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Unintended Effects From the Expansion of the Non-Contributory Health System in Peru

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Unintended Effects From the Expansion of the Non-Contributory Health System in Peru

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Abstract

Over the last two decades, the Peruvian government has made great efforts to improve access to health care by significantly augmenting the coverage of the non-contributory public health care system Seguro Integral de Salud (SIS). This expansion has a positive impact on welfare and public health indicators, as it limits the risk of catastrophic health-related costs for previously uninsured individuals and allows for the appropriate treatment of illnesses. However, it also entails some unintended consequences for informality, tax revenues, and GDP, since a few formal agents are paying for a service that the majority of (informal) agents receive for free. In this paper, we use a general equilibrium model calibrated for Peru to simulate the expansion of SIS to quantify the unintended effects. We find that overall welfare increases, but informality rises by 2.7 percent, while tax revenues and output decrease by roughly 0.1 percent. Given the extent of the expansion in eligibility, the economic relevance of these results seems negligible. However, this occurs because the expansion of coverage was mostly funded by reducing the spending per-insured person. In fact, we find larger costs if public spending is increased to improve the quality of service given universal coverage.

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I. INTRODUCTION

The Seguro Integral de Salud (SIS) was created in 2001 to provide (non-contributory) health services for poor Peruvians without health insurance. Initially, SIS eligibility was limited to poor children (<18 years) and poor pregnant women, with 16 percent of the population being covered in 2006. In 2007, eligibility was extended to the entire poor population. The enhanced coverage resulted in considerable improvements in several public health indicators. For example, Peru made substantial progress in maternal and child health outcomes under the Millennium Development Goals. Infant mortality was reduced by two-thirds between 1990 and 2015. At the same time, the rate of chronic child malnutrition in children under five fell dramatically and maternal mortality almost halved between 1997 and 2011 (WB 2019).

In 2019, according to the National Statistical System ("El Instituto Nacional de Estadística e Informática", INEI) 50.3% of women and 43.5% of men were covered by SIS, 23.9% of women and 24.5% of men were covered by EsSalud, and the percentage of men and women who have another type of health insurance reached 6.2% and 6.0%, respectively.[1] The remaining 19.8% of women and 25.8% of men are uninsured. However, only 1 in 5 Peruvians is poor.[2] In July 2020, former President Vizcarra reiterated government's intention to attain universal coverage and announced plans for a possible unification of SIS and EsSalud. However, the two public health insurance systems are vastly different as EsSalud is funded by payroll taxes paid by employers of formal sector workers, has a significantly lager budget per insured individual, and provides services through its own separate network of providers.

The pandemic experience has only underscored that a well-functioning public insurance system is critical. In March 2020, the coronavirus placed more pressure on the public health system which was already facing a nationwide state of emergency due to an outbreak of dengue that started in October 2019, as Vasquez-Chavesta et al. (2020) point out. The government provided a robust response in the initial stages of the COVID-19 outbreak, with early lock-down measures and the implementation of relatively ambitious economic safety nets to protect families and enterprises (Vázquez- Rowe & Gandolfi 2020). As of February 2021, Peru has the highest rate of COVID-19 related deaths per capita (while having an average number of cases and tests per capita), compared to other countries in South America. [3] Vázquez-Rowe & Gandolfi (2020) argue that structural deficiencies in the health system, high informality in the labor market, and the diverse cultural characteristics of many areas may have exacerbated the number of highly vulnerable groups.

Public health care systems positively affect the well-being of vulnerable individuals. Wagstaff & van Doorslaer (2003) argue that health insurance coverage not only protects individuals against catastrophically high health expenditures but also promotes appropriate treatment of illnesses which would otherwise be left untreated. For insured individuals, it is easier to receive

[1] http://m.inei.gob.pe/prensa/noticias/80-de-cada-100-mujeres-cuenta-con-seguro-de-salud-12123/

[2] https://data.worldbank.org/indicator/SI.POV.NAHC?locations=PE

[3] https://ourworldindata.org/coronavirus

adequate care and consultation from a doctor who raises awareness about health problems and prescribes appropriate medicine. Uninsured individuals instead are more likely to simply buy medication without much consultation, as Bernal et al. (2017) point out. Using rich micro level survey data and a regression discontinuity design, the authors find strong positive effects on health care utilization, doctor visits, and the prescription of medication stemming from the expansion of SIS.

Nevertheless, increasing the coverage of a non-contributory system could lead to tradeoffs affecting individual's labor market choices. As Loayza (2016) points out, informality can be the result of agents exiting the formal sector as a consequence of cost-benefit considerations. Levy (2008) argues that free health care creates incentives for reallocation of labor from the formal to the informal sector as individuals prefer to access noncontributory insurance and avoid taxation. This argument is supported by empirical evidence from Mexico. Bosch & Campos-Vazquez (2014) find that providing (essentially) free health access to the informal had a negative effect on the number of employers and employees formally registered in small firms. They estimate that without the program, 4.6 percent more employees would have formally registered.

There is a large public policy literature on the effects of health care on the labor market, see Gruber (1998) and Cutler (2002) for a survey. Much of the literature studies the links between welfare benefits and welfare dependency in terms of frequency and duration of participation. Mott (1992) for example argues that subsidies to the poor are likely to have negative labor supply effects via an income effect. Cutler (2002) argues that providing universal health coverage implies trade-offs between the positive gains of expanding health coverage and the potential welfare loss from the subsidy. Jaramillo et al. (2018) study the 2001 labor reform in Peru and highlight the risks of implementation of policies without consideration of the potentially unintended effects.

On an aggregate level, a reallocation from formal to informal activity can have significant implications for welfare. Most directly, it implies a loss of tax revenues and social security contributions. Furthermore, Galiani & Weinschelbaum (2012) argue that a larger share of informal activities might negatively impact overall long-run productivity. An OECD review of Peru (OECD 2016) also maintains that informality is strongly linked to low productivity, as the value-added from low-productive workers is not enough to cover the costs of being hired formally. Finally, individuals themselves might face adverse consequences from moving into informality as they may become uninsured against other risks, such as old-age poverty, disability, or unemployment (Bosch & Campos-Vazquez 2014).

In this paper, we employ a general equilibrium model, calibrated to the Peruvian economy, to simulate the expansion of SIS and analyze the effects from the introduction of non-contributory health care for a large fraction of the population. We find that the reform increases the share of informal workers by roughly 3 percent.[4] This occurs because, as a reaction to the reform, some agents optimally decrease the size of their business to prevent

[4] For simplicity, we refer to the series of reforms that increased SIS coverage only as 'the reform'.

audits and avoid taxation, while enjoying the benefits of free health insurance. Our results confirm that the reform increases overall welfare and particularly benefits the self-employed (informal) individuals. Their welfare increases compared to the pre-reform economy as they become insured against health risks but can still avoid income taxation. Our estimates of the unintended consequences are relatively small, as the expansion of coverage was funded by a reduction in the spending per insured person. In fact, our counterfactual analysis indicates that significantly increasing the generosity of the health insurance, which could occur either to raise the quality of service closer to the average of Latin American countries or from the government's plan to integrate the contributory and non-contributory systems, would magnify the unintended consequences from the reform.

