PAYG Pension Systems with Capital Mobility *

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Abstract

Consider an overlapping generation growth model involving identical countries whose fiscal policy reduces to a pay-as-you-go system with flat rate benefits and uniform payroll tax rate. In autarky, the tax rate is chosen so as to achieve a compromise between intragenerational and intergenerational redistribution. Assume now that there is capital mobility in a setting where national government act more cooperatively. This paper studies how the tax is affected by this combination of capital mobility and non cooperation. It shows that the tax rate increases and henceforth capital accumulation decreases as the number of countries involved increases.

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1 Introduction

One of the most notable features of the Maastricht Treaty is the fiscal convergence requirement that the gross debt of the general government should not be above 60% of GDP. This debt requirement was and still is the subject of critiques, one of them being that it should be enlarged to include all forms of liabilities, particularly those arising from the pay-as-you-go (PAYG) social security. One of the reasons for the debt requirement is to avoid that indebted countries have a free ride at the expenses of other "more vertuous" countries. Take the example of two countries that are identical is all respects, except for their level of endebtment. In autarky the indebted country has less capital, and thus less output that the other. Now let us make capital flow between the two countries. It will go from the less indebted country to the more indebted one in which the rate of interest is higher. The flow of capital will stop when the two rates of interest are equal. It is pretty clear that regardless of the reason for the differential level of debt, the more indebted country wins, and the other one looses in the long run.

In this paper we use this setting with a PAYG pension system as a source of endebtment. But instead of looking at the effect of differential levels of PAYG systems on the equilibrium after economic integration, we want to see what kind of PAYG pension each country will adopt before and after economic integration. Assuming that the PAYG pension system consists of a flat tax rate and a uniform retirement benefit optimally chosen, do we expect that capital mobility will affect this tax rate, and if so in what direction?

In autarky the tax rate is chosen in a way that takes into account its positive effect on redistribution, and its negative effect on capital accumulation. In an open setting with capital mobility, the tax has also the additional effect of making capital more attractive, which should boost it up. In other words, the expected effect of capital mobility is an increase in the level of the tax, and hence the size of the pension system.

One question to raise at this point is whether the number of countries involved matters. In the extreme example of a large number of identical countries, one expects that each individual country has no power on the world interest rate. It can then set the redistributive tax rate at its highest level subject to the world capital market constraint: aggregate savings and aggregate capital accumulation must be equal. As we show, the depressive effect of such an uncoordinated tax policy on capital accumulation is increasing with the number of countries involved. When there is just one country we are in the autarky case. The optimal solution in autarky is also the one we would obtain with coordination in the case of any number of identical countries.

Even though this paper is not concerned by the Maastricht Treaty's debt requirement, one sees clearly that uncoordinated policy leads to excess endebtment, and that some coordination is desirable.

It is clear that the above result comes from the fact that the government has a single and imperfect instrument to achieve two goals: the (modified) golden rule and intragenerational redistribution. Suppose that national government is not concerned by intragenerational redistribution; then it could use the PAYG pension policy to implement the golden rule. Alternatively, suppose that it can use debt policy to implement the golden rule; then it would use the linear social security scheme to achieve income equality within each generation.

To make the analysis simple, we use the standard overlapping generation model with inelastic labor supply, and we focus on a symmetrical setting: all countries are alike. In such a setting the optimal policy, from the viewpoint of a confederation of countries, is identical to that of each country in autarky. We compare this optimal policy with that chosen by each national government, when international capital mobility is made possible.

Economists have lately investigated the open economy aspects of pension schemes. The approach adopted so far has been to study the impact of factor mobility on a system initially designed for a closed economy. For example, Casarico (2002) studies the impact of capital mobility on the welfare of two countries differing only in their pension systems, one running a PAYG system and the other a fully funded scheme. She shows that the country with a PAYG system is likely to benefit from the opening of borders. Pemberton (1999, 2000) goes one step further. He assumes that a PAYG system is necessarily redistributive, which is not the case of a fully-funded system. He shows that a small open economy has a more generous pension system, but also a lower capital stock than the same economy in a closed economy. He also shows that even though a simultaneous shift from a PAYG to a fully-funded system would be Pareto improving individually, no country would do this. Another line of research focuses on both capital and labor mobility. In that case, there is a drive towards the equality of wage rate and of lifetime net income, which leads to corner solutions. To avoid such an outcome, Homburg and Richter (1993) and Breyer and Kolmar (2002) have introduced public goods and mobility costs. In so doing the empty community result could be assumed away.

