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The Impact of Optimal Tariffs and Taxes on Agglomeration

ABSTRACT

This paper extends an economic geography model by tariffs to analyze their impact on welfare and sustainability of agglomerations. Policies with and without cooperation are compared, with the goal of maximizing aggregated welfare in the former and regional welfare in the latter case. The main result is that under cooperation poorer regions are worse off in two respects. In the short-run they loose even more welfare and in the long-run sustainable agglomerations in richer regions get more likely. Thus, although cooperation could generate aggregated welfare gains the potential losers face even in the short-run no incentive to remove tariffs unless they are compensated appropriately, for instance by transfers. In this sense transfers from the rich to the poor are not only a policy to reach the goal of equity but also a necessary precondition to reach aggregated efficiency.

JEL-Classification: F13, H21, F42, R12, F15

Keywords: optimal tariffs, optimal taxation, policy coordination, economic geography, economic integration

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1 Introduction

The Uruguay Round has reduces tariffs reasonably, although protection still remains on a substantial level. Exceptions are mainly the large customs unions like EU and NAFTA within tariffs have been eliminated while outer tariffs tariffs are still reasonably. Though the EU, for instance, is characterized by an average tariff level of only 3.3% a few industries like textiles, clothing, leather goods and automotive industries are protected much stronger. Furthermore, corresponding import tariffs of the EU trade partners are, on average, 5 to 6 times of the EU-level (Francois, Glismann and Spinanger, 2000).

Justifying tariffs theoretically can be done either by the classical large country assumptions or by rent shifting arguments of the 'new trade theory' (e.g. Flam and Helpman (1987), Gros (1987) or Brander (1995) for an overview). Since the new economic geography (NEG) relies on very similar assumptions than new trade theory, namely monopolistic industries, the question arises whether also in these kind of models an incentive for tariffs exists and, in particular, how tariffs may affect the development of regional inequalities. Answering this question within a theoretical NEG-model is the main goal of the paper.

The development of the NEG has been initiated mainly Krugman (1991) with the goal of explaining sustainable income differences between regions or countries (e.g. surveys of Puga and Ottaviano (1998), Ottaviano (1999), Masahisa and Thisse (1996) and Fujita, Krugman and J.Venables (1999)). Although a broad variety of contributions have been derived so far the forces of driving agglomerations are almost identical: Positive externalities are emerging if industries and firms cluster together and the relative importance of externalities matters the more, the less important trade barriers are, such that falling trade costs, for instance by integration, make a sustainable core-periphery equilibrium more likely. Mainly for technical reasons, trade costs are usually considered to be of the iceberg-type according to Samuelson (1954), meaning that trade causes expenses without creating income of corresponding market participants.[1] Under this assumption in the short-run trade cost reductions always raise welfare in all regions as otherwise lost resources are saved. But, if trade costs are, at least partly, of a tariff type, this short-run result may not be valid anymore, since importing regions may loose additionally tariff- revenues. Especially for less developed regions who depend much on monopolistic imports this revenue loss could be strong enough to reduce regional welfare.

Tariffs affect also the long-run equilibrium by means of stabilizing the symmetric and equal distribution of economic activity. On the one hand tariffs increase trade costs and generate the well known effect of from the NEG that trade barriers protect domestic industries and a sustainable core-periphery equilibrium gets less likely. On the other hand tariffs generate revenues which are the higher the more the region or country relies on imports of monopolistically commodities. But, relying relatively more on imports implies also that the region is relatively less developed such that tariffs generate an implicit transfer from the rich to the poor. Therefore, as long as the symmetric distribution of economic activity is distorted, this implicit transfers by tariffs force the economy back to the symmetric equilibrium.

Nevertheless it must be emphasized that tariffs reduce aggregated welfare since resources are prevented to move to the more efficient region. From the view of a central planer, therefore, a removal of all kinds of trade barriers would increase aggregated efficiency. Unfortunately, this best solution concerning efficiency cannot be reached automatically, since potential losers face no incentive for common tariff reductions, in the short-run as well as in the long-run. One solution to this trade off between equity and efficiency could be an appropriate compensation of the losing region by the winning region, for instance by transfers. In this sense, transfers can be seen rather as a necessary policy to reach efficiency if initially unequal regions join a customs union than as a policy with the goal of equity.