We do not argue to scale back or withdraw the expansion of the non-contributory system, instead we suggest that the positive gains of the enhanced health coverage should be weighed against the negative implications from the reallocation of labor into the informal sector. To address the distortion in the labor market, we instead encourage reforms that address informality more directly. For example, streamlining labor regulations to expand the formal sector and sustained improvements in labor productivity will likely lead to a reduction in informality (Loayza 2016).

The remainder of the paper is structured as follows: In the next section we describe the Peruvian health care system in more detail, followed by the theoretical model and a description of our specification choices to match Peruvian data in Section 4. Section 5 then evaluates the model performance. In Section 6.1, we present and comment on the main results. In Section 6.2, we examine the effects of changes in the financing of the reform, in 6.3, we discuss the effects of substantially increasing the generosity of health insurance and provide concluding remarks in Section 7.

II. THE PERUVIAN HEALTH CARE SYSTEM

Peru's health care system is administered by the Ministry of Health, which provides health services for about 50% of the population through SIS and EsSalud, which provides for about 25% of the population. The remainder of those with insurance is served by the Armed Forces, National Police, and the private sector (WHO 2020). In 2019, according to INEI, about 20% of the population was uninsured.

SIS eligibility is determined by comparing IFH scores at the household level to geographical cluster thresholds.[5] Households with an IFH score below their respective cluster threshold are eligible, while those above the threshold are ineligible. The IFH score is a composite index built from information on the household's size, education, assets, dwelling, and existing health insurance coverage. While coverage of family members by EsSalud contributes to a higher IFH score, and therefore higher likelihood of exceeding the eligibility cut-off for SIS, other members of an individual's household having existing health care coverage through the EsSalud system does not exclude individuals from overage under SIS.

[5] During 2007-2011, individuals who wanted to become affiliated with SIS applied at health facilities.

EsSalud on the other hand is funded by payroll taxes paid by the employers of formal sector workers and provides services through its own separate network of providers. EsSalud members' average per capita income is more than twice as high as that of SIS subscribers. As a result of the differences in funding, in 2019, EsSalud had an average budget per affiliate that was 13.4 times higher than in SIS. At the same time, there are disparities in the availability of health services by geographical area: in general, human resources for health are scarce precisely where poor SIS members are located (WB 2019). According to National Superintendence of Health, the average waiting time to see a care provider is 135 minutes in public facilities compared to 80 minutes in EsSalud facilities.

The OECD and World Bank state in a joint report on Health in Latin America that "the quality of care is the missing link in the unrealized promise of universal health coverage in LAC" (OECD/WB 2020). Despite the improvement in health outcomes over the past decades (including immunization coverage), Peru falls short of the LA5 average in terms of some quality-of-care indicators such as immunization coverage among 1-year-olds for certain diseases such as tuberculosis or measles. Table 1 displays the percentage of surviving infants who received the final dose of standard vaccines, as reported by the World Health Organization. For example, while almost 9 out of 10 infants received their 3rd dose, respectively, of the diphtheria/tetanus vaccine as well as the hepatitis B vaccine, less than two thirds of one-year-olds in Peru received the complete dosage of the measles vaccine.

Table 1: Immunization of Infants in LA5

Country	BCG	DTP3	HepB3	Pol3	PcV3	MCV2	Hib3
Argentina	93	86	86	84	88	89	86
Brazil	79	73	80	85	84	54	80
Chile	98	96	96	96	95	91	96
Colombia	89	92	92	92	94	88	92
Mexico	76	82	56	82	86	73	82
Peru	81	88	88	87	80	66	88

Source: World Health Organization (Year 2019); BCG: Bacillus Calmette Guerin vaccine (tuberculosis), DTP3: 3rd dose, respectively, of diphtheria and tetanus toxoid with pertussis vaccine, HepB3: 3rd dose of hepatitis B vaccine, Pol3: 3rd dose of polio vaccine, PcV3: 3rd dose of pneumococcal conjugate vaccine, MCV2: 2nd dose of measles vaccine, Hib3: 3rd dose of Haemophilus influenzae type B vaccine

Furthermore, Table 2 shows that the (pre-COVID-19) capacity of the Peruvian health system and the quality of services remain, on average, relatively worse than in other Latin American countries, as measured by the number of hospital beds, doctors, and nurses per 1,000 people,

ICU beds per 100,000 people, and infant mortality rate (IMR). In response to the pandemic, in 2020 many countries, including Peru, have significantly increased the availability of ICU Beds.[6]

Table 2: Health Coverage and Services in LA5

Country	Hospital Beds	ICU Beds	Physicians	Nurses	IMR
Argentina	5.0	18.7	4.0	2.6	8.2
Brazil	2.2	20.6	2.2	10.1	12.4
Chile	2.2	7.3	2.6	13.3	6.0
Colombia	1.5	10.5	2.2	1.3	11.8
Mexico	1.5	3.3	2.4	2.4	12.2
Peru	1.6	2.9	1.3	2.4	10.3

Source: World Bank/OECD (Year 2019 or latest year available from 2015-2019); Beds, Physicians, and Nurses per 1,000 people ICU per 100,000 people; Infant Mortality per 1,000 live births

III. MODEL

We extend the work by Buera & Shin (2013) and Buera et al. (2015) on entrepreneurship and occupational choice to incorporate health shocks and health insurance as in Attanasio et al. (2010). The model considers a small open economy, populated by a continuum of infinitely lived individuals with measure one. Time is discrete and a period represents one year. In each period, individuals choose either to become entrepreneurs, self-employed, or work for a wage. Self-employed individuals and entrepreneurs can rent capital and hire labor to produce a homogeneous good. As in Lucas (1978), we assume that entrepreneurial talent is a fixed factor, and so entrepreneurs and self-employed individuals make a positive profit as their technology exhibits decreasing returns to scale.

