Labor Legislation and the Size of Informal Sector in Brazil.

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Abstract

This paper studies the increase in the rate of informal workers in the Brazilian economy that occurred between 1985 and 1999. We develop an overlapping generations model with incomplete markets in which agents are ex-post heterogeneous. We calibrate it to match some features of the Brazilian economy for 1985. We conduct a policy experiment which reproduces the 1988 constitution reforms that increased the retirement benefits and labor costs in the formal sector. We show that these reforms can explain the increase in informal labor. Then, we conduct a policy experiment and analyze its impact on the Brazilian economy.

1 Introduction

In the last decade the Brazilian economy observed a sharp increase in the rate of informal workers in the economy. This increase was observed among several different measures of informal employment. For example, if you measure the rate of informal workers using the number of workers that do not have a signed work card(called "carteira assinada"), the rate of informal workers corresponded to 28% of total workers in 1980. This number increased to 38% at the end of the 90's. Alternatively, if you measure the size of the informal sector using the rate of workers that do not contribute to the social security system, the rate was 52,8% in 1985 and increased to 62% in 1999. As can be seen, in both measures the increase was roughly 10%.

In order to explain this phenomena, the economic literature on informal labor markets must first recognize and define the informal sector. As the Brazilian law requires that employees have a signed card in order to work, one of the first definitions was to consider an informal worker as one that did not have a signed card. Another definition used was whether the worker was contributing to the social security system or not. The worker that did not contribute to the social security was considered informal. These two measures are highly correlated as Neri(2002) points out. Among the workers with a signed card, 95% contribute to the social security system while only 5% of the workers with no signed card contribute to it.

Once the definition of informal worker was made, studies of the wage differentials between formal and informal workers can be made. A well established fact in this literature was the significant wage differential between formal and informal wages even after controlling for observable characteristics and bias selection. On the one hand,

Pero(1992), Barros, Melo and Pero(1993), Fernandes(1996) show that there exists a wage differential in favor of the formal workers. This differential is increasing with age and school years. Carneiro and Henley(2001) find out that this differential is decreasing with duration and increasing in school years. They also find a bias selection term that is significant and positive for both sectors. On the other hand, Tannuri-Pianto and Pianto(2002) point out that this differential is decreasing in income and is highly explained by the difference in workers characteristics. They also find evidence that there exists segmentation to the workers in the lower quantiles. Menezes Filho, Mendes and De Almeida(2004) show that school years is the most important factor determining wages, instead of being in the formal sector or not. They also point out that conditional on education, the formal worker receives a lower wage than the informal worker. Soares(2004) observes that the wage differential between the two sectors decreases between 1981 and 1999 contributing to the reduction in wage inequality. He also shows that both the decrease in the rate of formal workers and the wage differential occurred at the same time as the pro market reforms of 1990. He concludes that the formal/informal differential was the second most important factor explaining the reduction in wage inequality after education.

Several studies tried to explain the reasons behind the drop in formal workers on the Brazilian economy. The consistent increase of the informal sector made a cyclical explanation very unlikely. Ramos(2002) reinforces the view that a structural change was the responsible for this change. He shows that the change in the economy's composition towards the service sector(a more informal sector) can account for 25% of this change. A second factor was the increase in the rate of informal workers in the industrial sector.

Another source that is used to explain this increase was related to the impact of the institution's on the informal sector as in Barros(1993) and Amadeo and Camargo(1996). This explanation is based on the fact that Brazilian legislation introduces a lot of rigidity

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in the economy. These extra frictions introduced by the legislation creates incentives for employers and employees to join the underground economy instead the formal one. These frictions affect both sides of the labor market. It affects supply because high labor costs caused by the legislation, reduces the wages received by workers, working like an implicit tax. On the demand side, firms have the incentive to hire the workers without a signed card because it reduces their costs and allow them to have higher flexibility.

As Neri(2002) points out the main difference between formal and informal employees does not concern their labor rights. These rights are easily obtained ex-post in court rooms. Causing employers to usually respect them. The main difference between formal and informal jobs concerns taxes and labor costs. Therefore, informal employment is mainly a fiscal problem instead of a quality of jobs problem.

In the model developed in this paper, We use an overlapping generations model and create a Dynamic General Equilibrium Model(DGEM) where the decision to work in the formal or informal sector is endogenous. We try to explain the increase in the informal labor participation through the increase in workers' benefits and labor costs introduced in the 1988's Brazilian new constitution[1].

In order to compare the economy before and after these changes, we calibrate a benchmark model that matches the main features of the Brazilian economy before the 1988 constitution changes. Then, we introduce the changes made in the constitution and observe their effects on the economy. The new steady state has a lower formal labor participation rate than the 1985 benchmark economy. Finally, we model policy reform and analyze its effects on the economy.

The paper is organized as follows. Section 2 presents some of the stylized facts about formal and informal sector in Brazil. The third section presents the model, char-

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[1] This new constitution was written after a long dictatorship in the country. As a result, this constitution included very generous benefits to the population to fulfill the expectation of more rights and benefits to a society that had none for 20 years.

acterizing the preferences, endowment, technology and the main features of the over-lapping generation model. The parametrization of the model is presented in section 4. In section 5, we present the results. We sum up the paper with the conclusion presented in section 6.

The first one shows the benchmark model that was calibrated to match the Brazilian 1985 characteristics. Then, we present the new steady state of this economy after the 1988 changes . Finally, we present the effects of an alternative policy experiment.

