El documento adjunto, titulado ***Optimal economic policy and growth in an open economy***, elaborado en conjunto por el Dr. Enrique R. Casares Gil y la Mtra. María Guadalupe García Salazar, es un **reporte de investigación** del proyecto **Tasa de Crecimiento en una Economía Liderada por el Sector Exportador**, aprobado por el Consejo Divisional de Ciencias Sociales y Humanidades y registrado con el número **571**, cuyo responsable es el Dr. Enrique R. Casares Gil.

ABSTRACT

Industrial policies have been used in almost all countries, some with success other with failure. To study the relation between subsidies, capital inflows and growth, we develop an endogenous growth model with two sectors, tradable and non-tradable. Domestic technological knowledge only is produced in the tradable sector through learning by doing and this knowledge is available to the non-tradable firms. We assume that there is a country risk that depends positively on the level of foreign debt. The market economy is clearly inefficient. We study, in the steady state, how the economy responds when the government only establishes the optimal investment subsidy in the tradable sector. Thus, the investment and employment are stimulated in the tradable sector. Therefore, the ratio of non-tradable to tradable capital decreases and the proportion of labor in the tradable sector increases. The real exchange rate appreciates. As total wealth increases, the ratio of consumption to non-tradable capital also increases. The ratio of foreign debt to tradable capital increases, but the ratio is higher than its Pareto-optimal value. The government corrects this overborrowing with a tax on the interest rate, so capital controls are necessaries for that the economy reaches the Pareto-optimal value.

OPTIMAL ECONOMIC POLICY AND GROWTH IN AN OPEN ECONOMY

1 INTRODUCTION

The learning-by-doing argument deduces that first-best economic policy of the government is a subsidy in the learning sector without any additional economic policy action. This literature has been the theoretical base of the infant industry argument, or industrial policy, to promote growth and development. These industrial policies (with others economic policies) have been used in in almost all countries, some with success other with failure (Robinson, 2011). Pack and Saggi (2006) affirm that there is little empirical support for an activist industrial policy. Meanwhile, Stiglitz and Greenwald (2014) support a new industrial policy (see also Rodrik, 2008). Nowadays, some policy makers have attraction on these types of stimuluses to promote economic growth, because of concern about the process of globalization. To study the relation between subsidies, capital inflow and growth, in this article, we extend the model of Casares and Sobarzo (2016) to an open economy with imperfect capital mobility.

In general, in endogenous growth models with learning-by-investing externalities, the investment subsidy produces a Pareto-optimal growth rate in the economy, no additional measures are necessary. However, in open economies with imperfect capital mobility, if the government only imposes an investment subsidy in the learning sector and it does not introduce additional economic policy measures, the economy can finish in an inefficient equilibrium, in particular, with a higher external debt with respect to its Pareto-optimal value.

In order to clarify the previous ideas, we develop a two-sector endogenous growth model with two specific capital goods, labor, two production externalities and imperfect international capital mobility. The production is divided in two sectors, tradable and non-tradable. We assume that the tradable sector generates a domestic technological knowledge through learning-by-investing and this knowledge is used in the other sector (spillover effects). Thus, the economy is commanded by the tradable sector.[1] We assume that there is a country risk that depends positively on the level of foreign debt. Therefore, the domestic interest rate is equal to the world interest rate plus the country risk. Thus, our model is a special case of the two-sector endogenous growth models (Lucas, 1988), in an open economy context, where physical capital is tradable capital and human capital is non-tradable capital and each capital is immobile between the sectors (see Turnovsky, 2009). Therefore, with two production externalities, labor and another externality due to the country risk, our model has not been sufficient studied in the literature.

Given the existence of production and country risk externalities, the market economy is clearly inefficient. To obtain the Pareto-optimal values of the variables, we find, in the steady state, the social planner´s solution where both production externalities are internalized, and the social planner knows the influence of his decisions on the country risk (on borrowing cost). To replicate the Pareto-optimal value of the variables, the government in the market economy establishes an investment subsidy in the tradable sector and a tax rate on domestic interest rate.

We first explain the response of the market economy, in the steady state, when the government only establishes the optimal subsidy rate of investment (a traditional industrial policy). Thus, when the subsidy rate increases, the investment in the tradable sector is encouraged and the stock of tradable capital increases over time. Consequently, the ratio of non-tradable to tradable capital decreases, but the ratio is lower than its Pareto-optimal value. That is, there is overinvestment. By the stimulus, the proportion of labor in the tradable sector increases, nonetheless the proportion is higher than its Pareto-efficient level. Therefore, there is a misallocation of labor between sectors. We suggest that the relative price of the non-tradable good decreases initially, so the real exchange rate depreciates, and the tradable sector is further encouraged. However, in the new steady state, the relative price of the non-tradable good increases, but the relative price is lower than its Pareto-optimal level.

[1] Duarte and Restuccia (2010) find that labor productivity grows faster in the tradable sectors than the non-tradable sectors.

As total wealth increases, the ratio of consumption to non-tradable capital increases, nevertheless the ratio is higher than the its Pareto-efficient value. Meanwhile, the ratio of foreign debt to tradable capital increases, but the ratio is higher than its Pareto-optimal level. Thus, there is overborrowing. In concordance, the economy is overgrowing. Therefore, if the government only applies traditional industrial policy, the market economy remains inefficient.

To correct this overborrowing, the government establishes an optimal tax rate on the domestic interest rate (capital controls), that is, it increases the borrowing cost, so reducing the ratio of foreign debt to tradable capital to the Pareto-optimal value. Also, all variables reach the Pareto-efficient level. Therefore, capital controls improve social welfare. These results are different with respect to a closed economy with similar production structure, studied in Casares and Sobarzo (2016), where the optimal subsidy is the only optimal economic policy. Thus, a government must care about the industrial policy that it choses in an open economy with imperfect capital mobility, given that it can induce to an overinvestment and an overborrowing and it can generate balance of payment problems. At the present time, the debt problem is a serious one.

Our result about subsidy in the tradable sector is related to models with learning externalities. Thus, from Clemhout and Wan (1970) to Korinek and Serven (2016), all of them conclude that the first-best economic policy is a subsidy in the learning sector. In particular, Korinek and Serven (2016) argue, in an endogenous growth model where the tradable sector creates greater learning than non-tradable sector, that if the government cannot use subsidies due to multilateral restrictions or targeting problems, the accumulation of foreign reserves can be a practical second-best policy to stimulate investment in the tradable sector (through depreciation in the real exchange rate), and improving social welfare.

Our result about restriction on international borrowing, and that capital inflow controls improve welfare, is related with models with country risk externalities and capital controls. Turnovsky (1997) deduce the optimal tax/subsidy rate on the domestic interest rate to emend a country risk externality in a one sector endogenous growth model with government spending in the production function. Also, Benigno and Fornaro (2014) develop a two-sector model, tradable and non-tradable, where the accumulation of foreign knowledge take place in the tradable sector. This technological improvement produces externalities. The first-best policy is subsidizing firms in the tradable sector. If subsidies are not available, the second-best policy for improve welfare is a tax on capital inflows (capital controls). Finally, Michaud and Rothert (2014) develop a two-sector model with tradable (learning sector) and non-tradable goods. They suppose that the government impose a borrowing constraint (capital controls) on households to correct a learning-by-doing externality in the tradable sector. The borrowing constraint produces increasing labor supply and reallocation of labor towards tradable goods, so economic growth is promoted. Therefore, optimal borrowing constraint improves welfare, close to the first-best policy (subsidies). Given that, our model is a special case of the two-sector endogenous growth models with two specific capital goods, two production externalities, labor and imperfect capital mobility, our results are not present in the literature. In particular, our capital control is first-best policy. However, we stress that the government must establish simultaneously both-policies to be first-best, if the government establish only one, both policies become second-best. In this article, we have studied a specific scenario, as in the previous articles mentioned.

