag{15}$$

Where $wd$ is the share of agents that are indebted in the long run. The experiment is designed to take as given in the implementation of both policies the same level of social transfers received by the individual. This was calibrated at roughly 15 per cent of the wage level.[8] In this way, the tax rate becomes endogenous and computational methods will be employed to solve for it, along with the steady-state equilibrium values for the interest rate and wage.

[8]For instance, this is the approximate ratio between the minimum income and the median earnings from wages and salaries in Finland (`http://www.stat.fi/til/pra/2015/pra_2015_2017-04-06_tie_001_en.html`).

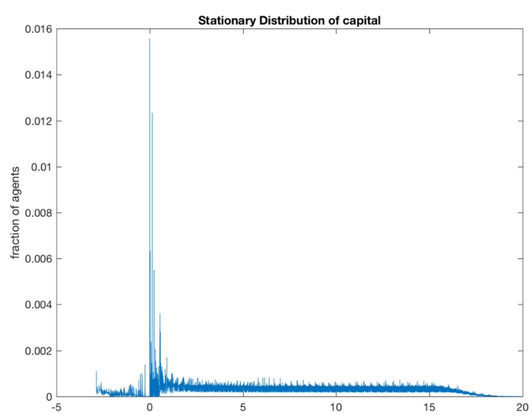
# 5 Results

## 5.1 Wealth-dependent transition probabilities versus the standard framework

The parameters that haven't been discussed explicitly in Section 3 are rather standard: the utility discount factor is set to 0.95 (the model's period is one year), the capital income share in output is 0.33 and the depreciation rate is chosen to be 5 per cent. The period utility function is logarithmic.

Incorporating an additional benefit of wealth, i.e., more productivity aside from the traditional buffer against adverse shocks, acts as an increase of the return agents get for their saving when optimising their decisions. Agents have an extra reason to save. Particularly, starting from the standard model, with a single transition probability calibrated such that it takes into account the distribution observed in our data set across health states, our specification makes indebted people less lucky than positive net wealth individuals (i.e., more susceptible of receiving bad health shocks, based on the evidence obtained from the ordered probit models). Because of that, as it is apparent in Table 5, less people maintain negative net assets in the long run, as compared to the single transition probability version of the model. This is one of the results that brings our model closer to the data, where the share of indebted households is around 2.3 per cent.

Figure 5: Stationary distribution of capital




The stationary distribution of capital is more clustered just above the threshold capital level, as shown in Figure 5 (similar to the real net wealth distribution reported in Figure 1). This is picked up by an increased Gini coefficient, which is, in fact, very

Table 5: Model results

| | (1) Aiyagari | (2) Wealth-dependent transition probabilities | (2a) Basic Income | (2b) Targeted Subsidy |
|---|---|---|---|---|
| Output | 1.92 | 1.79 | 1.66 | 1.65 |
| Aggregate efficient units of labour | 0.98 | 0.94 | 0.94 | 0.92 |
| Interest rate | 3.34 | 3.89 | 5.96 | 5.29 |
| Wage | 1.32 | 1.28 | 1.15 | 1.19 |
| Capital income tax rate | | | 0.57 | 0.19 |
| Government subsidy received by an individual | | | 0.18 | 0.18 |
| Government subsidy as a share of wage | | | 15.50 | 15.02 |
| Per capita capital level (mean) | 7.59 | 6.64 | 5.26 | 5.45 |
| Median capital level | 7.51 | 6.18 | 4.90 | 4.76 |
| Standard deviation of capital | 6.17 | 5.21 | 4.57 | 5.94 |
| Coefficient of variation for capital | 0.81 | 0.78 | 0.87 | 1.09 |
| Skewness of the capital distribution | 0.04 | 0.22 | 0.15 | 0.30 |
| Kurtosis of the capital distribution | 1.80 | 1.84 | 1.92 | 1.75 |
| Minimum level of capital | -2.86 | -2.86 | -2.86 | -2.86 |
| Maximum level of capital | 19.59 | 19.87 | 19.23 | 19.96 |
| Gini coefficient for the capital distribution | 0.56 | 0.68 | 0.79 | 0.73 |
| Welfare measure | 0.70 | 0.52 | 0.61 | 0.55 |
| Share of indebted agents | 14.36 | 3.59 | 6.72 | 32.09 |