2   Stylized Facts and Legislation Changes

There are some important stylized facts about the rate of worker participation in the formal sector in the Brazilian economy.

The definition of formal workers used here will be the rate of workers that contribute to the social security system.

The rate of formal workers in 1985 represented 47.2% of the labor force in 1985. In 1998, the private sector in Brazil had 65.4 million workers and only 41% of this total contributed to social security. This number was reduced to 38% on 1999, representing a reduction of 19% between 1985 and 1999.

Informality is more common among women then men.

The social security evasion rate falls monotonically with education and income. Actually, there is an even stronger fact: we observe a negative relation between informality and assets, wealth and income, i.e. the rate of formal workers increase with wealth. We can also observe that informality decreases with tenure.

Another interesting aspect relates to the age profile of the worker. We observe that the workers are more likely to enter the informal sector for their first job. Around 30 they reach the peak of formal rate. Above the age of 30 they reduce their participation in the formal sector. Therefore, it presents a hump shaped graph(see below).

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Figure 1: Formal Participation per Age
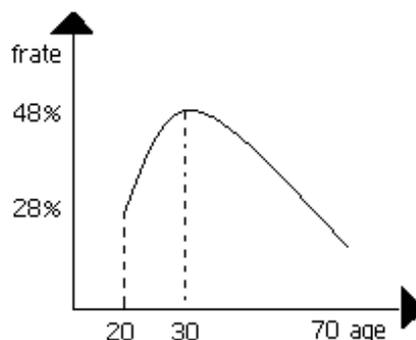
Neri(2000) provides evidence that informality is highly explained by the level of payroll taxes. Therefore, this suggests that the high informal labor participation rate is mainly a fiscal problem and not a legal one.

As mentioned previously, the 1988 constitution introduced several changes in the Brazilian labor legislation, the major changes are reported in the table below:

Table 1: 1988 Legislation Changes		
	Before 1988	After 1988
Maximum weekly hours	48	44
Minimum overtime premium	20%	50%
Maternity leave	3 months	4 months
paid vacation	1 monthly wage	4/3 monthly wage
Fine for dismissal	10% FGTS balance	40% FGTS bal.
Employer contribution to FGTS	8%	8%
Public health treatment	FGTS contributors	Universal
Ret. benefit despite contribution	1/2 minimum wage	1 minimum wage
Pension proportional to	last 36 contributions	last 36 contrib.

The constitution increased non-wage benefits and also dismissal costs. As a result of these changes the labor costs increased dramatically. It also increased the incentives for people to join the informal sector considering the fact that their future benefit is not directly linked with their contribution. Despite the increase in benefits, it also maintained the high levels of mandatory contributions, giving another incentive for people

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to move to the informal sector.

Pastore(2000) argues that the Brazilian labor legislation was one of the most rigid in the world, and the new constitution made it even worse. He also estimates that labor costs can sometimes account to 103.46% of the nominal wage.

Recently, more changes were made in order to compensate for the FGTS balance losses caused by the Brazilian plans to control inflation. In 2001, the FGTS paid by the employer increased from 8% to 8.5% and the dismissal fine increased from 40% to 50% of the FGTS balance. The extra 10% goes directly to the government.

In order to solve the Brazilian deficit problem of the social security system and also try to stimulate an increase in the number of workers that contribute to the system(formal workers), some reforms are under review. One possible change is reducing employer contribution from 8% to 2%. This change would cause an increase in formal sector wages attracting more workers. This policy experiment is conducted in this paper.

3 Model

We use an overlapping generations(OLG) model for the economy. In this economy, all agents are born with zero assets and zero contribution to the social security system, however different productivity shocks add heterogeneity to the model. Households are endowed with 1 unit of labor that they supply inelastically. They decide how much to consume, save and whether they will work in the formal or informal sector according to optimal decision rules. Once they join the formal sector, they contribute to the social security with some part of their wage.

Agents potentially live from period 1 to period J From age 1 to age $R - 1$, agents do not face a death probability. Every agent retires at age R and begin to face a positive probability of death. Agents die for sure at age J.

The stochastic feature of this model is similar to Kitao(2004), Aiyagari (1994) and Hugget(1993), and belongs to the Bewley (1986) class of models. The productivity shock is an idiosyncratic one that follows a Markov chain calibrated to match the Brazilian income process. In this model, markets are incomplete and agents are able to save for their retirement in two different ways: a risk free bond and a social security contribution. As in the Brazilian system, the social security system of this model provides a minimum benefit regardless of the agent's contribution to the system. The employer also deposits a fraction of the employee wage into the employee's social security account. We believe that this is the correct model to study this phenomena for two main reasons. First, this model is easily related to the definition of informal labor. Second, the model mimics the incentives observed in the Brazilian economy. The high productivity shock agents join the formal sector because they pay no tax on contribution savings and also receive the employer's deposits to their personal account. The low productivity shock agents enter the informal sector because they pay no tax and also have a minimum benefit guaranteed upon retirement.

3.1 Preferences, Endowments and Technology

The households have preferences over the homogeneous consumption good and leisure, given by the following:

$$E_0 \sum_{j=0}^{J} \beta^i \left[u \left(c_{t+j}, l_{t+j} \right) \right]$$

Our overlapping generation model is divided between working and retired agents who are endowed with initial assets zero and one unit of time that they can allocate between work and leisure[2].