The rest of the paper is organized as follows. In Section 2 the basic model is presented. Section 3 gives the second-best solution in a closed economy. Section 4 shows how the security scheme is affected in an open economy with a variable member of competing countries. The last section concludes.

2 The basic model

2.1 Consumption and production

Our model is one of overlapping generation and life-cycle saving. People live for two periods. They are I kinds of people differing by their productivity α^i. Their proportion in the population is p^i. With the exception of productivity, individuals are alike: same population growth rate and utility function. Members of generation t and skill i consume c_t^i in period t and supply one unit of labor. In period $t+1$, they are retired and consume d_{t+1}^i. In the absence of pension system they face the following budget constraints:

$$s_t^i = w_t^i - c_t^i \tag{1}$$

and

$$(1 + r_{t+1})\, s_t^i = d_{t+1}^i \tag{2}$$

where $w_t^i = \alpha^i w_t$ is the wage rate of type i's individuals, r_{t+1}, the rate of return on capital and s_t^i, saving.

The production side is assumed to be represented by an aggregate production function relating output Y_t to capital K_t and labor L_t:

$$Y_t = F(K_t, L_t),$$

where F is quasi-concave and homogenous of degree 1. This means that we can use an intensive form:

$$y_t = F(K_t, 1) = f(k_t)$$

with $y = Y/L$ and $k = K/L$.

With perfect competition factor payments are equal to the values of marginal products:

$$w_t = F_L'(K_t, L_t) = f(k_t) - f'(k_t) - f'(k_t)\, k_t = \omega(k_t) \tag{3}$$

and

$$1 + r_t = F_K'(K_t, L_t) = f'(k_t) = \varrho(k_t). \tag{4}$$

Both factors of production come from individuals' supplies. Labor supply is inelastic and given by:

$$L_t = N_t \sum p^i \alpha^i = N_t \tag{5}$$

where N_t is the size of generation t with constant rate of growth n: $N_t = (1+n)\, N_{t-1}$. Capital accumulation is given by individuals' savings (total depreciation after one period is assumed)

$$K_{t+1} = N_t \sum p^i s_t^i,$$

or

$$(1+n)\,k_{t+1} = \sum p^i s_t^i = \bar{s}_t. \tag{6}$$

Individuals take the prices w_t and r_{t+1} as given. They maximize an identical utility function with standard properties:

$$u\left(c_t^i, d_{t+1}^i\right)$$

subject to (1) and (2). From the first-order conditions one derives the saving and the indirect utility functions:

$$\begin{aligned} s_t^i &= s\left(w_t^i, r_{t+1}\right) &(7)\\ v_t^i &= v\left(w_t^i, r_{t+1}\right). &(8) \end{aligned}$$

2.2 Market equilibrium and first-best optimality

The intergenerational capital market constraint is defined by substituting (3), (4) and (8) in (7):

$$(1+n)\,k_{t+1} = \sum p^i \; s\left(\alpha^i \omega\left(k_t\right), \varrho\left(k_{t+1}\right)\right).$$

Under some standard assumptions[1], there exists a unique and stable steady-state equilibrium denoted by k^*:

$$(1+n)\,k^* = \sum p^i \; s\left(\alpha^i \omega^*, \varrho^*\right).$$

Social optimality is obtained by looking at the sum of lifetime utilities over types and generations with a discount factor β:

$$\sum_{-1}^{\infty} \beta^t \sum_{1}^{I} p^i u\left(c_t^i, d_{t+1}^i\right)$$

to be maximized subject the resource constraint:

$$f\left(k_t\right) = \bar{c}_t + \bar{d}_t / \left(1+n\right) + \left(1+n\right) k_{t+1}$$

where $\bar{c}_t$ and $\bar{d}_t$ denote average values.

In the steady-state, we obtain the following optimality conditions:

$$f'\left(\hat{k}\right) = \frac{1+n}{\beta} \tag{9}$$

[1] de la Croix and Michel (2002).

$$\hat{c}^i = \hat{c} \text{ and } \hat{d}^i = \hat{d} \tag{10}$$

$$\frac{\partial u}{\partial c^i}\beta = \frac{\partial u}{\partial d^i}(1+n) \tag{11}$$

where the $\widehat{}$ are used to denote optimal values. Formula (9) is the modified golden rule. Equation (10) is the expected outcome of a utilitarian objective and equation (11) combined with (9) tells us that the intertemporal marginal rate of substitution is equal to the marginal productivity of capital. We denote by $\widehat{\widehat{k}}$ the golden rule solution for which $f'\left(\widehat{\widehat{k}}\right) = 1+n$; it corresponds to (9) when $\beta = 1$.