Note: Model 1 is the typical Aiyagari model with the one single transition probability matrix for the process describing the idiosyncratic shocks. Model 2 introduces different transition probabilities for the health-related productivity shocks (i.e., more disadvantageous for indebted agents). Models 2a and 2b introduce the basic income and targeted subsidy, respectively. The values presented in this table are associated to the stationary equilibrium and make use of the invariant distribution obtained for capital. The welfare measure is computed by using this distribution and the corresponding individual utility functions for each level of consumption expressed as a policy function of assets.

close to the one recovered from the real data (i.e., 0.64).

Because of these features and the fact that the shocks that agents experience are, on average, more adverse (as evidenced by the lower aggregate efficient units of labour), the aggregate capital level (and, thus, also the output) is lower and the steady state interest rate is higher (3.89 per cent, but still below the 5.26 per cent discount rate embedded in preferences) than in the one-single-transition-probability-matrix version of the model. An extra explanation can be given by the fact that agents dispose of a new mechanism that can provide them less exposure to adverse shocks: just by saving enough to reach the capital threshold, they improve their prospects. This channel seems to be heavily used by optimising agents in this model, as evidenced by the large change in the share of people remaining indebted in the long run, as well as by the more significant positive skewness of the stationary capital distribution.

Figure 6: Policy function for capital

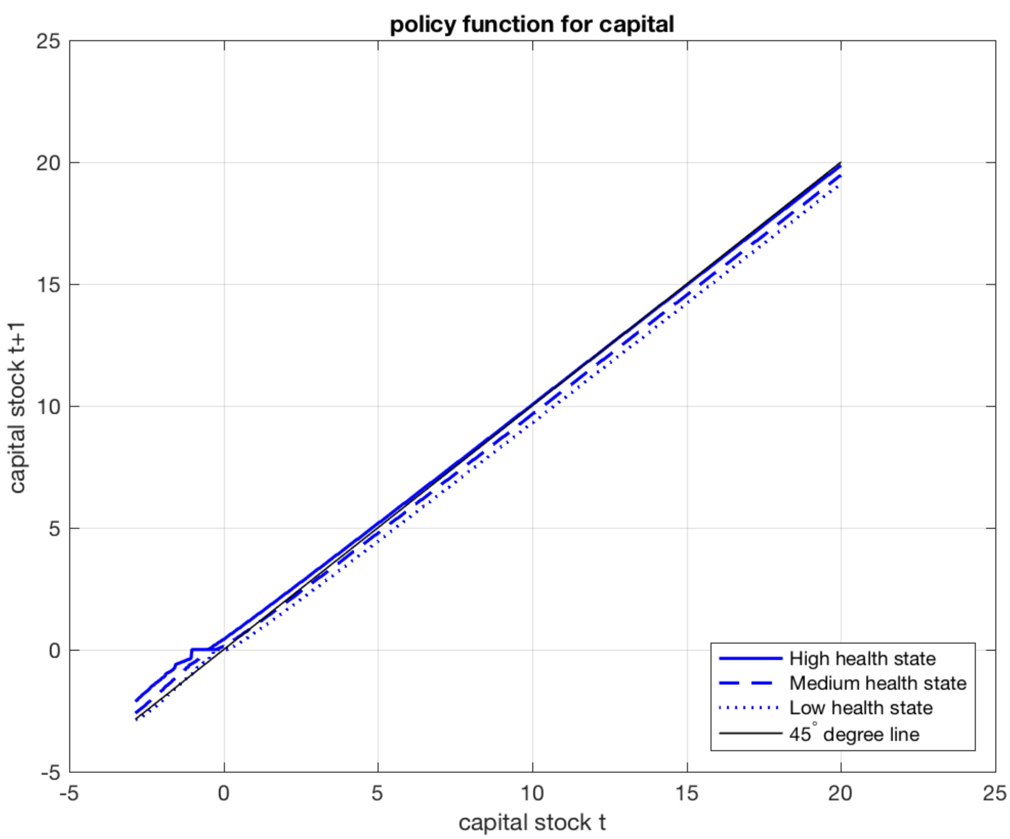
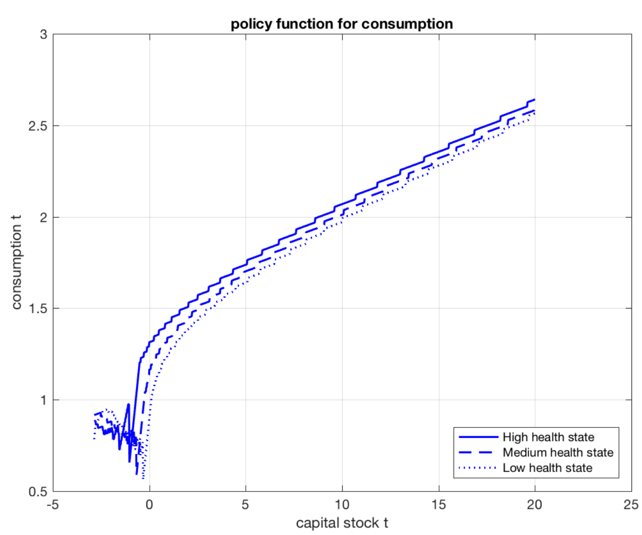