The utility function adopted is the following:

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[2]   Here they supply this one unit of labor inelastically.

$$u\left(c_t, l_t\right) = \frac{c_t^{1-\sigma}}{1-\sigma} + \varkappa \frac{\left(1-l_t\right)^{1+\phi}}{1+\phi}$$

Agents have an idiosyncratic labor productivity given by η, that is a stochastic process that follow a Markov process given by:

$$G_t\left(\eta', \eta\right) = prob(\eta_{t+1} = \eta' | \eta_t = \eta)$$

There are two different sector in this economy: the formal and the informal sector. The formal sector produces with the following technology:

$$y_F = F\left(K, L_F\right) = AK^\alpha L_F^{1-\alpha}$$

The informal sector has a different technology that is labor intensive and is given by:

$$y_I = F\left(L_I\right) = A_L L_I$$

3.2 Households

We have an overlapping generation model divided between working and retired agents. Agents work while their age ranges from $j = 1$ to $j = R - 1$. Once their ages reach $j = R$, agents retire.

The problem that the agents younger than R have to solve is the following. Agents choose their consumption, risk free asset holdings and how many hours to work.

The value function of the worker that is employed in the formal sector is:

$$V^F\left(j, \eta, a, s\right) = \max_{c, a', l} \left\{u\left(c_t, l_t\right) + \beta E[V\left(j+1, \eta', a', s'\right)]\right\} \tag{1}$$

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$$s.t. \left(1 + \tau^c\right) c + a' \leq a \left[1 + r \left(1 - \tau^k\right)\right] + \left(1 - \tau^w\right) \epsilon_j \eta w^f l$$
$$-\theta \min \left\{\epsilon_j \eta w^f, \overline{w}\right\} l + Tr_0$$

$$s' = s \left(1 + r\right) + \left(\theta + \theta_w\right) \min \left\{\epsilon_j \eta w^f, \overline{w}\right\} l \text{ if } j < R$$

The state variables in the above value function are the following: j is the age of the agent, a represents the asset holdings , η is the idiosyncratic productivity shock on employees and s is the total amount contributed to the social security program, until date t. The term ϵ_j is the age productivity equal across agents with the same age.

Agents pay a tax over consumption τ^c, their capital earnings τ^k, and their wages τ^w.The employee and the employer percentage contribution over the wage are given by θ and θ_w, respectively. Agents receive a transfer(Tr_0) when they are born. This transfer comes from the assets of the agents that died. These assets are divided by the government between the agents born that period.

The value function of the household that works in the informal sector is given by:

$$V^I \left(j, \eta, a, s\right) = \max_{c, a', l} \left\{u \left(c_t, l_t\right) + \beta E[V \left(j + 1, \eta', a', s'\right)]\right\} \qquad (2)$$
$$s.t. \left(1 + \tau^c\right) c + a' \leq a \left[1 + r \left(1 - \tau^k\right)\right] + \epsilon_j \eta w^i l + Tr_0$$
$$s' = s(1 + r)$$

The agent in the informal sector does not pay wage tax and does not contribute to the social security system. However, he still pays the consumption , capital earnings taxes and receive the transfers in the first period.

Each period, after the observation of the agents productivity idiosyncratic shock, agents have to choose if they will work in the formal or in the informal sector. Then, we have the following participation decision.

$$V(j, \eta, a, s) = \max\left\{V^F(j, \eta, a, s), V^I(j, \eta, a, s)\right\} \tag{3}$$

Let $\phi(j, \eta, a, s) = 1$ denote worker participation in the formal sector, i.e. $\phi(j, \eta, a, s)$ equals one whenever $V(j, \eta, a, s) = V^F(j, \eta, a, s)$.

Once agents reach age $j \geq R$, they are retired. Once retired they can no longer work and they face a death probability $P_d > 0$.

Therefore, the retired agents solve the following problem:

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\begin{aligned}
V^R(j, a, b) &= \max_{c,a'}\left\{u(c, l) + (1 - P_d)\beta V^R(j + 1, a', b)\right\} \tag{4}\\
s.t. \, (1 + \tau^c)c + a' &\leq a\left[1 + r\left(1 - \tau^k\right)\right] + b\\
b &= \max\left\{\underline{b}, \rho s_{R-1}, w^f\left(\epsilon_{R-1}\eta_{R-1}\right)\phi_{R-1}\right\}
\end{aligned}
$$

Retired agents choose their consumption and asset holdings to maximize their utility. They receive a social security benefit and continue to pay consumption and capital earning taxes.

3.3 Firms

The firms in the formal sector maximize the following profit function:

$$\max_{K,L} \Pi^F\left(w^f, r\right) = \left(1 - \tau^F\right)F(K, L) - \left(1 + \theta^w\right)w^f L - (r + \delta)K \tag{5}$$

The firms in the formal sector have to pay a tax over their revenue τ^F, hire labor and pay its wage proportional contribution(θ^w) to the social security system and rent capital that depreciates at a rate δ.

The fist order condition of this problem give us the following:

$$F_1'(K, L_F) = \frac{(r + \delta)}{\left(1 - \tau^F\right)} \tag{6}$$

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$$F_2'(K, L_F) = \frac{(1 + \theta^w) w^f}{(1 - \tau^F)} \tag{7}$$

The marginal productivity of labor and capital in the formal sector are reduced by the tax and contribution paid by the firm.

The firms that operates in the informal sector have the following expected profit:

$$\Pi^I\left(w^i\right) = (1 - p)\left[F\left(L_I\right) - w^i L_I\right] + p\left[\left(1 - \tau^F \gamma^F\right) F\left(L_I\right) - \left(1 + \theta^w \gamma^w\right) w^i L_I\right] \tag{8}$$

The great advantage for a firm in the informal sector is not paying taxes. However, there is a positive probability p that they are caught by government. In this case they have to pay the tax$\left(\tau^F\right)$, the contribution(θ^w) and add a fine$\left(\gamma^f\right)$ and (γ^w) over it.