The paper is organized as follows. In section 2, we develop an endogenous growth model of a small open economy with imperfect capital mobility and we solve it in the steady state. In section 3, we show the command economy and its steady state solution. In section 4, we deduce the optimal economic policy. Finally, in section 5, we give our conclusions.

2 THE MARKET ECONOMY

The economy is open and small with imperfect capital mobility. Thus, the world market determines the price of the tradable good and the world interest rate. There is a country risk that depends positively on the external debt. There are two productive sectors, tradable and non-tradable. The tradable and non-tradable goods are produced using physical capital, labor and domestic technological knowledge. Technological knowledge only is generated through learning-by-investing in the tradable firms (Arrow, 1962, Romer, 1986). This knowledge can be used by the non-tradable firms. We assume an adjustment cost for the investment in the tradable firms. The tradable and non-tradable firms maximize the present discounted value of its cash flow taking the externality as given. The government establishes an investment subsidy in the tradable sector and a tax rate on the domestic interest rate. The government has balanced budget constraint and any difference between tax income and subsidy spending is cover residually by a lump-sum tax o subsidy. The representative household maximizes the present value of his utility function subject to his budget constraint. The total labor supply is constant and there is free mobility of labor between the sectors. In summary, we extend the model of Casares and Sobarzo (2016) to an open economy with imperfect capital mobility.

2.1 THE TRADABLE SECTOR

Given that all tradable firms make the same choice and aggregating across firms, the aggregate production function of the tradable firm is:

$$Y_T = A_T K_T^{\alpha} L_T^{1-\alpha} [K_T^{1-\alpha}] \tag{1}$$

where Y_T is the output in the sector, A_T is a productivity parameter, K_T the stock of physical capital accumulated from the tradable good, L_T is the quantity of labor employed in the sector, α and $(1-\alpha)$ are the shares of K_T and L_T, respectively, with $0 < \alpha < 1$, and $[K_T^{1-\alpha}]$ is a learning externality. Thus, domestic technological knowledge is created through learning by investing in the tradable sector (Arrow, 1962, and Romer, 1986). We assume that K_T is sector-specific capital. We can see that the aggregate production function has constant returns to a broad measure of capital, with this, we can generate endogenous growth.

The rate of depreciation of K_T is zero. We assume an adjustment cost, Φ, for the net investment in the tradable sector, I_T,:

$$\Phi = \left(\frac{b}{2}\right)\left(\frac{I_T}{K_T}\right) \tag{2}$$

where b is a sensitivity parameter, $b > 0$. Thus, the total cost of investment is $I_T(1+\Phi) = I_T + (b/2)(I_T^2/K_T)$.

We define r^w as the world interest rate, which is constant, and we introduce a country risk premium. We define D as the amount of external debt and d as the ratio of external debt to K_T. Thus $d = D/K_T$ is a measure of the country risk (this specification is consistent with our endogenous growth model). Therefore, the domestic interest rate, r, is:

$$r = r^w + \eta d \tag{3}$$

where η is a positive parameter that depends of country specific factors (see Turnovsky, 1997 and Eicher and Turnovsky, 1999).

The price of the tradable good is used as the numéraire. We define w_T as the wage rate in the tradable sector. As we will see, the optimal government policy is to establish an investment subsidy in the tradable sector, μ, where $0 < \mu < 1$, and a tax rate on domestic interest rate, ε, where $\varepsilon > 0$. Considering than the correct discount rate is $(1+\varepsilon)r$, the decision problem of the tradable firm is to choose L_T and I_T that maximizes the present discounted value of its cash flow, taking the externality as given:

$$\max V_T = \int_0^\infty \left\{A_T K_T^\alpha L_T^{1-\alpha}[K_T^{1-\alpha}] - w_T L_T \; - (1-\mu)\left[I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right)\right]\right\} e^{-\int_0^t (1+\varepsilon) r(v) dv} dt$$

subject to the capital accumulation $I_T = \dot{K}_T$.The Hamiltonian is:

$$H = \left\{A_T K_T^\alpha L_T^{1-\alpha}[K_T^{1-\alpha}] - w_T L_T - (1-\mu)\left[I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right)\right] + q I_T\right\} e^{-\int_0^t (1+\varepsilon) r(v) dv}$$

where q is the shadow price of installed K_T. The first order conditions are:

$$w_T = A_T K_T (1-\alpha) L_T^{-\alpha} \tag{4}$$

$$q = (1-\mu)\left[1 + b\left(\frac{I_T}{K_T}\right)\right] \tag{5}$$

$$(1+\epsilon)\, r = \frac{A_T \alpha L_T^{1-\alpha} + (1-\mu)\left(\frac{b}{2}\right)\left(\frac{I_T}{K_T}\right)^2}{q} + \frac{\dot{q}}{q} \tag{6}$$

$$\lim_{t\to\infty} e^{-\int_0^t (1+\varepsilon) r(v) dv}\, q K_T = 0 \tag{7}$$

where we have considered the production externalities. Equation (4) says that w_T is equal to the marginal product of L_T. As q is the market price of one unit of K_T and its replacement price is equal to 1, equation (5) states that investment in the tradable sector is positive when $q > 1$. Equation (6) says that the domestic inters rate with taxes is equal to the marginal product of K_T, $A_T \alpha L_T^{1-\alpha}$, plus marginal reduction in installation cost of K_T with subsidies, $(1-\mu)(b/2)(I_T/K_T)^2$, all deflated by q, plus capital gains. Equation (7) is the transversality condition. The tradable firm finances investment via retained earnings, so dividends, π_T, to households is equal to the cash flow:

$$\pi_T = A_T K_T L_T^{1-\alpha} - w_T L_T - (1-\mu)\left[I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right)\right] \tag{8}$$

2.2 THE NON-TRADABLE SECTOR

Given that all non-tradable firms make the same election, the aggregate production function of the non-tradable firm is:

$$Y_N = A_N K_N^{\beta} L_N^{1-\beta} \left[K_T^{1-\beta}\right] \tag{9}$$

where Y_N is the output of the non-trade sector, A_N is a positive productivity parameter, K_N is the stock of physical capital accumulated form the non-tradable good, L_N is the labor employed in the sector, β and $(1-\beta)$ are the shares of K_N and L_N respectively, and $\left[K_T^{1-\beta}\right]$ is an externality. Since, there are spillover effects of knowledge between the sectors, $\left[K_T^{1-\beta}\right]$ is technological knowledge used in the non-tradable sector.