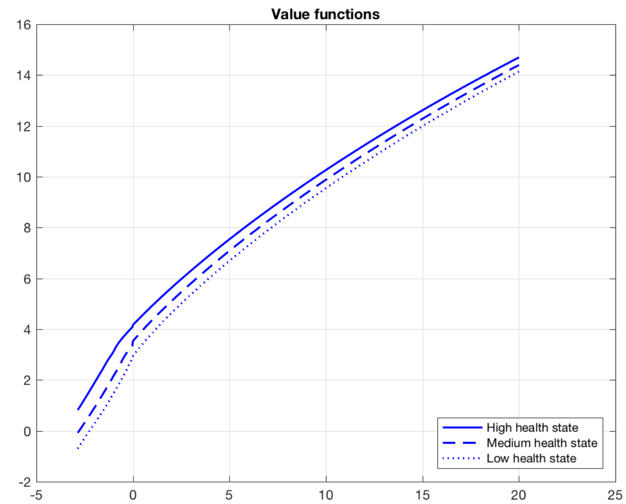

Figure 6 plots the decision rules $g^a(a, l)$ for the level of capital, with $l^{low,medium,high}$ denoting the three health-related productivity shocks, along a 45° line. The line corresponding to the most favourable shock ($l^{high}$) is always above the ones associated to the other two shocks, the line denoting the optimal decision of the agent faced with the least favourable shock ($l^{low}$) is always below and the one remaining ($l^{medium}$), in the middle. The decision rule associated with the 'good' state crosses the 45° line at a high capital level from the grid point, confirming that the equilibrium is stationary (i.e., agents don't accumulate more assets than this in the long run). There is also one such intersection at the lower end of the grid, in the case of the optimal decision of an agent faced with a negative health-related productivity shock. In comparison with the standard model, new interesting dynamics appear close to the threshold level: this acts as a binding borrowing limit for the agents with wealth levels above zero: once reached, agents prefer to keep assets constant such that they don't fall under the more unfavourable future distribution of shocks. This is the optimal behaviour provided that the shocks don't affect the level of current consumption too much: this is why agents with positive shocks are better suited than in the other two states to maintaining capital levels exactly at the threshold. There is also a small kink in the asset accumulation schedule for agents close to the threshold level, but below it: for the agents in that situation, deleveraging at a higher pace (until reaching zero net wealth) and being subject to a more favourable distribution of health-related shocks in the future is less costly than keeping the same debt but facing relatively worse prospects.

Figure 7: Policy function for consumption




These patterns are mirrored by the graph of the decision rules for consumption as well (Figure 7): approaching the capital threshold level from above, consumers decide

Figure 8: Value functions




to adjust consumption downwards just to keep the same level of assets that guarantees the more utility in the future. Approaching the threshold from below, by marginally forgoing current consumption, agents can reach the threshold level and, thus, expect significantly more utility for the next period. It should be mentioned that the shocks are the same, only their distribution differs above and below the capital threshold. The nonlinearity introduced with our specification is also captured by the value functions (Figure 8).