This gives the following first order condition:

$$\left(1 - p\tau^F \gamma^F\right) F'\left(L_I\right) = \left(1 + p\theta^w \gamma^w\right) w^i \tag{9}$$

In this model the informal sector is linear in labor and equation 9 determines the informal wage$\left(w^i\right)$ as a function of the parameters.

3.4 Social Security

The social security used in this model is constituted of two basic elements: the contribution and the benefits. The agents are not able to choose the amount that they contribute to the system. However they can choose if they will contribute to it or not by joining the formal sector or not.

Once they join the formal sector, they contribute a fixed percentage of their wage. This fixed percentage is divided into two different parts: the workers' part',θ, and the employers', θ_w.

There is no minimum contribution to the system, but we have a maximum contribution because we have a maximum benefit, $\overline{w}$. Therefore, the contribution can be computed in the following way: $(\theta + \theta_w) \min \left\{ \epsilon_j \eta w^f, \overline{w} \right\} l$.

The agent total contribution to the system is recorded by the law of motion

$$s' = \left\{ \begin{array}{c} s(1+r) + (\theta + \theta_w) \min \left\{ \epsilon_j \eta w^f, \overline{w} \right\} l; \ if \ 1_{\{\phi(x)=1\}} \ and \ j < R \\ s(1+r); \ if \ 1_{\{\phi(x)=0\}} \ and \ j < R \\ s \quad j \geq R \end{array} \right\}$$

3.4.1 Benchmark Model

The Brazilian social security system adopts a pay as you go system. In this kind of system the working agents contributions are used to finance the retired agents benefits. The benefits are given by $b(j, \eta_{R-1}, a_{R-1}, s_{R-1})$, where j is the age, η_{R-1} is the productivity of the agent in the last period working period, a_{R-1} is the total assets acumulation before retirement and s_{R-1} is the total contribution to the system before retirement.

In order to be eligible for a retirement benefit in Brazil no contribution is required, because we have a minimum retirement benefit guaranteed by law. Therefore, even the workers who have never contributed to the system receive the following benefit:

$$b(j, \eta_{R-1}, a_{R-1}, 0) = \{\underline{b}; \ j \geq R\} \tag{10}$$

The benefit of the workers that have contributed to the system before retiring is computed by the average of the last 36 monthly contribution wages. In this model, each period lasts 36 months, therefore the benefit that corresponds to the last 36 contributions equals the last wage $\left(\epsilon_{R-1} \eta w^f l \right)$ received by the agent. If this value is smaller than a constant benefit proportional to the total contribution(ρs_{R-1}) made before retirement, the benefit paid is the one proportional to the contribution. Since one period

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is equivalent to three years, we have the following benefits:

$$b(j, \eta_{R-1}, a_{R-1}, s_{R-1}) =$$

$$= \max \left\{ \underline{b}, \rho s_{R-1}, w^f \left(\epsilon_{R-1} \eta_{R-1} \right) \phi(R-1, \eta_{R-1}, a_{R-1}, s_{R-1}) \right\}$$

The first term in the parentheses guarantees the minimum benefit for the agent. The second term is the constant benefit proportional to the contribution and the third term is the benefit that equals your last contribution wage. If it is bigger than the minimum benefit, the worker receives it, otherwise she receives the minimum benefit $\underline{b}$.

As we have a pay as you go system, it must self finance itself. We expect the deficit to be equal to zero. However, in the Brazilian experience we have a positive deficit, i.e., the sum of the benefits is higher than the sum of the contributions. Therefore, in the model the consumption tax will balance the following government budget constraint. Let x be an extended state space that includes (j, η, a, s, b). The government budget constraint is balanced

$$\int_x [\tau^c c(x) + \tau^k ra + [\tau^w \epsilon_j \eta w^f l + (\theta + \theta_w) \min \{\epsilon_j \eta w^f l, \overline{w}\}] 1_{\{\phi(x)=1\}} +$$

$$+ p\gamma^w [\theta_w \min \{\epsilon_j \eta w^i l, \overline{w}\}] 1_{\{\phi(x)=0\}} + \tau^F y_F + p\tau^F \gamma^F y_I - b] d\Phi^*(x) = g \quad (11)$$

In equation 11 the left hand side is the sum of all taxes and the sum of the contribution(the sum of this contribution is across agents with a maximum age equals to $R-1$) minus the sum of benefits paid for agents older than $R-1$. It is important to note that we have an indicator function that equals one if the worker is in the formal sector($\phi(x) = 1$) and zero otherwise. The right hand side shows government spending g.

The benchmark model will have $\theta = \theta_w = 0.08$ and the minimum benefit will be equal to half of the minimum wage.

Once we calibrate the benchmark model to match some moments of the Brazilian economy, we will change the minimum benefit($\underline{b}$) to one minimum wage, the maximum contribution wage($\overline{w}$), contribution rate(θ^w) and the increase in labor costs.

4 Definition of a Competitive Equilibrium

A stationary competitive equilibrium is given by: (i) an interest rate r, an informal wage w_i, a formal wage w_f and a consumption tax τ_c; (ii) allocations $c(x), l(x), a\prime(x)$ and $b(x)$; (iii) government taxes(τ_k, τ_w, τ_F) and contributions (θ, θ_w) and (iv) an invariant distribution over the state variables $x = (j, \eta, a, s)$; such that:

1) Given the interest rates(r), the wages(w_i, w_f), contributions(θ, θ_w) and government taxes($\tau_c, \tau_k, \tau_w, \tau_F$), the allocations $c(x), l(x), a\prime(x)$ and $b(x)$ solve the household problem.