We define p_N as the relative price of the non-tradable to tradable good and $\dot{p}_N/p_N$ as the rate of growth of p_N. We note that in this economic context, the real exchange rate is inversely related with the level of p_N. The rate of depreciation of K_N is zero, so $I_N = \dot{K}_N$ is the net investment in the non-tradable sector. The wage rate in the non-tradable sector is defined as w_N. The non-tradable firm maximizes the present discounted value of its cash flow:

$$V_N = \int_0^{\infty} \left\{p_N A_N K_N^{\beta} L_N^{1-\beta} \left[K_T^{1-\beta}\right] - w_N L_N - p_N \dot{K}_N\right\} e^{-\int_0^t [(1+\varepsilon)r(v) - \dot{p}_N/p_N]dv} dt$$

where the correct discount rate is $(1+\varepsilon)r - \dot{p}_N/p_N$. Applicating the Euler equations (see Sargent, 1987), the optimal conditions are:

$$w_N = p_N A_N K_N^{\beta} K_T^{1-\beta} (1-\beta) L_N^{-\beta} \tag{10}$$

$$(1+\epsilon)r = A_N \beta K_N^{\beta-1} K_T^{1-\beta} L_N^{1-\beta} + \frac{\dot{p}_N}{p_N} \tag{11}$$

where we have regarded the production externalities. Equation (10) says that w_N is equal to the marginal product of L_N. Equation (11) states that domestic interest rate with taxes is equal to the marginal product of K_N plus capital gains. We note that we can obtain the same marginal conditions when the non-tradable firm maximizes profits at each point in time. The non-tradable firm finances investment via retained earnings, so dividends, π_N, to households is equal to the cash flow:

$$\pi_N = p_N A_N K_N^{\beta} K_T^{1-\beta} L_N^{1-\beta} - w_N L_N - p_N I_N \tag{12}$$

2.3 THE GOVERNMENT

The tax income of the government is given by $\varepsilon r D$ and the subsidy spending is $\mu[I_T + (b/2)(I_T^2/K_T)]$. To have a balanced government budget constraint, any difference between tax income and subsidy spending is cover residually by a lump-sum tax o subsidy, T. The government budget constraint is:

$$\mu\left[I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right)\right] - \varepsilon r D = T \tag{13}$$

2.4 THE REPRESENTATIVE HOUSEHOLD

Foreigners own the external debt of the households. The households receive labor income and dividends from de firms. The household budget constraint is:

$$\dot{D} = (1+\epsilon) r D + C_T + p_N C_N - w_T L_T - w_N L_N - \pi_T - \pi_N + T \tag{14}$$

where $(1+\epsilon) r D$ is interest expense with taxes on external debt, C_T is consumption of tradable good, C_N is consumption of non-tradable good and $\dot{D}$ is the increase in household debt through time.

The representative household maximizes the present value of a utility function with a constant elasticity of intertemporal substitution subject to equation (14):

$$\max U(0) = \int_0^\infty \frac{\left(C_T^\gamma C_N^{1-\gamma}\right)^{1-1/\sigma}}{1-1/\sigma} e^{-\rho t} dt$$

where σ is the elasticity of intertemporal substitution, ρ is a constant subjective discount factor, with $\rho > 0$, γ and $(1-\gamma)$ are the shares of C_T and C_N in the total expenditure on consumption, respectively, with $0 < \gamma < 1$. The Hamiltonian is:

$$H = \left\{ \frac{C_T^{\gamma(1-1/\sigma)} C_N^{(1-\gamma)(1-1/\sigma)}}{(1-1/\sigma)} - \lambda[(1+\epsilon)rD + C_T + p_N C_N - w_T L_T - w_N L_N - \pi_T - \pi_N + T] \right\} e^{-\rho t} dt$$

where λ is the shadow price of D. The control variables are C_T and C_N. The first order conditions are:

$$\gamma C_T^{\gamma(1-1/\sigma)-1} C_N^{(1-\gamma)(1-1/\sigma)} = \lambda \tag{15}$$

$$\frac{C_T^{\gamma(1-1/\sigma)}(1-\gamma)C_T^{(1-\gamma)(1-1/\sigma)-1}}{p_N} = \lambda \tag{16}$$

The state variable is D. The first order condition is:

$$(1+\epsilon)r + \frac{\dot{\lambda}}{\lambda} = \rho \tag{17}$$

Equating equations (15) and (16), we obtain:

$$\frac{C_N}{C_T} = \frac{(1-\gamma)}{\gamma}\frac{1}{p_N} \tag{18}$$

Equation (18) says that the marginal rate of substitution between C_N and C_T is equal to $1/p_N$. We consider that aggregate consumption, C, is:

$$C = C_T + p_N C_N \tag{19}$$

Using equations (18) and (19), we obtain:

$$C_T = \gamma C \tag{20}$$

$$C_N = \frac{(1-\gamma)C}{p_N} \tag{21}$$

Equations (20) and (21) are the demands of C_T and C_N, respectively. Now, we obtain the dynamic allocation condition for aggregate consumption. Taking logarithms and the derivatives of equations (20) and (21) with respect to time, we have:

$$\frac{\dot{C}_T}{C_T} = \frac{\dot{C}}{C} \tag{22}$$

$$\frac{\dot{C}_N}{C_N} = \frac{\dot{C}}{C} - \frac{\dot{p}_N}{p_N} \tag{23}$$

Taking logarithms and the derivative of equation (15), or (16), with respect to time and using equations (22) and (23), we find:

$$(1-\gamma)\,(1-1/\sigma)\frac{\dot{p}_N}{p_N} + \frac{1}{\sigma}\,\frac{\dot{C}}{C} = -\frac{\dot{\lambda}}{\lambda} \tag{24}$$

Substituting (17) in the equation (24), we obtain the dynamic allocation condition for aggregate consumption in time:

$$\frac{\dot{C}}{C} = \sigma \left[(1+\epsilon)r - (1-\gamma)\,(1-1/\sigma)\,\frac{\dot{p}_N}{p_N} - \rho\right] \tag{25}$$

where $r = r^w + \eta d$ and $\dot{C}/C = g_C$ is the growth rate of C.

2.5 MARKETS

Substituting dividends, equations (8) and (12), and the government budget constraint, equation (13), in the household budget constraint, equation (14), we obtain the resource constraint of the economy:

$$\begin{aligned} &A_T K_T L_T^{1-\alpha} + p_N A_N K_N^{\beta} K_T^{1-\beta} L_N^{1-\beta} \\ &= rD + C_T + p_N C_N + I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right) + p_N I_N + -\dot{D} \end{aligned} \tag{26}$$

where $A_T K_T L_T^{1-\alpha} + p_N A_N K_N^{\beta} K_T^{1-\beta} L_N^{1-\beta} = Y_T + p_N Y_N = Y$ is the total output of the economy. Given that the price of the non-tradeable good is flexible, we assure than always supply is equal to demand in the market of the non-tradable good. The equilibrium condition for the non-tradable good market is:

$$p_N A_N K_N^{\beta} K_T^{1-\beta} L_N^{1-\beta} = p_N C_N + p_N I_N \tag{27}$$

where $I_N = \dot{K}_N$. Using equation (27) and the resource constraint of the economy, equation (26), we find the equilibrium condition for the tradable good market:

$$\dot{D} = rD + C_T + I_T + \left(\frac{b}{2}\right)\left(\frac{I_T^2}{K_T}\right) - A_T K_T L_T^{1-\alpha} \tag{28}$$

The total supply of labor, L, is constant, so the labor market equilibrium condition is $L = L_T + L_N$.