## 5.2 Policy experiments

Having constructed a model that performs better than the single-transition probability matrix model in describing our data set, we test the implications of implementing the policies described in Section 4.

The results obtained by introducing a distortionary capital income tax in this setting are summarized in the last two columns of Table 5. As expected, output is lower in both policy experiments than in our baseline two-transition-probability-matrices model without taxes. This is mostly due to a lower capital level (less reasons to insure against adverse shocks in the policy scenarios), although the aggregate number of efficient units of labour is also lower in the targeted subsidy scenario. The evolution of the latter is governed by the share of people that remain indebted. It can be seen that this increases to 32 per cent, almost ten times higher than in the baseline. This is due to the fact that the targeted subsidy not only outweighs the negative wedge prevailing between the value functions of an agent with assets below the capital threshold and of one with wealth above it, but it also reverses it: this policy makes the agents with a small amount of debt better off than those with a small amount of saving. Although this seems to solve the problems of the agents previously disadvantaged, because of consumers crowding in below the capital threshold, there will be less effective units of labour at the aggregate level.

The steady state equilibrium interest rate is higher in both policy experiments, as taxing capital income provides a disincentive to save. The net interest rate, adjusted for taxes, is still lower than the discount rate embedded in agents' preferences. The benefit of the tax deduction the indebted agents receive for their interest-related expenses is counteracted by the fact that they need to pay a higher interest on their debt in these scenarios as compared with the baseline.

In the case of the targeted subsidy, although the agents receiving it get the same amount as those receiving the minimum income in the other policy experiment, the government has to finance a smaller aggregate subsidy (only for those indebted). Naturally, the taxes that the government needs to raise are smaller, yielding a lower tax rate and, consequentially, a smaller disincentive to save, which ultimately leads to obtaining a relatively higher aggregate capital level and lower interest rate than in the minimum income scenario.

Assuming that our model provides a better representation of reality than the standard incomplete markets model with no aggregate uncertainty, both policies seem to be welfare improving; the minimum income more so than the targeted subsidy policy. If the purpose of the policies was to reduce inequality, the Gini coefficient[9] computed for the capital distribution shows that, actually, the reverse happens. In both experiments, the variation between the asset holdings of individuals in the bottom of the wealth distribution and the amount of assets of agents in the upper-end of the distribution increases: on the one hand, in order to smooth their low-level consumption, the poor won't need to save as much as before the introduction of the subsidy, since this alone performs this task; on the other hand, once taxed on the capital income, the rich have to save even more to insure their high-level of consumption. In the case of the guaranteed minimum income scenario, the indebted face a lower cost of borrowing (i.e. the interest rate net of the tax deduction) than the targeted subsidy counterparts. On the contrary, the wealthy from the minimum income implementation have a lower

[9]A larger value signifies more inequality; zero is obtained if, for instance, all agents own the same level of wealth; a value of 1 would be obtained if one single agent owned all the assets available in the economy. Relating to known distribution shapes, for example, a Normal distribution has a lower Gini coefficient than a Uniform one, which is exceeded by a LogNormal distribution.

capital income than those in the targeted subsidy case (because of the higher tax) and the minimum income they receive - the same across individuals - is unable to provide smoothing for their high-level consumption levels. So, in this setting, the poor could borrow even more and the wealthy have to save more than in the other policy scenario in order to obtain the same amount of insurance as before the introduction of the capital income tax-financed guaranteed income.

If the objective of the policy makers was to reduce the number of people that are stuck in the bad-health-related-productivity-shock part of the wealth distribution, the result they would have obtained by implementing any of these policies would have been completely the opposite, especially in the targeted subsidy case. Increasing the level of output, another alternative endeavour for the government, fails as well.

## 5.3 Limitations of the analysis

These results have to be interpreted with care since our model is just a stylised representation of reality in which a reduced-form relationship (between wealth and health status) was built-in in a simplified way, i.e. two transition probability matrices specified for two regions of the wealth distribution. Nevertheless, there is scope for this approach to attract more complex modelling techniques while still keeping the breakdown between indebted agents and savers, considering the recent attention given to the redistributive channels of monetary policy among lenders and borrowers (not dealt with here).