2) Prices r, w_i and w_f satisfy the marginal condition:

$$r = \left(1 - \tau^F\right) \alpha A \left(\frac{K}{L_F}\right)^{\alpha - 1} - \delta \tag{12}$$

$$w^f = \frac{\left(1 - \tau^F\right)}{\left(1 + \theta^w\right)} \alpha A \left(\frac{K}{L_F}\right)^{\alpha} \tag{13}$$

$$w_i = \frac{\left(1 - p\tau^F\gamma^F\right)}{\left(1 + p\theta^w\gamma^w\right)} A_L \tag{14}$$

3) The consumption tax τ_c balances the government budget constraint:

$$\int_x [\tau^c c\left(x\right) + \tau^k ra + [\tau^w \epsilon_j \eta w^f l + \left(\theta + \theta_w\right) \min\left\{\epsilon_j \eta w^f l, \overline{w}\right\}] 1_{\{\phi(x)=1\}} +$$

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$$+p\gamma^w[\theta_w \min\left\{\epsilon_j\eta w^i l, \overline{w}\right\}]1_{\{\phi(x)=0\}} + \tau^F y_F + p\tau^F \gamma^F y_I - b]d\Phi^*(x) = g \quad (15)$$

4) Markets Clear:

$$K = \int a(x)d\Phi^*(x)$$

$$L_F = \int \epsilon\eta l(x)1_{\{\phi(x)=1\}}d\Phi^*(x)$$

$$L_I = \int \epsilon\eta l(x)1_{\{\phi(x)=0\}}d\Phi^*(x)$$

5) The invariant distribution of households over the state vector $x = (j, \eta, a, s)$, $\Phi^*(x)$, is a fixed point of the one period operator Q on the distribution $\Phi(x)$, i.e.,

$$\Phi^*(j, \eta, a, s) = \int_{A\times S\times J\times \eta} Q\left((j, \eta, a, s), A \times S \times J \times \eta\right) d\Phi^*(j, \eta, a, s)$$

and $Q\left((j, \eta, a, s), A \times S \times J \times \eta\right)$ is the following operator

$$
\begin{aligned}
j' &= j+1 \\
s' &= s(1+r) + (\theta + \theta_w)\min\left\{\epsilon_j\eta w^f, \overline{w}\right\}1_{\{\phi(x)=1\}} \\
s' &= s(1+r);\ if\ 1_{\{\phi(x)=0\}} \\
\eta' &= prob(\eta_{t+1} = \eta'|\eta_t = \eta) \\
a' &= a\left[1 + r\left(1 - \tau^k\right)\right] + (1 - \tau^w)\epsilon_j\eta w^f - \theta\min\left\{\epsilon_j\eta w^f, \overline{w}\right\} - (1 + \tau^c)c \\
&\quad, if\ 1_{\{\phi(x)=1\}} \\
a' &= a\left[1 + r\left(1 - \tau^k\right)\right] + \epsilon_j\eta w^i - (1 + \tau^c)c,\ if\ 1_{\{\phi(x)=0\}}
\end{aligned}
$$

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5 Parametrization

In order to simulate the model proposed above, we need to calibrate the parameters used.

The first group of parameters are the ones used in the production functions of the formal and informal sectors. The parameters are the following: A, the multifactor productivity of the formal sector firm; A_L, the productivity of the informal firm; and, finally, α the capital share in the formal sector. The production parameter, α, is set to the usual value of 0.36. The labor productivity is normalized to $A_L = 1$ and the multifactor productivity $A = 1.65$. The total factor productivity is chosen in order to make the wage differential between formal and informal sectors around 40%. The depreciation rate (δ) equals 0.20 because each period in this model lasts 3 years.

The second group of parameters are the different taxes: τ^c, the consumption tax; τ^k, the tax on capital; τ^w, the tax on wages; and, τ^F, the tax on firms revenues. We also have λ that represents the increase in labor related costs caused by 1988 constitution. In this model, the consumption tax, τ^c, will adjust in order for the government to have a balanced budget.

The tax on firms revenues (τ^F) will be responsible for the movements that increase the labor costs to firms. This tax amounts 11% to the transformation industries and it is obtained from Fernandes et alli(2005).

The tax on interest rates (τ^k) earned in Brazil is 20%. However, saving accounts are not taxed. Therefore, the effective tax is much lower. In Fernandes et alli(2005) this value is estimated at 8.8%.

The tax on labor income (τ^w) in Brazil has different marginal rates. The average rate of labor tax is set equal to 23%.

The third group of parameters are the ones set in the social security system: θ, the

worker contribution to the social security system; θ^w, that is the employer contribution to employees social security; $\overline{w}$, that is the maximum wage for which you are able to make the proportional contribution to the system; $\overline{b}$, that is the higher benefit that workers can receive once they retire; and, $\underline{b}$, the minimum retirement benefit guaranteed by law. The Brazilian legislation sets $\theta = \theta^w = 0.08.$. The maximum benefit and proportional contribution, $\overline{b}$ and $\overline{w}$ will be set equal to 10 times the minimum wage. The minimum benefit is set to half of the minimum wage before 1988 and to the minimum wage after 1988, i.e., $\underline{b}_{88} = \frac{1}{2}\underline{w}$ and $\underline{b}_{89} = \underline{w}$. The minimum wage will be set equal to 80% of the average wage.