2.6 STATIONARY VARIABLES

Given that the variables K_T, K_N, D and C are growing always, we redefine the model in terms of variables that are constant in the steady state, that is, in stationary variables. The first stationary variable, z, is the ratio of K_N to K_T, $z = K_N/K_T$. The second stationary variable, v, is the ratio of aggregate consumption to K_N, $v = C/K_N$. The third stationary variable, d, is the ratio of external debt to K_T, $d = D/K_T$. Given that $L = 1$, the labor market equilibrium condition is $n + (1 - n) = 1$, where n is the fraction of labor employed in the tradable sector and $(1 - n)$ is the fraction of labor employed in the non-tradable sector. Thus, the fraction n is the fourth stationary variable.

Considering the production externalities, the aggregate production functions in terms of stationary variables are:

$$Y_T = A_T K_T n^{1-\alpha} \tag{29}$$

$$Y_N = A_N K_T z^{\beta} (1 - n)^{1-\beta} \tag{30}$$

Considering that $I_T = \dot{K}_T$ and $I_N = \dot{K}_N$, the first order conditions of the tradable and non-tradable sector in terms of stationary variables are:

$$w_T = A_T K_T (1 - \alpha) n^{-\alpha} \tag{31}$$

$$q = (1 - \mu)\left[1 + b\left(\frac{\dot{K}_T}{K_T}\right)\right] \tag{32}$$

$$(1 + \varepsilon) r = \frac{A_T \alpha n^{1-\alpha} + (1 - \mu)\left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2}{q} + \frac{\dot{q}}{q} \tag{33}$$

$$w_N = p_N A_N K_T z^{\beta}(1-\beta)(1-n)^{-\beta} \tag{34}$$

$$(1+\epsilon)r = A_N \beta z^{\beta-1}(1-n)^{1-\beta} + \frac{\dot{p}_N}{p_N} \tag{35}$$

where $\dot{K}_T/K_T = g_{K_T}$ is the growth rates of K_T. Substituting $(1+\varepsilon)r$, equation (35), or equation (33), in equation (25), we obtain the growth rate of C in terms of stationary variables:

$$\frac{\dot{C}}{C} = \sigma \left[A_N \beta z^{\beta-1}(1-n)^{1-\beta} + \frac{\dot{p}_N}{p_N} - (1-\gamma)\,(1-1/\sigma)\,\frac{\dot{p}_N}{p_N} - \rho\right] \tag{36}$$

Using equations (21) and (27), the equilibrium condition for the non-tradable good market in terms of stationary variables is:

$$\frac{\dot{K}_N}{K_N} = A_N z^{\beta-1}(1-n)^{1-\beta} - \frac{(1-\gamma)v}{p_N} \tag{37}$$

where $\dot{K}_N/K_N = g_{K_N}$ is the growth rates of K_N. With equation (20), (28) divided by K_T, and $\dot{D}/K_T = \dot{d} + d(\dot{K}_T/K_T)$, we obtain the equilibrium condition for the tradable good market in terms of stationary variables:

$$\dot{d} = rd + \gamma vz + (1-d)\left(\frac{\dot{K}_T}{K_T}\right) + \left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2 - A_T n^{1-\alpha} \tag{38}$$

Alternatively, the equilibrium condition for the tradable good market can be defined as $\dot{D}/D = (1/d)\left[rd + \gamma vz + (\dot{K}_T/K_T) + (b/2)(\dot{K}_T/K_T)^2 - A_T n^{1-\alpha}\right]$. Equating wage rates in both sectors, equations (31) and (34), we find the efficient allocation condition for labor between the sectors:

$$A_T K_T (1-\alpha) n^{-\alpha} = p_N A_N K_T z^{\beta}(1-\beta)(1-n)^{-\beta} \tag{39}$$

Equating equations (33) and (35), we obtain the dynamic arbitrage condition for K_T and K_N:

$$\frac{A_T \alpha n^{1-\alpha} + (1-\mu)\left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2}{q} + \frac{\dot{q}}{q} = A_N \beta z^{\beta-1}(1-n)^{1-\beta} + \frac{\dot{p}_N}{p_N} \tag{40}$$

where the private returns of K_T and K_N are the same. Differentiating $Y = Y_T + p_N Y_N$, we obtain the growth rate of the total output, $\dot{Y}/Y = g_Y$,:

$$\frac{\dot{Y}}{Y} = \frac{Y_T}{Y}\frac{\dot{Y}_T}{Y_T} + \frac{P_N Y_N}{Y}\left[\frac{\dot{Y}_N}{Y_N} + \frac{\dot{p}_N}{p_N}\right] \tag{41}$$

where $Y_T/Y = 1/\{1 + [p_N A_N z^\beta (1-n)^{1-\beta}/A_T n^{1-\alpha}]\}$ is the share of Y_T in the total output and $p_N Y_N/Y = 1/\{[A_T n^{1-\alpha}/(p_N A_N z^\beta (1-n)^{1-\beta})] + 1\}$ is the share of $p_N Y_N$ in the total output. The growth rate of Y_T, $\dot{Y}_T/Y_T = g_{Y_T}$, and Y_N, $\dot{Y}_N/Y_N = g_{Y_N}$, are:

$$\frac{\dot{Y}_T}{Y_T} = \frac{\dot{K}_T}{K_T} + (1-\alpha)\frac{\dot{n}}{n} \tag{42}$$

$$\frac{\dot{Y}_N}{Y_N} = \frac{\dot{K}_T}{K_T} + \beta\frac{\dot{z}}{z} - (1-\beta)\frac{\dot{n}}{n}\frac{n}{(1-n)} \tag{43}$$

2.7 THE STEADY-STATE SOLUTION IN THE MARKET ECONOMY

We now proceed to obtain the steady state solution of the market economy. Taking logarithms and the derivatives of $z = K_N/K_T$ and $v = C/K_N$ with respect to time, we obtain $\dot{z}/z = \dot{K}_N/K_N - \dot{K}_T/K_T$ and $\dot{v}/v = \dot{C}/C - \dot{K}_N/K_N$. In the steady state $\dot{z}/z = 0$, we have that $\dot{K}_T/K_T = \dot{K}_N/K_N$. We next find the growth rate of K_T. Substituting equation (32) in equation (33), and considering that $\dot{q}/q = 0$ and $r = r^w + \eta d$, we have:

$$(1+\epsilon)(r^w + \eta d) = \frac{A_T \alpha n^{1-\alpha}}{(1-\mu)\left[1 + b\left(\dot{K}_T/K_T\right)\right]} + \frac{(b/2)\left(\dot{K}_T/K_T\right)^2}{\left[1 + b\left(\dot{K}_T/K_T\right)\right]} \qquad (44)$$

Using $r = r^w + \eta d$, the equilibrium condition for the tradable good market, equation (38) with $\dot{d} = 0$, is:

$$A_T n^{1-\alpha} = (r^w + \eta d)d + \gamma v z + (1-d)\left(\frac{\dot{K}_T}{K_T}\right) + \left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2 \qquad (45)$$