Throughout the paper we make the standard assumption that the market solution for k is below the golden rule value of k $\left(k^* < \widehat{\widehat{k}}\right)$. To decentralize the above optimum, one needs lump-sum transfer between the different types of individuals in the first period and an intergenerational transfer ascending (descending) if $k^* > (<)\,\hat{k}$. By ascending we mean that the transfer goes from the young to the old, which is the case of a PAYG pension system.

3 Redistributive PAYG social security in a closed economy

We are going to introduce a flat rate benefit PAYG pension system wherein workers pay a fraction τ of their earnings as payroll contribution and retirees receive a uniform pension z_t such that at each period

$$(1+n)\,\tau w_t = z_t.$$

Before proceeding consider a particular case where contributions are not transferred to the retirees but are given back to the workers as a demogrant. In that case we have a typical linear income tax with inelastic labor supply. There is no mechanism of intergenerational redistribution. With a utilitarian objective, the outcome is simple.

Assume first that aggregate saving is independent of income distribution. Then $\tau = 1$; $c^i = c$ and $d^i = d$ and k is unchanged. Assume then that aggregate saving decreases as income is redistributed (convex saving function). Then $\tau < 1$ if $k^* < \hat{k}$ and $\tau = 1$ if $k^* > \hat{k}$. As it is well known with such a linear tax we needs an additional instrument such as a public debt to achieve the optimal solution derived above.

With a Beveridgean PAYG we have a single instrument playing two roles: intra- and inter-generational redistribution. One thus expects that full optimality cannot be restored.

To make the presentation simple, we assume in the rest of this paper that the social planner maximizes the steady-state generational utilities ($\beta = 1$). This has some implications. In the first-best, we have the golden rule. With identical individuals and underaccumulation in the *laissez-faire*, optimal transfers are descending, payroll taxes is negative as well as the PAYG pension. This is a well-known and yet not appealing result. A negative pension does not make sense and will not be the solution here. Concern for intragenerational equity implies a positive flat rate pension.

From profit maximization, we have that wage and interest rate are function of k:

$$w = \omega(k) \text{ and } R = \varrho(k)$$

with $\omega'(k) > 0$ and $\varrho'(k) < 0$.

From utility maximization we have an indirect utility function with as argument net of tax earnings, $\omega^i = \alpha^i (1-\tau)\omega(k)$, the rate of interest $\varrho(k)$ and the flat rate pension $z = \tau(1+n)\omega(k)$:

$$V\left(\omega^i, \varrho, z\right) = V\left(\alpha^i (1-\tau)\omega(k), \varrho(k), \tau(1+n)\omega(k)\right),$$

with partial $\dfrac{\partial V^i}{\partial \omega^i} = -u'(c^i)\alpha^i\omega$, $\dfrac{\partial V^i}{\partial \varrho} = u'(c^i)s^i$ and $\dfrac{\partial V^i}{\partial z} = u'(c^i)/\varrho$.

Finally, from the equality between saving and capital accumulation, namely from

$$(1+n)k = \sum p^i \; s\left(\alpha^i(1-\tau)\omega(k), \varrho(k), \tau(1+n)\omega(k)\right),$$

we have that

$$k = k(\tau)$$

with $k'(\tau) < 0$.

We can now write the Lagrangean expression for the steady-state optimum:

$$\mathcal{L} = \sum^{I} p^i \; V\left(\alpha^i(1-\tau)\omega(k), \varrho(k), \tau(1+n)\omega(k)\right)$$

with FOC:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \tau} &= -\sum^{I} p_i \left(u'\left(c^i\right)\alpha_i^i\omega - u'\left(c^i\right)(1+n)\frac{\omega}{R}\right) \\ &\quad + k'(\tau)\sum^{I} p_i u'\left(c^i\right)\left[(1-\tau)\alpha^i\omega'(k) + \tfrac{s^i\varrho'(k)}{R} + \tfrac{(1+n)}{R}\tau\omega'(k)\right] \end{aligned} \quad (12)$$

After some manipulations and using the notation Ex for $\sum p^i x^i$ and $cov\,(x, y)$ for $Exy - ExEy$, we have

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \tau} &= -Eu'(c)\,\omega\left[\alpha - \frac{1+n}{R}\right] + k'(\tau)\,\omega'(\tau)\,Eu'(c) \\ &\quad \left[(1-\tau)\left(\alpha - \frac{1+n}{R}\right) + \frac{1+n}{R}\left(1 - \frac{s}{\bar{s}}\right)\right],\end{aligned}$$

where $\bar{s} = Es$.