The calibration used in this paper could be further improved in future analysis by setting up a panel for the ordered probit instead of the cross-sectional data we use (the sixth wave release in the SHARE database). In this way, the transition probabilities in the model can be more accurately tied to the actual flows that characterise the mobility between health states and financial positions in reality. Also, the robustness of our empirical results could be tested by using an objective measure of health status instead of the self-perceived one used in this paper.

Aside from improving the analysis by switching from a discrete to a continuous framework, more structure can be built in describing how wealth affects productivity (e.g., assume that wealth does not make an agent automatically more productive, but achieving more productivity first requires higher medical expenditure, which poor individuals cannot afford). These assumptions sensitively affect the steady state outcome.

Moreover, describing the interactions between wealth, health and productivity may render other modelling strategies more suitable, such as the life-cycle model or the overlapping generations model instead of the infinitely-lived agents paradigm. The data used, available for people older than 50 years, adds another argument in this direction.

Furthermore, given the fact that the calibration reflects the characteristics of a particular category of the population, the predictions of our model might not extrapolate well to the entire population.

The topic itself, measuring the implications of implementing a guaranteed minimum income, would benefit by incorporating labour choice at the individual level. Although our simple approach manages to produce endogenous aggregate labour, one cannot measure how the substitution effect between consumption and labour would change after the introduction of this policy financed by distortionary labour income taxes, which is one of the most debated topics around the subject: would people work more or less? In a model that would also have individual endogenous labour choice, this effect can be identified by looking at the agents for which the wealth effect is nil (the minimum income received is exactly the same as the tax paid for its financing). Going further and adding search and matching frictions in the labour market can provide an assessment of the effects on unemployment of a guaranteed basic income policy.

## 6 Conclusions

The model developed in this paper extends the standard Aiyagari-Hugget style model by allowing the distribution of uncertainty faced by individuals to endogenously change. Specifically, this happens as a function of the household's net wealth, incorporating the positive and concave relationship, documented in the literature and confirmed by the data, between wealth/income and the likelihood of facing favourable health shocks, that are further assumed to result in higher productivity. This mimics our own finding that individuals in households with debt are more likely to suffer from poor health and have lower productivity than individuals in households without debt.

The equilibrium outcome of our version of the model is able to deliver more inequality with respect to agents' asset holdings than the classical equilibrium allocation. Moreover, in our setting higher levels of saving are associated with an additional benefit aside from securing a capital buffer against the occurrence of negative shocks; that is gaining access to better health prospects.

Because we specify that the improvement of expected health-related productivity shocks is realised above a relatively low asset holding threshold, in the long run the bulk of agents will save just enough to qualify for the more fortunate chances.

The calibration makes use of the most recent SHARE data. We establish the two transition probability matrices in our extension based on an ordered probit model that has as dependent variable the self-reported health status (three constructed categories) and includes among the explanatory variables a dummy for indebted households. Furthermore, we obtain a statistically significant positive relation between the self-reported health status and the amount of labour income, which is an indication that health has a bearing on productivity. We calibrate this effect using relative labour income averages across the three groups of self-reported health.

This calibration is meant to be a preliminary step in providing more flexibility in an Aiyagari framework and to give a tractable account of the new interactions that arise in such a context. In the future, this can be more carefully tuned (e.g., by using a continuous functional form that characterizes the relation between wealth and health) in order to produce more sensible results.

Using the model to implement two social policy experiments - a guaranteed minimum income and a targeted subsidy - reveals that while both improve welfare, there is a greater improvement under a minimum income policy. Targeting individuals in a specific region of the capital distribution for government transfers creates incentives for agents to adjust their saving behaviour so that they remain in or enter that region in the long run, whereas a guaranteed minimum income policy creates a lot less of this kind of distortion. Because of this, although the guaranteed minimum income yields a higher capital income tax rate (in order to cover the flat income subsidy for all agents), the output losses that come from raising taxes to finance the social transfers are relatively similar. The steady-state capital level is lower in both experiments as compared with the 'no tax' baseline: in the case of the guaranteed minimum income policy this is because of the high capital income tax, while in the targeted subsidy scenario it is due to the larger share of people that have a net borrowing position. The aggregate efficient units of labour is also negatively affected by this increase in indebtedness in the targeted subsidy case, whereas no significant changes feed through this channel into the equilibrium allocation with guaranteed minimum income.