Using equations (44) and (45), we obtain the growth rate of K_T in the steady state:

$$g_{K_T}^* = \left[\frac{1}{(1-d^*) + (1+\epsilon)(r^w + \eta d^*)b}\right]\left[A_T n^{*(1-\alpha)} - (r^w + \eta d^*)d^* - \gamma v^* z^* \right.$$
$$\left. - (1+\epsilon)(r^w + \eta d^*) + \frac{A_T \alpha n^{*(1-\alpha)}}{(1-\mu)}\right] \qquad (46)$$

We denote steady state values with an asterisk. With the efficient allocation condition for labor between the sectors, equation (39), we find the level of p_N:

$$p_N = \frac{A_T(1-\alpha)n^{-\alpha}}{A_N z^\beta (1-\beta)(1-n)^{-\beta}} \qquad (47)$$

Using the equilibrium condition for the non-tradable good market, equation (37), and (47), the growth rate of K_N is:

$$g_{K_N}^* = A_N z^{*(\beta-1)}(1-n^*)^{1-\beta} - \frac{(1-\gamma)v^* A_N z^{*\beta}(1-\beta)(1-n^*)^{-\beta}}{A_T(1-\alpha)n^{*(-\alpha)}} \quad (48)$$

Finally, with equations (46) and (48), we obtain the steady state condition $g_{K_T}^* = g_{K_N}^*$:

$$\left[\frac{1}{(1-d^*)+(1+\epsilon)(r^w+\eta d^*)b}\right]\left[A_T n^{*(1-\alpha)} - (r^w+\eta d^*)d^* - \gamma v^* z^* \right.$$
$$\left. - (1+\epsilon)(r^w+\eta d^*) + \frac{A_T \alpha n^{*(1-\alpha)}}{(1-\mu)}\right]$$
$$= A_N z^{*(\beta-1)}(1-n^*)^{1-\beta}$$
$$- \frac{(1-\gamma)v^* A_N z^{*\beta}(1-\beta)(1-n^*)^{-\beta}}{A_T(1-\alpha)n^{*(-\alpha)}} \quad (49)$$

Considering that in the steady state $\dot{v}/v = 0$, so $\dot{C}/C = \dot{K}_N/K_N$. Using $\dot{C}/C$, equations (25) with $\dot{p}_N = 0$, (48) and $r = r^w + \eta d$, we obtain the steady state condition $g_C^* = g_{K_N}^*$:

$$\sigma\left[(1+\varepsilon)(r^w+\eta d^*) - \rho\right]$$
$$= \quad A_N z^{*(\beta-1)}(1-n^*)^{1-\beta} - \frac{(1-\gamma)v^* A_N z^{*\beta}(1-\beta)(1-n^*)^{-\beta}}{A_T(1-\alpha)n^{*(-\alpha)}} \quad (50)$$

Given that in the steady state $\dot{p}_N = 0$, the equation (35) becomes:

$$(1+\epsilon)(r^w+\eta d^*) = A_N \beta z^{*(\beta-1)}(1-n^*)^{1-\beta} \quad (51)$$

Equating equations (44) and (51), we have:

$$\frac{A_T \alpha n^{*(1-\alpha)}}{(1-\mu)\left[1+b\left(g_{K_T}^*\right)\right]}+\frac{(b/2)\left(g_{K_T}^*\right)^2}{\left[1+b\left(g_{K_T}^*\right)\right]}=A_N \beta z^{*(\beta-1)}(1-n^*)^{1-\beta} \tag{52}$$

where $g_{K_T}^*$ is given by equation (46). Therefore, the steady state solution is given by the system of four non-linear equations, (49), (50), (51), and (52), in four variables, z, n, v and d. Thus, we have that K_T, K_N C and D grow to an equal and constant rate in the steady state, g^* . With $\dot{p}_N = 0$ and equations (22) and (23), we also see that C_T and C_N grow at the rate g^* We next show that Y, Y_T and Y_N grow at the same rate g^*. Using equations (42) and (43), with $\dot{z} = 0$, and $\dot{n}$ = 0, we have than $g_T^* = g_{K_T}^*$ and $g_N^* = g_{K_T}^*$. Therefore, with equation (41) and $\dot{p}_N = 0$, we have that the growth rate of Y is:

$$g_Y^* = \frac{Y_T}{Y} g_{K_T}^* + \frac{P_N Y_N}{Y} g_{K_T}^* \tag{53}$$

where $Y_T/T + p_N Y_N/Y = 1$, so we conclude that $g_Y^* = g_{Y_T}^* = g_{Y_N}^* = g_{K_T}^* = g^*$.

We solve numerically the system of equations (49), (50), (51), and (52), with MATHEMATICA. We use the parameters α = 0.37 and β = 0.32, as in Valentinyi and Herrendorf (2008). Thus, the tradable sector is more capital intensive than the non-tradable sector (data of US economy). We set γ = 0.4 (see Rabanal and Tuesta, 2013). The estimates of the elasticity of intertemporal substitution are low, we give σ = 0.5 (see Yogo, 2004). We use $r^w = 0.04$, ρ = 0.04, η = 2 and b = 16, as in Ortigueira and Santos (1997), used by Eicher and Hull (2004) and Turnovsky (2009).[2] As the values of A_T and A_N depend on the single characteristics of an economy, they are set only for explanatory purposes, A_T = 0.4 and A_N = 0.4. For the moment, we establish $\mu = 0$ and ε = 0. We obtain that n^* = 0.3838, z^* = 1.5762, v^*

[2] Barro and Sala-i-Matin (2004) indicate that a high value of the parameter b, for example b = 10, produces unrealistic high values of q but explains observed empirically speeds of convergence.

= 0.3215, d^* 0.0137, the relative price is p_N^* = 0.9775, the country risk premium is 0.0275 (275 basis points) and g^* = 0.0137. Thus, the steady state growth rate is 1.37% per annum. In the next section, we develop and solve the command economy.

3 THE COMMAND ECONOMY

The market economy is clearly inefficient. To find the Pareto-optimal solution, the social planner internalizes the two production externalities. The planner also knows that when he chooses D and K_T, he affects the borrowing cost, $r = r^w + \eta\, D/K_T$. Thus, the planner internalizes the country risk externality. Therefore, the social planner maximizes the present value of the utility function:

$$\max U(0) = \int_0^\infty \frac{\left(C_T^\gamma C_N^{1-\gamma}\right)^{1-1/\sigma}}{1-1/\sigma} e^{-\rho t} dt$$

subject to the equilibrium condition for the tradable good market, $\dot{D} = rD + C_T + I_T + (b/2)(I_T^2/K_T) - A_T K_T n^{1-\alpha}$ and the equilibrium condition for the non-tradable good market, $\dot{K}_N = A_N K_N^\beta K_T^{1-\beta}(1-n)^{1-\beta} - C_N$, where we are taking into account the labor market equilibrium condition in terms of stationary variables. The Hamiltonian is:

$$H = \left\{ \frac{C_T^{\gamma(1-1/\sigma)} C_N^{(1-\gamma)(1-1/\sigma)}}{(1-1/\sigma)} - \mu_D[rD + C_T + I_T + (b/2)(I_T^2/K_T) - A_T K_T n^{1-\alpha}] \right.$$
$$\left. + \mu_N\left[A_N K_N^\beta K_T^{1-\beta}(1-n)^{1-\beta} - C_N\right] + \tilde{q}[I_T] \right\} e^{-\rho t}$$

where $\dot{K}_T = I_T$, μ_D and μ_N are the shadow prices of D and K_N, respectively. The shadow price of K_T is $\tilde{q}$, where $\tilde{q} = q\mu_D$ and q is the market price of installed K_T. The control variables are C_T, C_N, n and I_T. The first order conditions are:

$$\gamma C_T^{\gamma(1-1/\sigma)-1} C_N^{(1-\gamma)(1-1/\sigma)} = \mu_D \tag{54}$$

$$C_T^{\gamma(1-1/\sigma)}(1-\gamma)C_N^{(1-\gamma)(1-1/\sigma)-1} = \mu_N \quad (55)$$

$$\mu_D A_T K_T (1-\alpha)n^{-\alpha} = \mu_N A_N K_N^{\beta} K_T^{1-\beta}(1-\beta)(1-n)^{-\beta} \quad (56)$$

$$q = \left[1 + b\left(\frac{I_T}{K_T}\right)\right] \quad (57)$$

where, in equation (57), we have used the fact that $\tilde{q}/\mu_D = q$.The state variables are K_T, K_N and D. The first order conditions are:

$$\frac{\left[A_T n^{1-\alpha} + + \left(\frac{b}{2}\right)\left(\frac{I_T}{K_T}\right)^2 + \eta d^2\right]}{q} + \frac{(\mu_N/\mu_D)\left[A_N K_N^{\beta}(1-\beta)K_T^{-\beta}(1-n)^{1-\beta}\right]}{q} + \frac{\dot{q}}{q} + \frac{\dot{\mu}_D}{\mu_D} = \rho \quad (58)$$

$$A_N \beta K_N^{\beta-1} K_T^{1-\beta}(1-n)^{1-\beta} + \frac{\dot{\mu}_N}{\mu_N} = \rho \quad (59)$$

$$(r^w + \eta 2d) - \rho = -\frac{\dot{\mu}_D}{\mu_D} \quad (60)$$

Let $p_N = \mu_N/\mu_D$ be the shadow price of K_N in terms of the shadow price of foreign debt (in units of the tradable good). Using $p_N = \mu_N/\mu_D$, $z = K_N/K_T$, $I_T = \dot{K}_T$, and equations (57), (58) and (60), we find:

$$(r^w + \eta 2d) = \frac{\left[A_T n^{1-\alpha} + \left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2 + \eta d^2\right]}{\left[1 + b\left(\dot{K}_T/K_T\right)\right]} + \frac{p_N\left[A_N z^\beta (1-\beta)(1-n)^{1-\beta}\right]}{\left[1 + b\left(\dot{K}_T/K_T\right)\right]} + \frac{\dot{q}}{q} \tag{61}$$

where the word interest rate plus the marginal increase in the cost of borrowing due to an increase in the external debt, $\eta 2d$, is equal to the social returns of K_T. Wherein, the social returns of K_T is the sum of the social marginal product of K_T in the tradable sector, $A_T n^{1-\alpha}$, the marginal reduction in installation cost of K_T, $(b/2)\left(\dot{K}_T/K_T\right)^2$, the marginal reduction in the cost of borrowing due to an increase in K_T, ηd^2, the social marginal product of K_T in the non-tradable sector, $p_N\left[A_N z^\beta (1-\beta)(1-n)^{1-\beta}\right]$, all deflated by $q = 1 + b\left(\dot{K}_T/K_T\right)$, plus capital gains.

Taking logarithms and the derivative of $\mu_N = \mu_D p_N$ with respect to time, we obtain: $\dot{\mu}_N/\mu_N = \dot{\mu}_D/\mu_D + \dot{p}_N/p_N$. Using $\dot{\mu}_N/\mu_N$, $z = K_N/K_T$, and equations (59) and (60), we have:

$$(r^w + \eta 2d) = A_N \beta z^{\beta-1}(1-n)^{1-\beta} + \frac{\dot{p}_N}{p_N} \tag{62}$$

where the word interest rate plus $\eta 2d$ (the marginal increase in the cost of borrowing due to an increase in the external debt) is equal to the social returns of K_N (the social marginal product of K_N plus capital gains).

Equating equations (61) and (62), we obtain the dynamic arbitrage condition for K_T and K_N in terms of the stationary variables:

$$\frac{\left[A_T n^{1-\alpha} + \left(\frac{b}{2}\right)\left(\frac{\dot{K}_T}{K_T}\right)^2 + \eta d^2\right] + p_N\left[A_N z^\beta (1-\beta)(1-n)^{1-\beta}\right]}{\left[1 + b\left(\dot{K}_T/K_T\right)\right]} + \frac{\dot{q}}{q} = A_N \beta z^{\beta-1}(1-n)^{1-\beta} + \frac{\dot{p}_N}{p_N} \tag{63}$$

where the social returns of K_T and K_N are the same. Using $p_N = \mu_N/\mu_D$ and equation (56), we obtain the efficient allocation condition for labor between the sectors, identical to equation (39) in the market economy.

Using $\mu_N = p_N\mu_D$ in equation (55), and substituting the result in equation (54), we obtain the marginal rate of substitution between C_N and C_T: $C_N/C_T = [(1-\gamma)/\gamma](1/p_N)$. Using the previous equation and $C = C_T + p_N C_N$, we obtain the demand of C_T: $C_T = \gamma C$ and the demand of C_N: $C_N = (1-\gamma)C/p_N$. In order to find $\dot{C}/C$, we follow the same procedure than in the market economy. Taking logarithms and the derivative of equation (54), or (55), with respect to time and using equations (22), (23) and (60), we find the dynamic allocation condition for aggregate consumption in time:

$$\frac{\dot{C}}{C} = \sigma\left[(r^w + \eta 2d) - (1-\gamma)(1-1/\sigma)\,\frac{\dot{p}_N}{p_N} - \rho\right] \tag{64}$$

The equilibrium condition for the non-tradable good market in terms of stationary variables is similar to equation (37) and the equilibrium condition for the tradable good market in terms of stationary variables is similar to equation (38).