Denoting

$$\varepsilon = -\frac{k'(\tau)\,\omega'(\tau)}{\omega} > 0,$$

this can be rewritten:

$$\frac{\partial \mathcal{L}}{\partial \tau} = -cov\,(u'(c), \alpha) + \left(\frac{(1+n)}{R} - 1\right) Eu'(c)\,\alpha + \frac{\varepsilon \dfrac{1+n}{R}\; cov\;\; (u'(c), s/\bar{s})}{1 + (1-\tau)\,\varepsilon}. \tag{13}$$

We now interpret these two expressions. According to (12) the tax has five effects on welfare. Two direct effect, one negative through the tax levy and one positive through the pension benefit. Then there are three indirect effects resulting from capital accumulation ($k'(\tau) < 0$). The decline in capital hurts individual's wage earnings, fosters capital income and depresses pension benefits.

We now turn to (13). To interpret this equation let us assume that in the *laissez-faire* ($\tau = 0$), we are at the golden rule ($R = 1 + n$). At this point an infinitesimal tax increase is neutral from the viewpoint of capital accumulation. It is desirable from the viewpoint of intragenerational equity. In this equation, the first term is positive and the second is zero. The third term is equal to $\varepsilon\;cov\,(u'(c), \alpha)$ [with homothetic preferences and $\tau = 0$, $cov\,(u'(c), \alpha) = cov\,(u'(c), s/\bar{s})$].

In other words, for $\varepsilon < 1$, the desirability of a redistributive PAYG is unambiguous:

$$\left.\frac{\partial \mathcal{L}}{\partial \tau}\right|_{\tau=0} = -cov\,(u'(c), \alpha)\,(1-\varepsilon) > 0.$$

As τ increases, the covariance terms are decreasing and R increases. With well-behaved utility and production functions, one expects an optimal value of τ that implies $\dfrac{\partial \mathcal{L}}{\partial \tau} = 0$.

The desirability of a redistributive PAYG scheme such as defined here depends on a number of parameters: wage inequality and the concavity of the utility function which determines the size of the equity terms; the level of capital accumulation in the *laissez-faire* which determines the direction of intergenerational redistribution.

Even though we assume that there is underaccumulation in the *laissez-faire* and that equity consideration imply $\tau > 0$, let us for a moment consider a couple of extreme examples. For example, if the equity terms are negligible and if there is underaccumulation, one might expect

$$\left.\frac{\partial \mathcal{L}}{\partial \tau}\right|_{\tau=0} < 0.$$

In other words, to foster capital accumulation, it would be optimal to have a negative PAYG scheme with a negative tax and a negative pension benefit. Alternatively, if there is overaccumulation in the *laissez-faire*, a positive PAYG is clearly desirable: it leads to lower saving and it redistributes income among workers.

Another way to interpret the above equation is to assume that $k'(\tau)$ or ε are zero. This could be the case if the social planner chooses not only τ and z, but also the stock of capital while making sure that this stock of capital generates an interest rate (and a wage rate) consistent with the equality between saving and investment. In that case, we only keep the first two terms of (13): the PAYG scheme strikes a balance between intragenerational equity and capital accumulation concerns. As we show below this is the outcome achieved in a small open economy where the interest rate is given but must be consistent with the general equilibrium constraints.

We now turn to the interior solution of our problem by taking (13) equal to 0. We have three terms: the first one is positive and gives the direct effect of the PAYG scheme on income distribution; the second term is negative and reflects the depressive effect of PAYG on capital accumulation; the third term gives the second order regressive effect of PAYG which fosters capital income and hence inequality. The optimal level of τ results from a comparison between these three effects.

It must be clear that a number of assumptions are made for the sake of presentation even though they may appear not very realistic. Assuming a tax-transfer scheme limited to a proportional payroll tax in the first period and a flat rate benefit is restricted. Doing so we want to avoid a trivial package that would achieve both the golden rule and intragenerational equality all together. This would be the case with a linear income tax in the first period and public debt. Also introducing elastic labor supply, considering a partial contributive pension system, or allowing for some liquidity constraints would not change the main results.