In our model, self-employed individuals are informal while entrepreneurs are formal, and the distinction is determined by the size of their businesses. We assume that if the size of a business exceeds a critical threshold (which is public knowledge), it is audited by the government and becomes formal, which means the entrepreneur pays taxes. As a result, they are covered by the public health insurance system. Therefore, agents with low productivity and/or capital will optimally choose to operate a small firm, which means they become self-employed (and thus they do not pay taxes and are not covered by the public health insurance). This is in line with the stylized facts about Latin America outlined by Galiani & Weinschelbaum (2012), which hold true for the Peruvian economy: (i) unskilled workers tend to be informal,

[6] It is difficult to draw an international comparison of the increase in ICU bed capacity during the COVID-19 pandemic. To cite the 2020 OECD report on intensive care beds capacity: "While some of the beds and other resources in curative (or acute) care hospital units may be temporarily converted into flexible intensive care units, a key point, especially for COVID-19 treatment, is that intensive care beds need to be equipped with respiratory equipment. There may be differences in the notion of intensive care affecting the comparability of the data across countries" (https://www.oecd.org/coronavirus/en/data-insights/intensive-care-beds-capacity)

while skilled ones have formal jobs, and (ii) small firms tend to operate informally while large firms are formal.

Shocks/Heterogeneity

As in Aiyagari (1994), agents are ex-ante identical and there is no aggregate uncertainty. Ex-post, however, agents are heterogeneous in terms of their financial wealth. Each period, agents receive labor ability, entrepreneurial productivity, and health shocks denoted by ν, z and h which follow independent autoregressive Markov processes. These shocks affect agents' returns from working and or operating a firm. Markets are incomplete and as a result, individuals accumulate assets to partially self-insure. However, some agents have access to a government-provided public health insurance system, which is discussed in more detail below.

Timing

At the beginning of each period the labor productivity ν, entrepreneurial ability z, and health h shocks are realized. After observing the outcome of all shocks, agents make their occupational choice for the current period and there are no costs to changing occupations. Conditional on their financial wealth, labor productivity, entrepreneurial ability, and health, entrepreneurs decide how much capital to rent (from a financial intermediary who in turn makes zero profits) and labor to hire (in a competitive labor market). After production takes place, entrepreneurs sell their production and compensate their workers according to the prevailing wage per unit of effective labor and repay their loans. Finally, workers pay their payroll taxes and entrepreneurs pay their income taxes.

Government

The government does not have access to lump sum taxation and instead finances itself with distortionary taxes to income, payroll, and consumption taxes. It provides health insurance to entrepreneurs and workers and balances its budget every period. The health insurance reimburses individuals who receive a bad health shock ($h < 1$). The size of the transfer depends both on the severity of the shock (which in turn determines the financial burden for the individual) and the generosity of the system (which is exogenously determined).

Preferences and Technology

Individuals discount future utility using a common discount factor β. Agents' preferences over consumption and leisure are represented by the function proposed by Greenwood et al (1988).

$$U(c,l) = \frac{(c - \psi n^{\phi})^{1-\sigma}}{1-\sigma},$$

where $n \in (0,1)$, is the fraction of time that an individual devotes to working (either as a worker, self-employed, or entrepreneur, depending on the occupational choice for the current period). The Frisch elasticity of labor supply is $\frac{1}{\phi-1}$, the inter-temporal elasticity of substitution is $\frac{1}{\sigma}$, and ψ is a scale parameter that determines the relative value of leisure.

In the corporate sector, large firms operate in a perfectly competitive market. The production function for the representative firm of the corporate sector is a constant return to scale Cobb-Douglas technology which takes as inputs the aggregate capital and efficiency units of labor used in the corporate sector, i.e., the capital and labor not employed by the entrepreneurs and self-employed. The production function for the representative firm of the corporate sector is:

$$F(K, L) = K_c^{\alpha} L_c^{1-\alpha} \qquad (1)$$

where K_c is aggregate capital and L_c the efficiency units of labor used in the corporate sector and α is the capital share. Firms in the corporate sector hire workers in a perfectly competitive labor market and rent capital from financial intermediaries.

The production function for entrepreneurs (and self-employed agents, which are in fact entrepreneurs that operate small informal businesses) is

$$f(z, k, l) = z k^{\alpha} l^{\theta}, \qquad (2)$$

where z is individual entrepreneurial productivity, k the stock of capital rented by the entrepreneur, and l labor employed from a perfectly competitive and frictionless labor market (including the fraction of time that entrepreneurs work in their own firm as explained below). As in Buera & Shin (2013), we assume that $\alpha + \theta < 1$, implying that there are diminishing returns to scale in the variable input factors at the firm level. The entrepreneurs (and self-employed) make a positive profit (which is an increasing function of the managerial ability and scale of the business).

Credit Markets

Entrepreneurs finance their investment with their own resources and can rent physical capital from a financial intermediary with a within-period contract at the equilibrium rental rate.

Banerjee & Duo (2005) document that poor countries also have low levels of financial development with much less access to formal financial services. According to Buera et al. (2011), a common explanation for the poor performance of entrepreneurs in developing economies is their inability to obtain formal credit. We follow these authors and model imperfection in financial markets as limits to the amount of capital entrepreneurs can rent. We assume that the upper bound on capital, depends on the entrepreneur's assets and the strength of financial institutions, $k \leq \kappa a$ and $a \geq 0$, where κ governs the strength of financial institutions and a is an individual individual's financial wealth.[7] Firms in the corporate sector do not face financing constraints.

[7] $\kappa = 1$ implies financial autarky since all capital is financed by the entrepreneur and $\kappa \to +\infty$ implies perfect credit markets. As explained in Buera et al. (2015), this simple collateral constraint can also be derived from a limited-enforcement problem where individuals cannot be excluded from future economic activity.

Health

The health shock h affects agent's net income given either by the wage or entrepreneurial profit net of taxes. We make this assumption to parsimoniously capture the idea that individuals with bad health face financial costs—both for treatment and from lost income. Individuals that are formal need to pay payroll taxes but are insured against health risks. The generosity of the health care system, the share of health-related costs an individual has to pay out-of-pocket, is determined by a coinsurance rate $(1-\gamma)$.

Following Attanasio et al. (2010) we assume that an agent with a bad health shock ($h < 1$) looses a share of $1-h$ of their net income.[8] The public health insurance system then transfers $\gamma(1-\mathrm{h}) \times income$ while agents need to cover the share $(1-\gamma)$ themselves. However, health only has a monetary value in our model, i.e., there is no additional utility loss from being in bad health and there is no relationship between health and individual productivity as in Attanasio et al. (2010).[9]

The size of the transfer depends on the generosity of the health insurance system (as measured by γ), the severity of the health shock (a lower h implies worse health), and the net income of the individual (either from wages or entrepreneurial profits depending on the occupation, which captures the opportunity cost of the time lost due to bad health).