The last group of parameters are the punishment parameters: γ^F, the fine that a firm has to pay once it is detected not paying its taxes; and γ^w, the probability of being caught not paying the employee contribution to social security taxes; and the probability of being caught not paying taxes, p. Both fines are set equal to 1.5, implying a fifty percent fine. The probability of being caught not paying taxes equals 2.3%.

The death probability was obtained from the IBGE mortality tables.

The parameterization used in the model can be viewed in the table below.

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| Table 3.2: Parametrization used in the Model			
	Benchmark	After 88	θ^w Reduction
A_L	1	1	1
A	1.80	1.80	1.80
α	0.36	0.36	0.36
δ	0.20	0.20	0.20
β	0.90	0.90	0.90
τ^F	0.11	0.132	0.132
τ^k	0.088	0.088	0.088
τ^w	0.23	0.23	0.23
θ	0.08	0.08	0.08
θ_w	0.08	0.08	0.02
$\underline{b}$	$\frac{1}{2}\underline{w}$	$\underline{w}$	$\underline{w}$
$\overline{b}$	$10\underline{w}$	$10\underline{w}$	$10\underline{w}$
γ^F	1.5	1.5	1.5
γ^w	1.5	1.5	1.5
p	0.023	0.023	0.023
g	$0.18y$	$0.18y$	$0.18y$

6   Results

In this section we present the results. We present a table with the results of the bench-
mark model, the pay as you go system, where the government guarantees a minimum
benefit of half the minimum wage for every agent. Then we present the same pay as you
go system but with the higher benefits and labor costs caused by the 1988 constitution.
We conclude presenting the results of a policy experiment in which the 1988 benefits
and costs are the same, but now the government reduces the firm contribution to social
security(θ^w) from 8% to 2%.

6.1   Benchmark

The benchmark model is calibrated in order to match some of the moments observed in
the Brazilian economy for 1985. The model is able to replicate some important aspects
of the data. The formal labor market participation rate observed in the data equals
47.2% and the model obtains 49%. The consumption tax is higher than the observed in

the economy because in the model there is no government deficit, whereas the Brazilian government operates with a deficit. The age profile of formal labor participation is hump shaped in the data and also in the model, as can be seen in the figure below.

Table 3.2:Formal Rate per Age
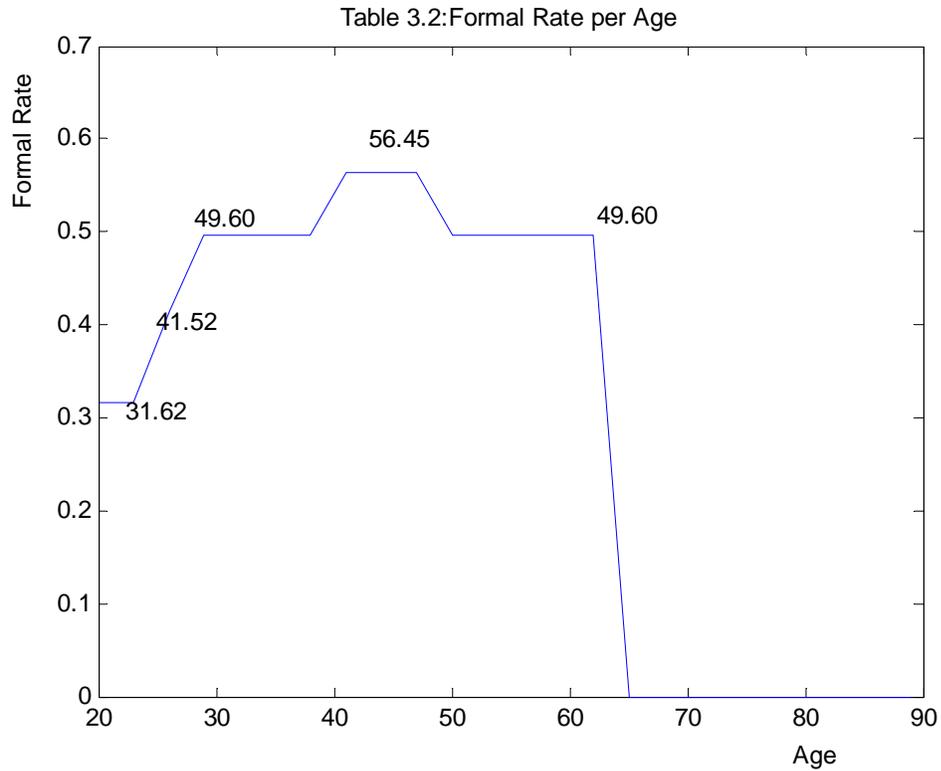
The low participation rate for the young workers can be explained due to the fact that since young workers have a lower productivity, and joining the formal sector will result in paying a big share of their income as tax and contribution to social security. The first one would be the wage tax(τ_w) that is set equal to 23%. The second kind of tax is an indirect one, because the tax charged on the firms is transferred to workers through a lower wage than their marginal productivity. Finally, we have the contribution to the

social security system that is a fixed rate(8%) of the wage. This kind of contribution makes the contribution scheme very severe for the low productivity agents. The participation increases with age because their age specific productivity also increases until period 8 in the model, that corresponds to age 44. The drop in formal rate participation after period 11 is also explained by a decrease in productivity observed by older agents. The decrease observed in the model is not as strong as the one observed in the data because in the model retirement is exogenous. In the Brazilian economy an observed fact is that people "retire" from the formal sector and move to the informal earning the retirement benefit plus the informal wage.