3.1 THE STEADY-STATE SOLUTION IN THE COMMAND ECONOMY

We now proceed to obtain the steady state solution of the command economy. We know that in the steady state $\dot{K}_T/K_T = \dot{K}_N/K_N$. Following the same procedure that we used in the market economy, we will deduce the growth rate of K_T. Using the equilibrium condition for the tradable good market, equation (38) with $\dot{d} = 0$, equation (61) with $\dot{q} = 0$, and the level of p_N, equation (47), we obtain the growth rate of K_T in the steady state:

$$g_{K_T}^* = \left[\frac{1}{(1-d^*) + (r^w + \eta 2d^*)b}\right]\left[A_T n^{*(1-\alpha)} + A_T(1-\alpha)n^{*(-\alpha)}(1-n^*) - (r^w + \eta d^*)d^* - \gamma v^* z^* - (r^w + \eta 2d^*) + \eta d^{*2} + A_T n^{*(1-\alpha)}\right] \tag{65}$$

With the equilibrium condition for the non-tradable good market, equation (37), and p_N, equation (47), we obtain the steady state growth rate of K_N, identical to equation (48). With equations (65) and (48), we obtain the steady state condition $g_{K_T}^* = g_{K_N}^*$:

$$\left[\frac{1}{(1-d^*)+(r^w+\eta 2d^*)b}\right]\left[A_T n^{*(1-\alpha)} + A_T(1-\alpha)n^{*(-\alpha)}(1-n^*) - (r^w+\eta d^*)d^* - \gamma v^* z^* - (r^w+\eta 2d^*) + \eta d^{*2} + A_T n^{*(1-\alpha)}\right] = A_N z^{*(\beta-1)}(1-n^*)^{1-\beta} - \frac{(1-\gamma)v^* A_N z^{*\beta}(1-\beta)(1-n^*)^{-\beta}}{A_T(1-\alpha)n^{*(-\alpha)}} \quad (66)$$

We know that $\dot{C}/C = \dot{K}_N/K_N$ in the steady state. Using equations (64), with $\dot{p}_N/p_N = 0$, and (48), we obtain the steady state condition $g_C^* = g_{K_N}^*$:

$$\sigma\left[(r^w+\eta 2d^*)-\rho\right] = A_N z^{*(\beta-1)}(1-n^*)^{1-\beta} - \frac{(1-\gamma)v^* A_N z^{*\beta}(1-\beta)(1-n^*)^{-\beta}}{A_T(1-\alpha)n^{*(-\alpha)}} \quad (67)$$

Given that in the steady state $\dot{p}_N = 0$, the equation (62) becomes:

$$(r^w+\eta 2d^*) = A_N \beta z^{*(\beta-1)}(1-n^*)^{1-\beta} \quad (68)$$

Considering that $\dot{q} = 0$ and $\dot{p}_N = 0$, equation (63) becomes:

$$\frac{\left[A_T n^{*(1-\alpha)} + \left(\frac{b}{2}\right)\left(g_{K_T}^*\right)^2 + \eta d^{*2}\right] + A_T(1-\alpha)n^{*(-\alpha)}(1-n^*)}{\left[1+b\left(g_{K_T}^*\right)\right]} = A_N \beta z^{*(\beta-1)}(1-n^*)^{1-\beta} \quad (69)$$

where $g_{K_T}^*$ is given by equations (65). Therefore, the steady state solution is given by the system of four non-linear equations, (66), (67), (68), and (69), in four variables,

z, n, v and d. We also have that K_T, K_N C and D grow to an equal and constant rate in the steady state, g^*. With $\dot{p}_N = 0$ and equations (22) and (23), we also see that C_T and C_N grow at the rate g^*. Using the same procedure that in the market economy, we conclude that $g_Y^* = g_{Y_T}^* = g_{Y_N}^* = g_{K_T}^* = g^*$.

Using the parameter values of section 2, we solve the system of four non-linear equations in four variables. We obtain n^* = 0.5278, z^* = 0.2359, v^* = 1.3636, d^*= 0.0412, p_N^* = 1.4651 and g^* = 0.0825. We can see that the optimal growth rate is 8.25% per annum. Thus, the market economy has a lower growth rate (1.37%) than the command economy. The government in the market economy can reach the Pareto-optimal values with an investment subsidy in the tradable sector and a tax rate on interest rate.

4 THE OPTIMAL ECONOMIC POLICY

The government in the market economy tries to reach the Pareto-optimal solution through economic policy. Given the existence of two production externalities and the presence of the country risk externality, the appropriate economic policy is to subsidize the investment in the tradable sector and to establish a tax rate on the domestic interest rate.

In order to replicate the command economy in the steady state, a tax rate on the domestic interest rate in the market economy must satisfy: $(1+\varepsilon)(r^w + \eta d^*) = r^w + \eta 2d^*$ and a subsidy rate on investment in the tradable sector must satisfy: $A_T \alpha n^{*(1-\alpha)}/(1-\mu) = A_T n^{*(1-\alpha)} + \eta d^{*2} + A_T(1-\alpha)n^{*(-\alpha)}(1-n^*)$. If we substitute the previous equivalence conditions in the steady state solution of the market economy, equations (49), (50), (51) and (52), we obtain the steady state solution of the command economy, equations (66), (67), (68) and (69). Thus, the market and social planner's solutions are identical.

Solving for μ and ε of the previous equivalence conditions, we obtain the optimal subsidy and tax rates in the steady state:

$$\mu = 1 - \frac{A_T \alpha n^{*(1-\alpha)}}{A_T n^{*(1-\alpha)} + \eta d^{*2} + A_T(1-\alpha) n^{*(-\alpha)}(1-n^*)}$$

$$\epsilon = \frac{(r^w + \eta 2d^*)}{(r^w + \eta d^*)} - 1$$

Using the previous equations and the Pareto-optimal steady state values, we obtain the optimal subsidy rate on investment, μ = 0.7652, and the optimal tax rate on the interest rate, ε = 0.6736. With this optimal economic policy, we solve the system for z, n, v and d of the market economy, equations (49), (50), (51), and (52)., and we obtain n^* = 0.5278, z^* = 0.2359, v^* = 1.3636, d^* = 0.0412, p_N^* = 1.4651 and g^* = 0.0825. Thus, the steady state growth rate is 8.25% per annum. Note that all these levels correspond to the Pareto-optimal solution.

We now study how the variables of the market economy respond when the government only establish the optimal subsidy rate, that is, μ = 0.7652 and ε = 0. Thus, when the subsidy rate increases, the investment in the tradable sector is encouraged and the stock of K_T increases over time. Consequently, the level of z decreases to the new steady state level, from z^* = 1.5762 to z^* = 0.2230, but the Pareto optimal value is z^* = 0.2359. Thus, there is overinvestment. As the tradable sector is stimulated, the proportion of labor in the tradable sector also rises, from n^* = 0.3838 to n^* = 0.5452, nonetheless the Pareto-efficient level is n^* = 0.5278. Therefore, there is a misallocation of labor between sectors. We suggest that the relative price of the non-tradable good declines initially, so the real exchange rate depreciates, and the tradable sector is strengthened. However, in the steady state, the relative price of the non-tradable good rises, from p_N^* = 0.9775 to p_N^* = 1.45633, but the Pareto-optimal level is p_N^* = 1.4651. Also, as total wealth rises, the level of v increases, from v^* = 0.3215 to v^* = 1.3722, nevertheless the Pareto-efficient value is v^* = 1.3636. Meanwhile, the ratio of foreign debt to tradable capital increases, from d^* = 0.0137 to d^* = 0.0838, but the Pareto-optimal level is d^* = 0.0412. Thus, there is overborrowing. Therefore, as the tradable sector is the leading technological sector, in the new steady state, the growth rate of the economy increases, from g^* = 1.37% to g^* = 8.38% per annum, but the Pareto-efficient level is 8.25% per annum. Therefore, the economy is overgrowing. Consequently, if the government only applies traditional industrial policy, the market economy remains inefficient.