Entrepreneurs' Problem

Both entrepreneurs and self-employed individuals take the interest rate and wage rate as given. Thus, the indirect profit function of an entrepreneur/self-employed with productivity z solves:

$$\pi^i(a,z) = \max_{\{k,l\}} z\,k^{\alpha}\,l^{\theta} - (r+\delta)k - w\,\max\{0, l-n^i\}, \qquad (3)$$

$$s.t.\ k \leq \kappa a$$

where $i \in \{E, SE\}$ and n^i is the fraction of time that an entrepreneur/self-employed works in their own firm. a represents the stock of financial wealth, k is the desired stock of capital for production, and l is the demand for labor efficiency units. The entrepreneur's/self-employed agent's own labor supply is part of the labor services used for production, and thus an entrepreneur only pays a wage to the labor demand that exceeds their own labor supply. Both the entrepreneur and self-employed solve the same problem, but in our model, when the entrepreneur chooses to operate a small firm, we label these agents as self-employed and assume their business is informal.

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[8] In their model, a medical expenditure shock affects individuals' disposable resources for consumption. For insured individuals a fraction of these expenditures is covered by the health insurance. However, households make consumption and labor supply decisions under uncertainty since the shock hits them later in the period.

[9] In reality, a more generous health care system is likely to improve individual health and thus might have a positive impact on productivity and welfare. Therefore, our model potentially underestimates the true welfare gains from the expansion of SIS.

Occupational Choice

As in Buera & Shin (2013), the occupational choice is a static problem because there is no uncertainty in the entrepreneurial activity, since agents observe the draw of the shocks for the current period before they make their decision and there are no costs from switching occupations.[10] Thus,

$$y(a,h,z,\nu) = \max_{o\in\{E,SE,W\}}\{y^E;\ y^{SE};\ y^W\}, \qquad (4)$$

describes the occupational choice problem for an individual with assets a, labor productivity ν, entrepreneurial productivity z, and health h. We denote the optimal occupational choice by $o \in \{E, SE, W\}$. Given a health draw, an individual becomes an entrepreneur when their assets and entrepreneurial ability result in entrepreneurial profits that exceeds the income, they would receive from working given their labor productivity.

The income an individual receives from working is given by

$$y^W(\nu,h) = (1-\tau^w)\, h\, \nu\, wn + \gamma\,(1-h)\, wn, \qquad (5)$$

where τ^w is the payroll tax[11], h is the health draw, ν is the labor productivity, w is the wage rate, n the fraction of time that the individual devotes to working, and γ measures the generosity of the health insurance system.

Self-employed individuals instead operate a small informal business, they do not pay taxes and are not covered by the government-provided health insurance system (thus, they must bear the health risk). Hence their income is

$$y^{SE}(z,h,a) = h\,\pi^{SE}, \qquad (6)$$

where π^{SE} is the indirect profit function of a self-employed individual that hires an optimal amount of capital k^{SE} and labor l^{SE}.

Entrepreneurs on the other hand pay taxes. They are audited when their sales exceed a threshold $f(z,k,l) \geq \Phi$ which is public information and exogenously determined by the government.[12] This assumption is motivated by the fact that health care coverage for

[10] Our model also abstracts from differences in job security/labor laws, and does not consider pension benefits etc. These factors potentially make the choice to become informal in the model more attractive than in reality.

[11] As Galiani & Weinschelbaum (2012) point out, the equilibrium of the economy is unaltered if we instead tax firms' labor costs, as what matters is the total tax on labor earnings.

[12] Galiani &Weinschelbaum (2012) instead assume that there is a fixed cost to operating a formal firm and a non-zero probability of being detected when operating informally. Both assumptions generate a positive relationship between firm size and formality which is observed in the data.

entrepreneurs in Peru is contingent on sales and turnover OECD (2016).[13] Therefore, in our model, entrepreneurs are insured against health risks in the same way that workers are (since both pay taxes and are thus considered formal).

The income an individual receives from entrepreneurial activity is given by

$$y^E(z,h,a) = (1-\tau^{\pi})\, h\, \pi^E + \gamma\,(1-h)\,\pi^E \quad \text{if } f(z,k,l) \geq \Phi, \qquad (7)$$

where $\pi^E(z,a)$ is the indirect profit function of an entrepreneur. Hence, based on the outcome of the shocks and asset holdings, agents optimally select whether they are formal or informal with their choice of optimal capital and labor inputs (which in turn determines the size of their business and their sales).

Consumer's Problem in Recursive Form

The problem of an individual with financial wealth a, entrepreneurial productivity z, and health h who chooses consumption c, assets tomorrow a' , and how much labor n to supply, can be summarized by the following Bellman equation. As in Buera & Shin (2013), the max operator in the budget constraint represents the occupational choice presented in Equation (4), which in turn depends on the indirect profit function π which solves the entrepreneurs' problem in Equation (3).

$$V_t(a,z,h,\nu) = \max_{c,a',n\geq 0} u(c,n) + E_{z',\nu',h'}[V_{t+1}(a',z',h',\nu')|a,z,h,\nu], \qquad (8)$$

$$s.t.\ (1+\tau^c)c + a' = \max\{y^w;\ y^{SE};\ y^E\} + (1+r)a,$$

Thus, given the sequence of optimal static decisions for the occupational choice and for the profit maximization of the entrepreneurs, the dynamic program is analogous to a standard capital accumulation problem with production. Where the income of a worker is given by Equation (5) and the income of the self-employed and the entrepreneur are given by Equation (6) and Equation (7), respectively. Both workers and entrepreneurs choose the fraction of time that they work, but entrepreneurs work in their own business.

Competitive Equilibrium

The representative firm in the corporate sector maximizes its profits, and as usual, the equilibrium wage is determined by the marginal product of labor in the corporate sector: $w = F_L'(K,L)$. We assume a small open economy, so the interest rate r is exogenously given. Capital depreciates at the rate δ, thus the zero-profit condition of the financial intermediaries implies that the rental rate of capital is $R = r + \delta$.

[13] Before 2013, microenterprise eligibility was based on the number of employees.

A stationary competitive equilibrium is defined such that individuals take wages and the interest rate as given and solve the profit maximization, occupational choice and consumer problems as described in equations (3), (4), and (8), respectively. The policy rule $a'(a, z, h, \nu)$ which solves the consumption-saving decision, together with the labor supply decision, and the transition probabilities of productivity shocks induce a distribution of agents in this economy $G(a, z, h, \nu)$.

The labor market clears, i.e., $N = L^C + L^E + L^{SE}$, where aggregate labor supply N is found by integrating the labor supply in efficiency units of each worker and the aggregate labor demand is the sum of the aggregate labor demand from the corporate sector L^C and the aggregate labor demand from the entrepreneurial sector $L^E + L^{SE}$.