Anticipating on the next section, opening the economy will only affect the third term in equation (13).

4 Redistributive PAYG social security in an open economy

We now consider J identical countries. Capital is mobile. Again we restrict our analysis to the steady-state. What is new is that there is a single world interest r which clears the international capital market. This is expressed by the equality between savings and capital accumulation:

$$\sum_j^J \sum_i^I p^i \ s\left(\alpha^i \omega\left(k_j\right)\left(1-\tau_j\right), \varrho\left(k_j\right), \tau_j\left(1+n\right)\omega\left(k_j\right)\right) = \left(1+n\right)\sum_j^J k_j. \tag{14}$$

From this equation (14), we note that the demand for capital k_j in country j is a function of τ_j but also of the tax rates τ_{-j} chosen in the other J countries. Given that all countries are identical, we can rewrite (13) as:

$$k_j = k = \frac{\varphi\left(\tau_1, \ldots, \tau_J\right)}{J} \tag{15}$$

where $\varphi(\tau) = k(\tau)$ in the closed economy. Basically, what (15) says it is that the effect of a tax τ_j on the demand for capital is diluted over all countries. In a closed economy, we have seen that the tax will be lower if it has a depressive effect on capital accumulation because less capital means higher capital income which is to the benefit of the productive workers. This depressive effect is now diluted over J countries. To see this, we write the optimality condition for a country belonging to the set of J identical countries.

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \tau} &= -cov\left(u'\left(c\right), \alpha\right) + \left(\frac{1+n}{R} - 1\right) E \ u'\left(c\right)\alpha \\ &+ cov\left(u'\left(c\right), \frac{s}{\bar{s}}\right)\frac{1+n}{R}\frac{\varepsilon}{J} / \left(1-\left(1-\tau\right)\varepsilon/J\right).\end{aligned} \tag{16}$$

When $J=1$, we have equation (13). When J is large, we have (13) without the third term. This is the case of a small open economy which implies a relatively lower capital accumulation and a relatively higher tax than when J is small. One clearly sees that as J increases, the tax increases and the capital accumulation decreases. The dilution effect operates.

The strategic interaction among the J countries is easily dealt with here because of symmetry. When country j maximizes $\mathcal{L}$ with respect to τ_j given all the other τ_{-j}'s, the FOC is a function of all these τ_{-j}'s. However because of symmetry, it suffices to solve our FOC writing $\tau_j = \tau_{-j} = \tau$.

Note that the effect of τ on k is what we called a second order effect. This appears clearly in a simple example with Cobb-Doublas production function and logarithmic utility functions (see the appendix).

5 Conclusion

This paper compares redistributive PAYG social security systems in autarky and in an open economy with capital mobility. It shows that capital mobility implies more redistribution but also less capital accumulation. To some extent, this conclusion contradicts the standard result that increasing factor mobility makes redistribution more difficult. However the two problems are quite different. In a static model of tax competition, national governments try to attract foreign capital and to do so they decrease the tax on capital income which is redistributive. At the final equilibrium, in the symmetric case, aggregate output is unchanged but there is less redistribution in each country. In our OLG model, national government want also to attract foreign capital. The only policy instrument is the PAYG scheme which has a positive impact on the rate of return of capital. It is therefore not surprising that each national government increases its payroll tax even though in the final equilibrium this uncoordinated policy results in a lower aggregate level of capital accumulation.

Tax competition results in a decrease in welfare. The gain in income redistributed does not compensate for the loss in production as we know that both in autarky and in a cooperative setting this solution would not have been chosen.

In the particular case where the pension system would be purely contributive $z_t^i = \tau\alpha^i w_t$, there would be no tax competition *per se*. Capital mobility does not have any effect on the choice of the payroll tax. Each country uses it to achieve the golden rule and realizes that there is nothing to gain in departing from it.

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Appendix
A numerical example

Simulation

Our simulations are based on the following specification: log-linear utility function: $U(c,d) = log\ c + 0.8\ log\ d$, Cobb-Douglas production function $f(k) = k^{0.4}$, two productivity levels $\alpha_1 = 0.5$; $\alpha_2 = 2$ and population growth rate: $n = 0.01$. We simulate the effect of changing p_1 (the fraction of lower productivity workers) on both the capital stock and the tax rate in four settings: the *laissez-faire* ($\tau = 0$), the golden rule, the second best in autarky and the second best in a small open economy.