In order to correct the overborrowing, the government establishes an optimal tax rate on the domestic interest rate (capital controls), ε = 0.6736, that is, it increases the borrowing cost, so reducing the ratio of foreign debt to tradable capital to the Pareto-efficient value. Also, all variables reach the Pareto-efficient level. Therefore, capital controls are a first-best policy and social welfare improves. However, we note that the government must establish simultaneously both-policies to be first-best, if the government establish only one, both policies become second-best.

This is a sharp difference with respect to a closed economy with similar production structure, studied in Casares and Sobarzo (2016), where the optimal subsidy is the only optimal economic policy. Thus, a government must concern about the economic policy that it choses in an open economy, given that it can induce to overborrowing, overgrowing, and problems in the balance of payment.

Our tax rate on interest rate is a first-best policy.[3] Benigno and Fornaro (2014) affirm that when there are technological externalities and subsidies are not available to tradable firms, the second-best policy for improve social welfare is a tax on capital inflows (capital controls). Also, Korinek and Serven (2016) argue that when there are learning externalities and there are targeting problems with subsidies, the government can stimulate investment in the tradable sector through accumulation of foreign reserves as a second-best policy (by means of real exchange rate depreciation). Similarly, Michaud and Rothert (2014) supposes that the government establish a borrowing constraint (capital controls) on households to correct a learning

[3] If our government cannot use investment subsidies, our ε can be reinterpreted as a subsidy on interest rate, so this second-best policy improves social welfare (see Turnovsky, 1997).

externality in the tradable sector. Thus, economic growth is promoted, and the optimal borrowing constraint improves social welfare, close to the first-best policy (subsidies). Therefore, in this article, we have experimented with a specific scenario.

5 CONCLUSIONS

We have presented a two-sector endogenous growth of an economy with imperfect capital mobility and three externalities. First, we have studied how the economy respond when the government establishes the optimal investment subsidy in the tradable sector. Thus, the investment and employment are stimulated in the tradable sector. Therefore, the ratio of non-tradable to tradable capital decreases and the proportion of labor in the tradable sector increases to the new steady state levels. However, their levels are inefficient. We have suggested that the real exchange rate depreciates initially, and the tradable sector attracts more resources. Nevertheless, in the new steady state, the real exchange rate appreciates, but its level remains inefficient. As total wealth increases, the level of the ratio of consumption to non-tradable capital also increases, but this ratio is higher than the its Pareto-efficient level. Also, the ratio of foreign debt to tradable capital increases, but it is higher with respect to its Pareto-optimal value. Thus, the economy is overinvestment, overborrowing and overgrowing. Therefore, the economy is in an inefficient level. The government corrects this with tax rate on the interest rate, so capital controls are necessaries for that the economy reach the Pareto-optimal values. This type of capital controls provides an improvement in social welfare.

We have indicated that some recent articles have assumed that there are multilateral restrictions, or targeting problems, to implement subsidies in practice. Thus, this literature has shown second-best policies to improve social welfare. The second-best policies include tax on capital inflows, accumulation of foreign reserves, real exchange depreciation and borrowing constraint on households, among others. Our first-best policies are an investment subsidy in the tradable sector and a tax rate on interest rate. We have mentioned that, if the government establish only one policy, both policies become second-best. In this article, we have experimented only with different scenarios, as in the literature mentioned.

However, targeting problems and the politics of policy (Robinson, 2011) remain present, so a government must have concern about the industrial policy that it choses (namely investment subsidy in the tradable sector) in an open economy with imperfect capital mobility. Thus, unwittingly, a government can induce to an overinvestment and an overborrowing in the economy and can produce balance of payment problems.

REFERENCES

Arrow, K. J. (1962), “The Economic Implication of Learning by Doing”, Review of Economic Studies, 29, 155-173.

Barro, R. J. y X. Sala-i-Martin (2004), Economic Growth, Second Edition, The MIT Press.

Benigno, G. and L. Fornaro (2014). “The Financial Resource Curse”, The Scandinavian Journal of Economics, 116,1, 58-86.

Casares, E. R. and H. Sobarzo (2016). “Externalities, Optimal Subsidy and Growth”, in A. Pinto, E. Accinelli G., A. N. Yannacopulos and C. Herves-Belo (editors), Trends in Mathematical Economics. Dialogues Between Southern Europe and Latin America, Springer, 53-71.

Clemhout, S. and H. Y. Wan (1970), “Learning-by-Doing and Infant Industry Protection”, Review of Economic Studies, 37, 33-56.

Duarte, M. and Restuccia, D. (2010). “The Role of the Structural Transformation in Aggregate Productivity”, Quarterly Journal of Economics, 125, 129–173.

Eicher, T. and S.J. Turnovsky (1999), International Capital Markets and Non-Scale Growth, Review of International Economics, 7, 171-188.

Eicher, T. and L. Hull (2004), Financial Liberalization, Openness and Convergence, Journal of International Trade & Economic Development, 13, 443-459.

Korinek, A. and L. Serven (2016), Undervaluation through foreign reserve accumulation: Static losses, dynamic gains, Journal of International Money and Finance, 64, 104-136.

Lucas, R. E. (1988)," On the Mechanics of Economic Development", Journal of Monetary Economics, 22 (1988), 3-42.

Michaud, A and J. Rothert (2014), "Optimal Borrowing Constraints and Growth in a Small Open Economy", Journal of International Economics, 94, 326-340.

Ortigueira, S. and M. S. Santos (1997), "On the Speed of Convergence in Endogenous Growth Models", American Economic Review 87, 383-399.

Pack, H. and K. Saggi (2006). "Is There a Case for Industrial Policy? A Critical Survey", World Bank Research Observer, 21, 2, 267-297.

Rabanal, P. and V. Tuesta (2013), "Nonmanufacturing Goods and the Real Exchange Rate", Open Economies Review, 24, 3, 495-535.

Robinson, J. A. (2011). "Industrial Policy and Development: A Political Economy Perspective", in J. Yifu Lin and B. Pleskovic (editors), Lessons from East Asia and the Global Financial Crisis, The International Bank for Reconstruction and Development / The World Bank.

Rodrik, D. (2008). "Normalizing Industrial Policy", Commission on Growth and Development, Working Paper No. 3, World Bank.

Romer, P. M. (1986), "Increasing Returns and Long-Run Growth", Journal of Political Economy, Vol. 94, 5, 1002-1037.

Sargent, T. J. (1987), Macroeconomic Theory, Second Edition, Academic Press.

Stiglitz, J. E. and B. C. Greenwald (2014). Creating a Learning Society. A New Approach to Growth, Development, and Social Progress, Columbia University Press.

Turnovsky, S. J. (1997). "Equilibrium Growth in a Small Economy Facing an Imperfect World Capital Market", Review of Development Economics, 1, 1-22.

Turnovsky, S. J. (2009), Capital Accumulation and Economic Growth in a Small Open Economy, Cambridge University Press.

Valentinyi, A. and B. Herrendorf (2008), “Measuring Factor Income Shares at the Sectoral Level”, Review of Economic Dynamics, 11, 820–835.

Yogo, M. (2004), “Estimating the Elasticity of Intertemporal Substitution When Instruments Are Weak”, Review of Economics and Statistics, 86, 3, 797-810.