The government budget constraint satisfies

$$g + \int \gamma(1-h)(wn^W + \pi^E)dG = \int (\tau^w wn^W + \tau^\pi \pi^E + \tau^c c)dG, \qquad (9)$$

where the left-hand site of Equation (9) represents the government's spending on transfers to health insured agents and on final consumption g, while the right-hand side shows total tax revenues from payroll, corporate income, and consumption taxes.

IV. CALIBRATION

Table 3 presents parameters in the model that were selected from the literature. Table 4 instead presents parameters that we calibrated to match certain moments of the Peruvian data.

Parameters Taken from the Literature

Consumption is stable over time if $\beta = \frac{1}{1+r}$, where $r = 0.03$ is the annual interest rate. Hence, β is set to 0.97 in the model. The relative weight on consumption versus non-market time ψ is selected such that agents spend $1/3$ of their time working. The coefficient of relative risk aversion σ is set at 1.5 in line with the findings of Attanasio et al. (1999). Rogerson & Wallenius (2013) argue that a Frisch elasticity of 0.5 is in line with the data and thus we choose $\phi = 3$.

For the technology parameters, we follow Buera et al. (2011) and set the capital share of output to 0.2633[14] and the parameter κ that governs the strength of financial institutions equal to 0.26. The labor share of output for entrepreneur's is set to $\theta = 0.5267$, following Buera et al. (2013). The annual depreciation rate is set to 6 percent following Stokey & Rebelo (1995).

[14] Céspedes & Ramírez-Rondán (2014) point out, available research for Peru considers a capital share of output to be between 0.33 and 0.69. Our results are robust to changes in this parameter.

Table 3: Summary Calibration

Parameter	Description (Source)	Value
β	Discount factor (see text)	0.97
r	Annual interest rate	0.03
ψ	Relative weight on consumption (see text)	0.44
$1/\sigma$	Intertemporal elasticity of substitution (Attanasio et al. 1999)	0.67
$1/(\phi-1)$	Frisch elasticity of labor supply (Rogerson & Wallenius 2013)	0.50
α	Capital share of output (Buera et al. 2011)	0.26
κ	Strength of financial institutions (Buera et al. 2011)	0.26
θ	Labor share output entrepreneur (Buera et al. 2013)	0.53
δ	Depreciation rate (Stokey & Rebelo 1995)	0.06
ρ_v	Persistence labor productivity (Floden & Lindé 2001)	0.91
σ_v^2	Standard deviation labor productivity (Floden & Lindé 2001)	0.21
ρ_z	Persistence entrepreneurial productivity	0.91

The natural logarithm of the labor productivity and entrepreneurial ability processes are approximated with five-state Markov processes, using the methodology of Tauchen (1986). As estimated by Floden & Lindé (2001), we set the persistence of the labor productivity shock to 0.91 and the standard deviation of the labor productivity shock to 0.21. We set the persistence of the entrepreneurial ability shock to equal the persistence of the labor productivity shock. The median value of the grids for both the labor productivity shock and entrepreneurial ability shock are normalized such that average productivity of workers and entrepreneurs is unity.

Parameters for Peru

Table 4 summarizes parameters that were calibrated to match moments of the Peruvian economy. We calibrate the implicit tax rates in the model to match Peru's revenues as a share of GDP (for personal income, corporate income and consumption)[15]. The implied effective payroll tax rate in our model is 15.2 percent. We use the revenues from taxes on corporate income and taxes on goods and services to calibrate the corporate income tax and consumption tax and set $\tau^{\pi} = 0.11$ and $\tau^{c} = 0.07$. The government's final consumption expenditure g is calibrated to satisfy the government's budget constraint. The generosity of the health insurance system, γ, is calibrated to match Peru's public health spending as a share of 3.2 percent (OECD 2016).

The standard deviation of the entrepreneurial ability shock σ_z^2 is calibrated to match the 43 percent share of workers reported by the Socio-Economic Database for Latin America and the Caribbean (SEDLAC). The grids and transition matrices for the entrepreneurial ability and labor productivity shocks are shown in Appendix A.1. The production threshold Φ is calibrated to match the 89 percent of informal establishments in Peru, as reported by SEDLAC. Thus, our calibration allows us to match the distribution of workers, entrepreneurs, and self-employed individuals in Peru.

[15] The payroll tax rate is calibrated to match the sum of revenues from the individual income tax and social security contributions.

Table 4: Summary Calibration for Peru

Target Moment	Data	Model	Parameter
Payroll tax revenue/GDP	5.3%	5.8%	$\tau^w = 0.15$
Corporate income tax revenue/GDP	5.4%	3.9%	$\tau^\pi = 0.11$
Consumption tax revenue/GDP	11.0%	11.2%	$\tau^c = 0.07$
Public health spending/GDP	3.2%	3.7%	$\gamma = 0.06$
Share of workers	43%	48.8%	$\sigma_z^2 = 0.49$
Share of informal establishments	89%	89.7%	$\Phi = 2.5$

To choose the parameters governing the health shocks, we use data from the National Household Survey of Peru ("Encuesta Nacional de Hogares", ENAHO). Table 5 summarizes the parameterization of the health shock in our model. We separate health into three categories: good, fair, and poor. We calibrate the transition matrix such that in our model roughly 40 percent of agents are in good health, which corresponds to the fraction of ENAHO respondents that report having no symptoms of discomfort, illness, disease or accidents in the past 4 weeks. Of the 60 percent individuals who indicate some form of illness, disease, or accident, 18.3 percent report not being able to perform their daily activities in the past 4 weeks. Thus, we adapt the Markov chain so that around 11 percent of agents in our model are in poor health (18.3 percent $\times$ 60 percent = 11 percent). The remaining 49 percent of the total population are characterized to be in fair health. Thus, we match in our model the percent of persons that report having bad, fair, and good health (11, 49, and 40 percent, respectively).

The bad health shock is calibrated such that it implies a cost to individuals of about 24 percent of their income as survey respondents indicate that, conditional on not being able to perform their activities, they cannot work for an average of 4.8 out of the past 20 workdays ($4.8/20 = 0.24$). The fair health shock is calibrated to match the 10.6 percent average per capita health care spending from the ENAHO survey (thus, agents with fair health only have 89.4 percent of their income available). Good health is assumed to have no impact on income. Hence, the health shock lies on the following grid: $h \in \{0.76;\ 0.89;\ 1\}$.