A second stylized fact that the model can account for is the positive relation between assets and formal labor participation as can be seen in picture 3.4. This relation is positive in the model because of the fact that high productivity workers have a higher wage and receive a relatively higher benefit when joining the formal sector. This happens because they pay no tax on savings held as contributions, their contribution receives an additional employers' contribution and the maximum contribution cap makes contributions regressive. Therefore, agents that receive higher wages will have a higher incentive to join the formal sector.

Figure 3.3: Formal Rate per Assets
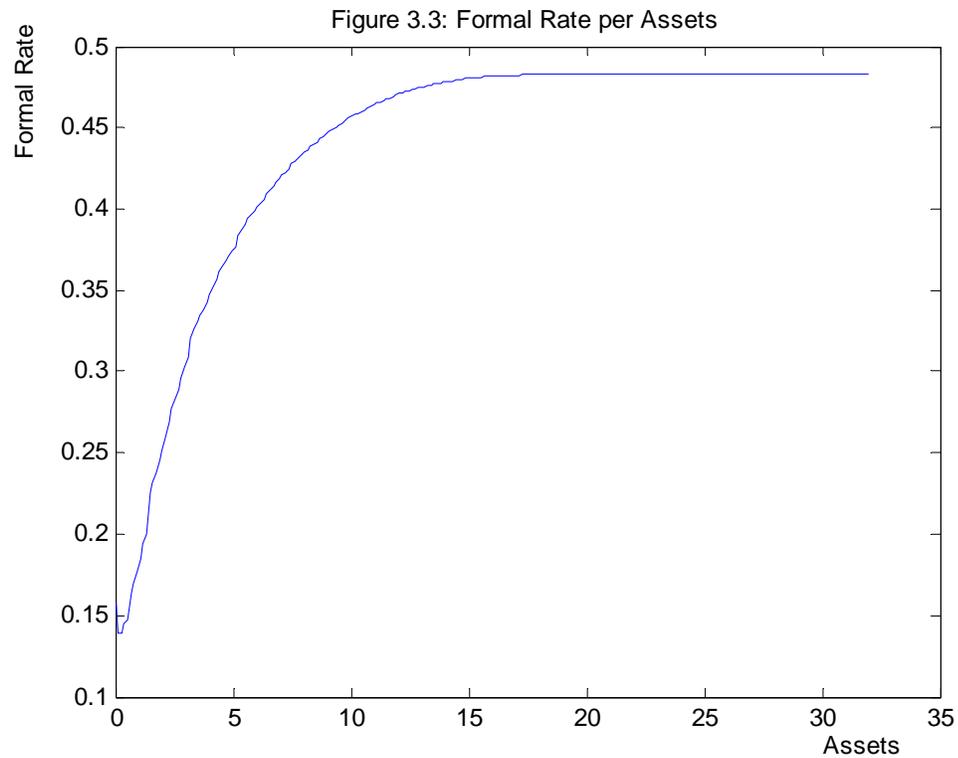
The model is able to get close to the formal labor participation rate and to reproduce some key characteristics of the data. As a result, we believe it is the appropriate framework to analyze the effects of the legislation change of 1988 and a good laboratory for policy experiments.

6.2   Economy after 1988 changes

The table below presents the results for the benchmark model and also the different policy experiments.

Table 3.3: Results Before and After 1988		
	Benchmark	1988 constitution
$Formal\ Rate$	49.00%	42.47%
w^f	100	98.64
w^i	100	99.92
r	100	84.51
τ_c	23.90%	29.15%
K/L_F	3.08	3.19
K/Y	1.19	1.07
$Total\ K$	100	89.96
$Welfare$	100	103.52
$Min.\ Ben.$	$\frac{1}{2}\underline{w}$	$\underline{w}$
τ_F	0.11	0.132

As observed in the data, the model similarly generates a decrease in the formal labor participation rate. The rate of formal workers dropped from 49% to only 42.47%, a decrease of almost 7%, 70% of the one observed in the data. Notice that the decrease in the formal sector wage causes more people to join the informal sector. This can be explained by the conjunction of two factors. The guaranteed higher benefits provided incentives for the low productive guys to move into the informal sector where they also benefit from no wage taxes. As the benefits increased, the increase in the consumption tax is responsible for satisfying the government budget constraint. Finally, we observe a drop in the total assets accumulated in the economy. This is a result of the extra insurance provided by the government through the higher benefits.

6.3   Reduction in Employers Contribution Reform

In this section we analyze the effects of a policy that reduces the employers contribution(θ_w) to the social security system from 8% to 2%, while keeping the high costs and benefits introduced in the previous section.

This decrease in the employers' contribution is purposed in order to encourage people to join the formal sector. This would happen because the employer contribution works like an implicit tax on employees[3].

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[3]   A contribution or a tax introduced in a CRS firm is charged from the employee as a lower wage.

The results of the introduction of this policy is presented in the table below, where you are able to compare the results with the previous ones.