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Appendix A: Additional Tables

Table A1: Self reported health status ordered probits

| VARIABLES | (1) Wealth-Health | (2) Debt-Health |
|---|---|---|
| Debt | | -0.302*** |
| | | (0.014) |
| Log Total HH Income | | 0.805*** |
| | | (0.042) |
| Log Total HH Income$^2$ | | -0.035*** |
| | | (0.002) |
| Income quintile 4 | | -0.044*** |
| | | (0.008) |
| Income quintile 3 | | -0.076*** |
| | | (0.011) |
| Income quintile 2 | | -0.097*** |
| | | (0.013) |
| Income quintile 1 | | -0.148*** |
| | | (0.018) |
| HH net worth ($m) | 0.672*** | |
| | (0.045) | |
| HH net worth ($m) $^2$ | -0.246*** | |
| | (0.022) | |
| Wealth quintile 4 | -0.010 | |
| | (0.011) | |
| Wealth quintile 3 | -0.028* | |
| | (0.015) | |
| Wealth quintile 2 | -0.082*** | |
| | (0.018) | |
| Wealth quintile 1 | -0.161*** | |
| | (0.020) | |
| Age | -0.020*** | -0.005** |
| | (0.002) | (0.002) |
| Age$^2$ | -0.000*** | -0.000*** |
| | (0.000) | (0.000) |
| Years of education | 0.036*** | 0.039*** |
| | (0.001) | (0.001) |
| Female | -0.039*** | -0.039*** |
| | (0.004) | (0.004) |
| Registered partnership | 0.017 | -0.002 |
| | (0.017) | (0.017) |
| Married, not living with spouse | 0.003 | -0.023 |
| | (0.019) | (0.019) |

Table A1: Self reported health status ordered probits

| VARIABLES | (1)<br>Wealth-Health | (2)<br>Debt-Health |
|---|---|---|
| Never married | -0.049*** | -0.062*** |
| | (0.009) | (0.009) |
| Divorced | -0.010 | -0.025*** |
| | (0.008) | (0.008) |
| Widowed | 0.002 | 0.010 |
| | (0.007) | (0.007) |
| Employed or self-employed | 0.220*** | 0.206*** |
| | (0.007) | (0.007) |
| Unemployed | -0.088*** | -0.070*** |
| | (0.013) | (0.013) |
| Permanently sick | -1.222*** | -1.253*** |
| | (0.015) | (0.015) |
| Homemaker | -0.020** | 0.004 |
| | (0.008) | (0.008) |
| Other | -0.246*** | -0.233*** |
| | (0.013) | (0.015) |
| Germany | -0.540*** | -0.525*** |
| | (0.012) | (0.012) |
| Sweden | 0.058*** | 0.134*** |
| | (0.012) | (0.012) |
| Spain | -0.274*** | -0.161*** |
| | (0.011) | (0.011) |
| Italy | -0.380*** | -0.279*** |
| | (0.011) | (0.011) |
| France | -0.417*** | -0.325*** |
| | (0.012) | (0.012) |
| Denmark | 0.221*** | 0.268*** |
| | (0.013) | (0.013) |
| Greece | 0.043*** | 0.125*** |
| | (0.012) | (0.012) |
| Switzerland | 0.145*** | 0.255*** |
| | (0.014) | (0.014) |
| Belgium | -0.246*** | -0.144*** |
| | (0.011) | (0.011) |
| Israel | -0.246*** | -0.059*** |
| | (0.015) | (0.015) |
| Czech Republic | -0.497*** | -0.390*** |
| | (0.012) | (0.013) |
| Poland | -0.654*** | -0.558*** |
| | (0.016) | (0.016) |