Table 5: Parameterization of Health Shock

Parameter	Description (Source)	Value
h_b	Cost of bad health ($4.8/20$ days no work)	0.76
h_f	Cost of fair health (avg. health spending)	0.89
h_g	Normalization of good health	1.00
$P(h = b\|h = b)$	Prob. of staying in bad health	0.80
$P(h = f\|h = b)$	Prob. of moving from bad to fair health	0.18
$P(h = b\|h = b)$	Prob. of staying in bad health	0.65
$P(h = f\|h = b)$	Prob. of moving from bad to fair health	0.05
$P(h = b\|h = b)$	Prob. of staying in bad health	0.65
$P(h = f\|h = b)$	Prob. of moving from bad to fair health	0.33

V. Model Performance

Given the parametrization explained in the previous section, we simulate the model and calculate statistics (not linked to the calibration) to evaluate the model's fit to the Peruvian economy. Table 6 shows that the model is able to accurately reproduce interesting aspects of Peru's income distribution, such as the relative incomes by occupation and the degree of income inequality.

Table 6: Data Moments and Model Performance

Moment	Data	Model
Relative income informal/formal	0.28	0.24
Relative income worker/entrepreneur	0.69	0.73
Capital labor ratio	2.75	2.37
Income Gini coefficient	42.8	39.6

Our model generates similar results to those reported by SEDLAC for Peru, where formal workers earn 31 percent less than entrepreneurs and informal self-employed individuals earn 72 percent less than entrepreneurs. These results are line with the argument by Galiani & Weinschelbaum (2012) that informality is linked to low productivity as informal individuals do not produce enough value-added to cover the costs of being hired formally. The capital labor ratio in our model of 2.37 is close to the estimates of Céspedes & Ramírez-Rondán (2014). The resulting income distribution in the model is quite similar to the one observed in the data, as summarized by the Gini coefficient.

VI. Policy Experiment

We use the model to simulate the impact of the expansion of the non-contributory health care system (SIS) on informality, welfare, and tax revenues. Before the reform, only workers and entrepreneurs are insured against health risks. More specifically, self-employed individuals are not covered by the health insurance (which means they must cover health related expenses out-of-pocket) and they do not pay taxes. In the initial equilibrium, roughly 5 percent of agents are entrepreneurs, 49 percent are workers, and the remaining 46 percent are self-employed. After the reform, all individuals become health insured and self-employed agents still do not pay taxes.[16] The extension of the health coverage to the self-employed individuals roughly mirrors the increase in SIS coverage between 2006 to 2019 (where SIS eligibility increased by about 35 percentage points).

However, an important feature of the Peruvian reform is that government in fact expanded the eligibility without a commensurate increase in public health spending, which means the generosity and quality of the coverage were effectively reduced. Even before the expansion,

[16] Formally, we adjust Equation (6) such that the self-employed also receive a transfer from the health insurance system of $\gamma(1-h) \times \pi^{SE}$.

there already was a shortage of health workers. As Bernal et al. (2017) point out, Peru only had 1.24 health workers in public facilities per 1,000 population, compared to the recommended 2.3, by the World Health Organization (WHO 2013).[17] After the 2006 reform, there was a rapid increase in health expenditures and by 2009 SIS' budget was 47 percent higher. However, the increases were disproportionate to the expansion of population coverage, with the result that spending per person covered decreased by 31 percent (Bernal et al. 2017). Since 2014, the number of SIS affiliates has grown by 5.3 percent on average compared to the 0.1 percent growth of available resources (roughly implying a 5 percent decline in resources per affiliate over the past 5 years).

We incorporate this critical aspect of the reform into our simulations. More precisely, we require public health spending as a fraction of GDP to remain unchanged after the reform by reducing the generosity of the health care system (which means the out-of-pocket spending for individuals is higher for any given shock). Therefore, the increase in the number of beneficiaries in fact lowers the actual insurance per person.

To explore whether the financing mechanism (the mix of taxes and social security parameters selected by the government) drives our results, we conduct a second counterfactual experiment where the generosity of the health insurance remains unchanged and instead the consumption tax is increased to finance the additional spending needs. In a third counterfactual, we simulate the impact of a possible unification of the contributory and non-contributory systems by assuming a significant increase in the quality/ generosity of the system (given that the former spends over 13 times more per insured individual).

A. Results

Table 7 summarizes the results of extending the non-contributory health insurance to the self-employed individuals. In our model, as a response to the policy change, some agents find it optimal to decrease the size of their business to eschew income taxes while remaining health insured. As a result, the share of individuals that choose to become entrepreneur decreases by 1.1 percentage points and the share of self-employed increases by 1.26 percentage points or 2.7 percent. This implies an increase in the ratio of informal to formal establishments by 2.65. To put these results into perspective, Bosch & Campos-Vazquez (2014) find a 4.6 percent increase in informal employment after the introduction of the Mexican program Seguro Popular.[18]

The income distribution of workers, entrepreneurs and self-employed is also affected. Entrepreneurs still earn more than both self-employed and workers, but their advantage compared to workers shrunk by 0.04 percentage points while their advantage compared to informal workers increased by 0.28 percentage points. Even though self-employed individuals

[17] As shown in Table 1 and Table 2, Peru's health indicators still lag other Latin American countries.

[18] Two factors might explain why our model predicts a smaller increase in informality for Peru: 1) There was a substantial increase in the Mexican health budget dedicated to improvement of the service provided and 2) the authors find evidence that firms reallocate labor from formal to informal contracts, a form of informality our model abstracts from.

face smaller income declines when they experience bad health shocks due to the health insurance, the relative income differences increased as the least productive entrepreneurs operated business with size just above the formality threshold no longer elect to become entrepreneurs. This selection raises the average income of the remaining entrepreneurs more than it raises the average income of the newly self-employed. As a result, the income distribution becomes slightly more unequal (as measured by the Gini coefficient). As more agents move into the informal sector, the average productivity in the sector increases and capital demand increases. However, since some agents decrease the size of their business to avoid taxation, capital demand from entrepreneurs falls (which explains the fall in the capital labor ratio in the entrepreneurial sector). Furthermore, the capital labor ratio in the corporate sector declines, which results in a decrease in real wages. As a result of these changes, output falls by 0.08 percent.

Table 7: Results Expansion SIS

Moment	Before	After
Share of workers	48.78%	48.62%
Share of entrepreneurs	5.26%	4.16%
Share of self-employed	45.96%	47.22%
Relative income informal/formal	23.72%	23.68%
Relative income worker/entrepreneur	74.31%	74.59%
Income Gini coefficient	0.3960	0.3962
Payroll tax revenue/GDP	5.83%	5.82%
Corporate income tax revenue/GDP	3.93%	3.67%
Consumption tax revenue/GDP	11.16%	11.13%
Public health spending/GDP	3.74%	3.75%
Generosity of health insurance	6.19%	5.81%
Capital labor ratio corporate sector	2.293	2.288
Capital labor ratio entrepreneurial sector	2.227	2.195
Output	1.00	0.9992

In our first policy experiment, the government does not raise taxes to finance the expansion of coverage and instead adjusts the generosity of the health care system. Since there are slightly fewer workers in the economy, the payroll tax revenues as a share of GDP decreases by 0.01 percentage points. A stronger effect is observable for the corporate income tax revenues which decrease by 0.26 percentage points as a result of the drop in the share of entrepreneurs in the economy. Since self-employed individuals only pay consumption tax in our model, overall tax revenue as a share of GDP declines by roughly 0.1 percent. This reduction is accompanied by a downward adjustment in the generosity of the health care system by 0.38 percentage points after the reform was implemented. Since the health insurance in our model operates through an income weighted compensation (and self-employed individuals earn much less than entrepreneurs and workers) the necessary adjustments in the generosity of the

health care system are smaller compared to the declines in the resources per affiliate observed in the Peruvian data.