Table 3.4: Comparison among the different Policies			
	Benchmark	1988 constitution	Reduction θ_w
$Formal\ Rate$	49.00%	42.47%	51.48%
w^f	100	98.64	100.77
w^i	100	99.92	100.13
r	100	84.51	106.53
τ_c	23.90%	29.15%	22.31%
K/L_F	3.08	3.19	2.89
K/Y	1.19	1.07	1.18
$Total\ K$	100	89.96	99.03
$Welfare$	100	103.52	108.80
$Min.\ Ben.$	$\frac{1}{2}\underline{w}$	$\underline{w}$	$\underline{w}$
τ_F	0.11	0.132	0.132

The reduction in the employers' contribution to the social security helps to increase the formal labor participation rate. This rate increase from 42.47% after 1988 constitution to 51.48%. This contribution reduction also increases the wages in the formal and informal sector compared to the benchmark model, but gives a lower formal wage than the post constitution outcome.

Importantly the increase in formal labor participation rates allows a reduction in the consumption tax while still providing the same minimum benefit with more workers contributing to the social security, the government deficit is reduced for two reasons: high revenues and fewer workers to provide the minimum benefit.

The expansion of the formal labor market also causes an increase in the average wage.

The total capital in this economy also increases when you compare with the 1988 alternative policies. Now, the lower employer contribution reduces the future benefits, therefore, agents have to save more today. However, the increase in labor force participation is greater than the increase in capital, causing interest rates to increase in response to the lower K/L_F.

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We conclude that the introduction of such policy would cause an increase in the formal labor participation rate and also reduce the deficit in the system.

7 Conclusion

We developed a overlapping generations model in order to explain the increase in the Brazilian informal labor market over the last two decades. This model was able to reproduce important features of the data, encouraging us to use it to make policy experiments.

The first experiment was to introduce changes similar to the ones observed in the 1988 constitution that affect the labor market. As a result of the higher benefits and labor costs, the model outcome reproduces the drop in formal labor participation rates observed in Brazil. In the model this rate dropped from 49% to 42.47% while in the data these values were 47.2% and 38%. Therefore, the interpretation that the higher benefits and labor costs introduced in 1988 could be the responsible for this drop is supported by this model. The higher benefits also reduced the amount of capital in the economy because the government provided more insurance in the form of higher benefits.

The second experiment was to test the effects of an alternative policy where the employers' contribution to the social security system is reduced from 8% to 2%. In this case, the model generates a great increase in the formal labor participation rate. This rate increases from 42.47% in the post 1988 economy to 51.48%. This increase is also associated with an increase in formal and informal wages compared to the benchmark model. We are also able to see an increase in the capital in this economy.

The increase in informal rate participation in Brazil is a very interesting and challenging one. We aim to expand this research adding endogenous labor supply to the model and also endogenous retirement decision. The results obtained in this stylized model must be used in a very careful way given the fact that the model incorporates

only some features of the Brazilian system.

8 Appendix B: Algorithm

Because the model does not have a close solution, we need to use a numerical solution procedure. Therefore we use the following algorithm.

Step 1: We have to choose the parameters p, τ^f, γ^f, λ, θ^w and γ^w. This parameters determine the informal sector wage w^i.

Step 2: Guess $\frac{K}{L_F} = \frac{\overline{K}}{L_F}$ and compute the factor prices $r\left(\frac{\overline{K}}{L_F}\right)$ and $w\left(\frac{\overline{K}}{L_F}\right)$ from equations 6 and 7respectively.

Step 3: Solve the following value functions: $V^F(j,a,\eta,s)$ and $V^I(j,a,\eta,s)$.

Step 4: Determine the labor supply, i.e., the workers will choose if they work in the formal or the informal sector solving equation3.

In steps 3 and 4 we solve the individual problems for the state variables $x = (j,a,\eta,s)$ and obtain the policy functions $c(x)$, $a'(x)$, $l(x)$ and $s'(x)$.

Step 5: Compute the invariant distribution $\Phi^*(x)$ over $x = (j,a,\eta,s)$.

Step 6: Compute aggregate capital(K) and labor$(L_F$ and $L_I)$.

$$K = \int a(x)\, d\Phi^*(x) \tag{16}$$

$$L_F = \int I(F)\,\eta l(x)\, d\Phi^*(x) \tag{17}$$

$$L_I = \int I(I)\,\eta l(x)\, d\Phi^*(x) \tag{18}$$

Compute $\frac{K}{L_F}$. If $\frac{K}{L_F} = \frac{\overline{K}}{L_F}$, the procedure ends. If $\frac{K}{L_F} \neq \frac{\overline{K}}{L_F}$, we need to adjust $\frac{K}{L_F}$. Therefore, we use the following adjustment rule: $\frac{\overline{\overline{K}}}{L_F} = \xi\frac{\overline{K}}{L_F} + (1-\xi)\frac{K}{L_F}$. With this new capital formal labor ratio, we go back to step 2.

9 Appendix C: Income Process

In order to calibrate the income process used in the present work, we followed Tauchen(1986) in order to approximate a continuous process through a finite-state Markov chain.

In order to do that we used the log wage variance$(var(\log w_{it}))$ and the lagged log wage covariance$(cov(\log w_{i,t}, \log w_{i,t-1}))$ to obtain the auto correlation of the process. These moments were obtained from the table1 in Santos and Souza(2005). We calculate the persistence of an AR(1) process ρ for eight different lags. Then, we take the average of them that equals: $\rho = 0.948$. As in the model one period lasts to three years, we used $\rho_M = \rho^3$, where ρ_M is the persistence in the model's process.

However, the log wage variance used in the calibration came from a different paper source because the sample used in Santos and Souza(2005) included only formal workers in a specific metropolitan area. Therefore, this variance would be lower than the one observed for the Brazilian economy. For this reason we used the variance from Arbache(1998) that equals 0.865.

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