Figure 1 gives the four capital stock profiles. We are in underaccumulation in the *laissez-faire*. If $p_1 = 0$ or 1 we are in a indentical-individuals-economy in which case the tax can achieve the golden rule. Note that the capital stock measured in efficiency units is the same for $p_1 = 0$ and $p_1 = 1$ even though in aggregate terms it is higher with $p_1 = 0$ than with $p_1 = 1$. Finally, the second best capital stock is higher in autarky than in a small open economy. This is consistent with what we have seen above. At the same time as it appears on Figure 2 the tax rate is higher in a small open economy than in autarky. For $p_1 = 0$ or $p_1 = 1$, we have the same tax rate (negative) that leads to the golden rule.

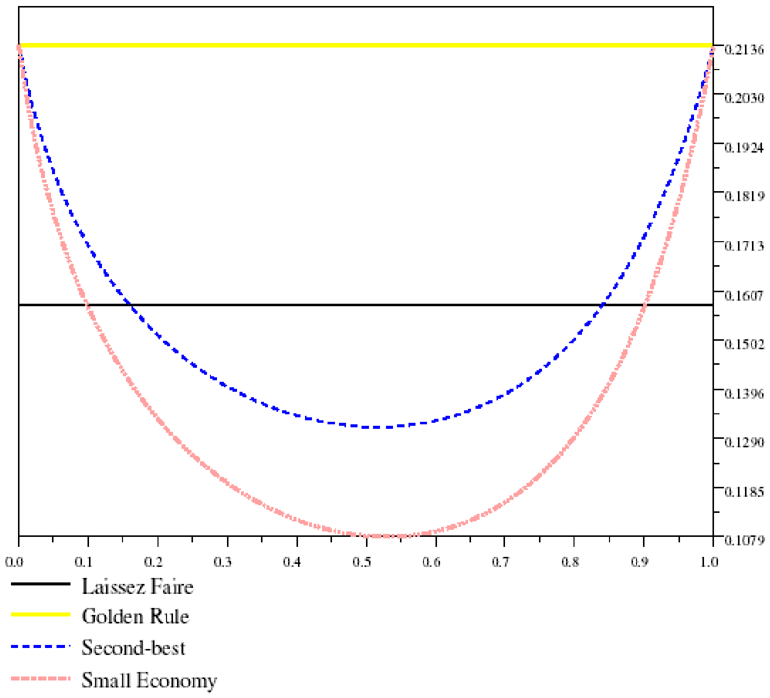

Figure 1: Effect of p_1 on capital stock

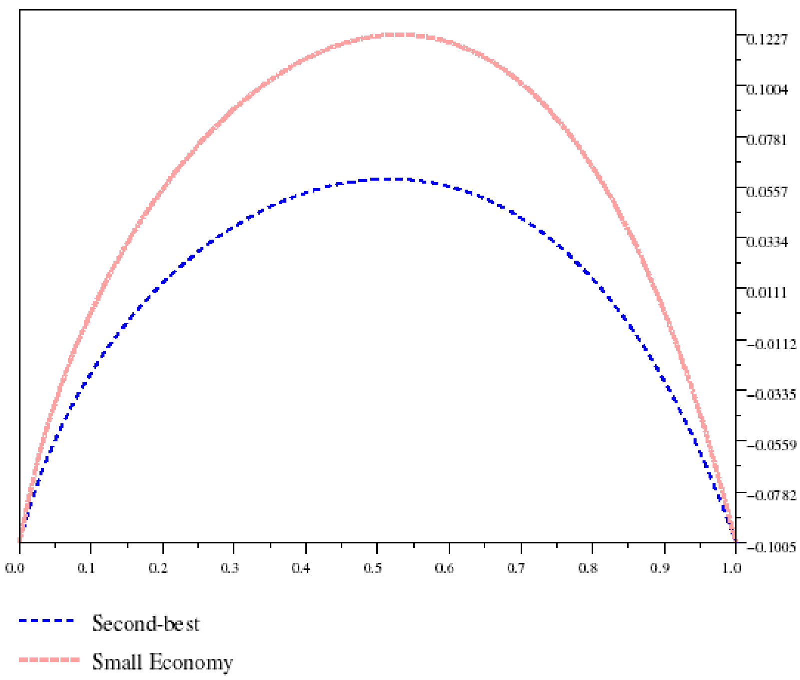

Figure 2: Effect of p_1 on the payroll tax