Unsurprisingly, the reform benefits self-employed individuals. Their welfare increases by 0.13 percent compared to the pre-reform economy as they become insured against health risks but can still avoid income taxation.[19] However, this welfare increase is smaller than the increase of 1.76 percent estimated by Attanasio et al. (2010) as a response to additional Social Security and Medicare outlays in the United States.[20] Welfare for entrepreneurs on the other hand declines by 0.16 percent while welfare for workers increases by 0.05 percent. Since entrepreneurs make up the smallest share of the population, overall welfare actually increases which might be beneficial for securing political support for the reform.

B. The Financing Mechanism

In the first policy experiment, the government does not increase taxes to finance the reform and instead lowers the generosity of the health care system, which mimics the behavior of the Peruvian government during the expansion of SIS. In a second policy experiment, we assume that the government increases the consumption tax to finance the increases in spending instead of lowering the generosity of the health care system.[21] Table 8 summarizes the findings.

Column 4 presents the results from the second policy experiment and column 3 repeats the results from the first experiment for convenience. Financing the expansion of the health care system through an increase in consumption taxes instead of a reduction in the generosity of the health care system leads to a stronger increase in informality. The shares of workers and entrepreneurs fall by more and the share of self-employed increases more compared to the first policy experiment. Workers' relative income compared to entrepreneurs slightly worsens while the relative income of the self-employed increases by almost 6 percentage points compared to the pre-reform economy. Output decreases by 0.3 percent. In terms of welfare, this implies that self-employed are better off from this reform as their welfare increases by 0.57 percent. As with the first policy experiment, welfare losses from entrepreneurs are overcompensated by the welfare improvements for self-employed and overall welfare increases. The alternative financing of the expansion results in a more unequal income distribution as measured by the Gini coefficient. Unsurprisingly, the revenues from consumption taxes increase in this counterfactual, allowing the government to expand the public health spending by 0.39 percentage points to 4.13 percent of GDP while keeping the nominal generosity of the health care system constant.

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[19] We measure welfare changes in units of consumption, using a utilitarian welfare function where each individual is equally weighted. Thus, our welfare measure misses other potential social gains from the reform such as better the treatment of illnesses discussed earlier.

[20] This occurs because in their model, the health insurance is much more generous than in Peru (with replacement rates of up to 50 percent) and is more valuable as agents make consumption decisions under uncertainty (as they assume agents do not observe the health shock at the beginning of the period)

[21] We do not allow the government to finance the reform by a transitory increase in public debt. However, given that the reform potentially also improves individual health and thus productivity, one could imagine positive effects on aggregate productivity and growth, which would allow for higher future tax revenues and a reduction in future public debt.

Table 8: An Alternative Financing of the Reform

Moment	Before	PE 1	PE 2
Share of workers	48.78%	48.62%	48.59%
Share of entrepreneurs	5.26%	4.16%	3.34%
Share of self-employed	45.96%	47.22%	48.07%
Relative income informal/formal	23.72%	23.68%	23.73%
Relative income worker/entrepreneur	74.31%	74.59%	68.29%
Income Gini coefficient	0.3960	0.3962	0.3973
Payroll tax revenue/GDP	5.83%	5.82%	5.79%
Corporate income tax revenue/GDP	3.93%	3.67%	3.78%
Consumption tax revenue/GDP	11.16%	11.13%	12.07%
Public health spending/GDP	3.74%	3.75%	4.13%
Generosity of health insurance	6.19%	5.81%	6.19%
Capital labor ratio corporate sector	2.2934	2.2884	2.2978
Capital labor ratio entrepreneurial sector	2.2265	2.1947	2.2305
Output	1.00	0.9992	0.9973

C. Increasing the Generosity/Quality of Health Care

While health expenditure has grown in LAC, it remains well below the OECD average and is more dependent on private spending (OECD/WB 2020). Peru's public health spending of 3.2 percent GDP is below the 4.6 percent average of the five largest Latin American countries presented in Table 9 and the 7.7 percent average in OECD countries.

While the expansion of the non-contributory health insurance system has almost achieved universal coverage, going forward the country will likely have to substantially increase its health spending in order to achieve an effective system that delivers better quality services and health results. During his state of the union speech in July 2020, former President Vizcarra communicated plans to achieve universal coverage such that all uninsured Peruvians will become affiliated with SIS by July 2021. More recently, in September 2020, the Ministry of Economy and Finance announced plans to close the gap in universal insurance, merge the existing systems (EsSalud and SIS) and alleviate poverty. The implementation of these policies would not only expand the coverage of SIS further but, more importantly, increase the generosity and quality of the insurance at the cost of higher public health care spending (given that EsSalud currently spends thirteen times more per insured person than SIS).

Table 9: Health Spending as a Share of GDP

Country	Total	Public	Private
Argentina	9.1	6.6	2.5
Brazil	9.5	4.0	5.5
Chile	9.0	4.5	4.5
Colombia	7.2	4.9	2.3
Mexico	5.5	2.8	2.7
Peru	5.0	3.2	1.8
Average	8.0	4.6	3.5

Source: World Bank

We use our model to analyze the implications for Peru of increasing its public spending, e.g., raising the generosity/quality of health care to the average of other Latin American or OECD countries. In this third policy experiment, we again allow the government to adjust the consumption tax rate. As shown in Table 10, if the government raised its health spending to the Latin American average, it would need to increase the consumption tax rate from 7 to 8.8 percent in order to finance the additional spending. This results in higher tax revenues as the share of total tax revenues on GDP rises 0.55 percentage points. However, the share of entrepreneurs falls by 2.4 percentage points while the share of self-employed increases by 2.6 percentage points. Output decreases by 0.9 percent. Overall welfare increases in this counterfactual scenario by 1.31 percent as all groups benefit from a more generous insurance, indicating broad political support.