Table A1: Self reported health status ordered probits

| VARIABLES | (1)<br>Wealth-Health | (2)<br>Debt-Health |
|---|---|---|
| Luxembourg | -0.456*** | -0.289*** |
| | (0.017) | (0.016) |
| Portugal | -0.910*** | -0.775*** |
| | (0.017) | (0.017) |
| Slovenia | -0.439*** | -0.360*** |
| | (0.012) | (0.012) |
| Estonia | -1.222*** | -1.084*** |
| | (0.012) | (0.013) |
| Croatia | -0.358*** | -0.179*** |
| | (0.014) | (0.015) |
| Constant cut1 | -1.835*** | 3.162*** |
| | (0.091) | (0.244) |
| Constant cut2 | -0.702*** | 4.289*** |
| | (0.090) | (0.244) |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is self reported health status, 1= 'poor' or 'fair', 2 = 'good', 3='very good' or 'excellent'.

Table A2: Marginal effects on probability of health status - Continuous wealth

| Variable | dy/dx | se |
|---|---|---|
| HH Net Worth | | |
| Low | -0.215*** | (0.014) |
| Medium | 0.038*** | (0.003) |
| High | 0.177*** | (0.012) |
| HH Net Worth squared | | |
| Low | 0.079*** | (0.007) |
| Medium | -0.014*** | (0.001) |
| High | -0.065*** | (0.006) |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3: Marginal effects on probability of health status - Wealth quintiles

| Variable | dy/dx | se |
|---|---|---|
| Quintile 4 | | |
| Low | 0.003 | (0.004) |
| Medium | -0.001 | (0.001) |
| High | -0.003 | (0.003) |
| Quintile 3 | | |
| Low | 0.009* | (0.005) |
| Medium | -0.002* | (0.001) |
| High | -0.007* | (0.004) |
| Quintile 2 | | |
| Low | 0.026*** | (0.006) |
| Medium | -0.005*** | (0.001) |
| High | -0.022** | (0.005) |
| Quintile 1 | | |
| Low | 0.052*** | (0.006) |
| Medium | -0.009*** | (0.001) |
| High | -0.042*** | (0.005) |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4: Marginal effects on probability of health status - Debt

| Variable | dy/dx | se |
|---|---|---|
| Debt | | |
| Low | 0.097*** | (0.004) |
| Medium | -0.015*** | (0.001) |
| High | -0.081*** | (0.004) |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5: Productivity OLS

| VARIABLES | (1)<br>coef. | (2)<br>se |
|---|---|---|
| Health | 0.096*** | (0.004) |
| Age | 0.134*** | (0.005) |
| Age squared | -0.001*** | (0.000) |
| Years of education | 0.035*** | (0.001) |
| Female | -0.354*** | (0.006) |
| Registered partnership | 0.007 | (0.021) |
| Married, not living with spouse | 0.014 | (0.025) |
| Never married | -0.027** | (0.012) |
| Divorced | 0.062*** | (0.010) |
| Widowed | 0.079*** | (0.015) |
| Employed or self-employed | 0.704*** | (0.010) |
| Unemployed | -0.041** | (0.021) |
| Permanently sick | -0.042 | (0.030) |
| Homemaker | -0.365*** | (0.032) |
| Other | 0.312*** | (0.024) |
| Germany | -0.081*** | (0.019) |
| Sweden | 0.148*** | (0.020) |
| Spain | -0.277*** | (0.021) |
| Italy | 0.219*** | (0.021) |
| France | 0.076*** | (0.021) |
| Denmark | 0.354*** | (0.019) |
| Greece | -0.667*** | (0.022) |
| Switzerland | 0.932*** | (0.021) |
| Belgium | 0.165*** | (0.019) |
| Israel | -0.030 | (0.025) |
| Czech Republic | -1.233*** | (0.020) |
| Poland | -1.522*** | (0.025) |
| Luxembourg | 0.383*** | (0.026) |
| Portugal | -0.677*** | (0.029) |
| Slovenia | -0.684*** | (0.022) |
| Estonia | -1.240*** | (0.019) |
| Croatia | -1.113*** | (0.025) |
| Constant | 4.914*** | (0.150) |
| R-squared | 0.417 | |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is log total labour income (employed and self-employed).