Increasing public spending and the generosity/quality of the health insurance even further, however, has sizable effects for informality. Our model suggests that if Peru were to implement OECD level health care spending, to finance an almost doubling of the generosity/quality of the public insurance system (which is comparable to offering the quality of EsSalud to everyone after unifying the two systems), no individual would find it beneficial to become an entrepreneur anymore. Informality would increase significantly by 12.3 percent leaving more than half of the model population better off in the informal sector. This has direct consequences for output, which falls by 1.13 percent compared to the pre-reform level.

Reducing entrepreneurship has direct economic costs. As Quadrini (2000) and Cagetti & Nardi (2006) point out, entrepreneurs contribute to the economy in a significant way. Though they account for a small share of the population, they own a significant share of wealth and produce a large part of total output. Furthermore, entrepreneurs stimulate economic activities, innovation, and increase aggregate investment. Moreover, a vibrant entrepreneurial sector invests more which stimulate stimulates labor demand and increase wages, which also benefits workers (Kitao 2008).

Table 10: Increasing the Generosity of Health Care

Moment	Before	LA	OECD
Share of workers	48.8%	48.5%	48.4%
Share of entrepreneurs	5.3%	2.9%	0%
Share of self-employed	46%	49%	52%
Relative income informal/formal	23.72%	23.70%	–
Relative income worker/entrepreneur	74.3%	65.1%	–
Income Gini coefficient	0.396	0.399	0.401
Payroll tax revenue/GDP	5.8%	5.7%	5.6%
Corporate income tax revenue/GDP	3.9%	3.5%	0%
Consumption tax revenue/GDP	11.2%	13.2%	16.1%
Public health spending/GDP	3.7%	4.6%	7.7%
Generosity of health insurance	6.2%	7.8%	11.2%
Capital labor ratio corporate sector	2.293	2.307	2.308
Capital labor ratio entrepreneurial sector	2.227	2.237	2.203
Output	1.00	0.9910	0.9887

VII. Conclusions

In this paper we analyze the impact of the expansion of the non-contributory health system SIS through the lens of a structural model of the Peruvian economy that incorporates informality, entrepreneurship, and a health insurance system.

We simulate the expansion of SIS in our model by providing all individuals in the economy with health insurance (irrespective of whether they are in the formal sector and pay taxes or not), while decreasing the generosity of the health care system to keep public health spending as a fraction of GDP constant. We find that that the reform increases the share of informal workers by 2.7 percent as some agents optimally 22 decrease the size of their business to prevent audits and avoid taxation while enjoying the benefits of free health insurance. As a result, output and the real wage fall by about 0.1 percent. Overall welfare improves and the reform is particularly beneficial for the self-employed individuals as they become insured against health risks but can still avoid income taxation, while the welfare of formal entrepreneurs declines by 0.16 percent.

Our estimates of the unintended costs from the reform are smaller than other estimates in the literature mainly because in Peru the increase in health coverage was not accompanied by a commensurate increase in public health spending. In fact, when we evaluate the effect of recent policy proposals to substantially increase the generosity and quality of the public health care system, we find that increasing government spending to levels observed in other Latin American or OECD countries would result in a substantial disincentive to the entrepreneurial activity in favor of informality.

Looking ahead, our results emphasize that the positive gains from expanding health coverage should be weighed against the negative unintended consequences from the reallocation of labor into the informal sector. To address this distortion in the labor market and its potential negative effects on output, we suggest to best counter it by using appropriate policy instruments, such as streamlining labor regulations, sustained improvements in labor productivity through, e.g., investments in education, and supporting policies for entrepreneurs that act on reducing informality most directly (Prado, 2011). According to Ahn et al. (2019), such a policy package provides the best of both worlds — a higher long-term productivity and a reduction in non-salary costs, which might help to address the distortion in the labor market caused by the expansion of free health coverage.

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A Appendix

A.1 Markov processes for z and ν

The Markov process for the labor productivity ν is given as follows:

$$\nu \in \{0.2357,\ 0.3815,\ 0.6177,\ 1.0,\ 1.6189,\ 2.6210,\ 4.2432\}$$

$$P_{\nu} = \begin{vmatrix} 0.68 & 0.32 & 2.95E\text{-}03 & 2.24E\text{-}07 & 1.06E\text{-}13 & 0 & 0 \\ 0.05 & 0.70 & 0.24 & 1.43E\text{-}03 & 6.58E\text{-}08 & 1.85E\text{-}14 & 0 \\ 1.22E\text{-}04 & 0.08 & 0.74 & 0.18 & 6.59E\text{-}04 & 1.84E\text{-}08 & 3.10E\text{-}15 \\ 4.86E\text{-}09 & 2.89E\text{-}04 & 0.13 & 0.75 & 0.12 & 2.89E\text{-}04 & 4.86E\text{-}09 \\ 3.09E\text{-}15 & 1.84E\text{-}08 & 6.59E\text{-}04 & 0.18 & 0.74 & 0.08 & 1.21E\text{-}04 \\ 2.95E\text{-}23 & 1.86E\text{-}14 & 6.58E\text{-}08 & 1.43E\text{-}03 & 0.24 & 0.70 & 0.05 \\ 4.14E\text{-}33 & 2.83E\text{-}22 & 1.06E\text{-}13 & 2.24E\text{-}07 & 2.95E\text{-}03 & 0.32 & 0.68 \end{vmatrix}$$

The Markov process for the entrepreneurial ability z is given as follows:

$$z \in \{0.0268,\ 0.0896,\ 0.2994,\ 1.0,\ 3.3399,\ 11.1550,\ 37.2580\}$$

$$P_{z} = \begin{vmatrix} 0.71 & 0.28 & 1.50E\text{-}03 & 3.75E\text{-}08 & 3.33E\text{-}15 & 0 & 0 \\ 0.05 & 0.72 & 0.22 & 7.02E\text{-}04 & 1.09E\text{-}08 & 5.55E\text{-}16 & 0 \\ 6.27E\text{-}05 & 0.07 & 0.76 & 0.16 & 3.04E\text{-}04 & 3.07E\text{-}09 & 1.11E\text{-}16 \\ 8.20E\text{-}10 & 1.00E\text{-}04 & 0.11 & 0.77 & 0.11 & 1.07E\text{-}04 & 8.20E\text{-}10 \\ 9.78E\text{-}17 & 3.07E\text{-}09 & 3.03E\text{-}04 & 0.16 & 0.76 & 0.08 & 6.28E\text{-}05 \\ 1.01E\text{-}25 & 5.85E\text{-}16 & 1.09E\text{-}08 & 7.13E\text{-}04 & 0.21 & 0.73 & 0.05 \\ 8.80E\text{-}37 & 9.67E\text{-}25 & 3.33E\text{-}15 & 3.75E\text{-}08 & 1.58E\text{-}03 & 0.2880 & 0.71 \end{vmatrix}$$