The remainder of the paper derives theoretically the above presented

[1] An exception is Ottaviano, Tabuchi and Thisse (2003), who assume that trade costs absorb ressources.

results step by step. Section 2 presents the basic NEG-model with tariffs on the two considered industries, a competitive sector and a monopolistic sector. Section 3 analyzes briefly, as a reference case, the standard outcome if policy is inactive. Section 4 starts the policy analysis by the assumption that regions do not cooperate and follow the goal of maximizing only their own welfare. Contrastly, section 5 analyzes the optimal policy in case of cooperation. But, compared with the no-cooperation case the aggregated welfare gain can be distributed unevenly across both regions. In order to avoid these regional welfare losses section 6 derives the necessary transfers to sustain at least the welfare level of the no-cooperation case for each region. Finally, section 7 analyzes the consequences of the derived policies for the long-run income convergence and how the sustainability of core-periphery equilibria is affected. Section 8 concludes.

2 The model

The model of this section bases on a general 2-region-agglomeration model of Forslid (1999) which is an analytically solvable version of the original core-periphery model of Krugman (1991). The innovation of the model is the additional consideration of tariffs and taxes by which governments may achieve the goals of welfare optimizing and income convergence. The main distinction between tariffs and other trade costs is that tariffs generate government revenues while other trade costs, modeled as iceberg type, imply only costs with no corresponding income.

There are two symmetric regions called home and abroad. Symmetry of both regions guarantees that, with the notational exception of an asterisk, most equations describing foreign behavior are similar to corresponding domestic equations. Therefore, the model is presented mainly from the domestic perspective and corresponding foreign equations are illustrated only if necessary.

The economy in both regions consists of two sectors, a competitive sector, named agriculture, producing a homogeneous good A under constant returns of scale (CRS) and a monopolistic sector, named industry, producing differentiated varieties, x_i, under increasing returns to scale (IRS). All available varieties from both regions are combined to a composite good X which is consumed according to the preferences

$$U = X^{\gamma} A^{1-\gamma}, X = \left[\int_{i=0}^{n+n^*} x_i^{\frac{\sigma}{1-\sigma}} di \right]^{\frac{1-\sigma}{\sigma}}, \tag{1}$$

where n and n^* denote the number of domestic and foreign firms and σ the constant elasticity of substitution between varieties. All firms within each region face identical demand and supply conditions such that optimal in- and output decisions will be identical within each region. Therefore, and for simplicity the subscript i is neglected in the following.

There are two input factors of production, unskilled and skilled labor. Unskilled labor is immobile between both regions and to guarantee symmetry the unskilled labor supply of each region is normalized to one. Aggregated skilled labor supply is normalized to one, too, but, in contrast to unskilled labor, mobile between both regions following real wage differences. Therefore, in case of full employment L skilled are employed in the domestic region and L^*=1-L skilled are employed in the foreign region.

The homogenous agricultural good A is produced with the only input unskilled labor and marginal cost of unity. Since competition guarantees zero profits and agricultural goods are traded for free producer prices of unity hold in both regions. Consumer prices, in contrast, may differ between both regions according to corresponding taxes and tariffs. For simplicity only regional taxes t_A and t_A^* on agricultural consumption are considered. But, since the agricultural good is homogeneous, the impact of a tax is very similar to the impact of a tariff. Both instruments raise consumer prices by the same size and the only difference is that rents created by a tariff are separated in producer rents and government revenues while taxes create only government revenues. The value of all rents is equal for both instruments such that regional welfare is unaffected by the choice of the instrument. Therefore and since the objective of this paper is rather an analysis of regional welfare than intraregional income distribution, concerning the agricultural sector in the following only taxes will be considered. If t_A denotes the net tax rate agricultural consumer prices are given by $1+t_A$ and government receives the share $T_A \equiv t_A/(1+t_A)$ of agricultural consumption expenditure as revenues. For the only reason of notational simplicity in the following the gross tax T_A will be preferred.

The industrial sector consists of n domestic and n^* foreign firms producing each a differentiated variety x under increasing returns to scale. Trade of varieties requires usual "iceberg" trade costs $\tau \geq 1$ according to Samuelson (1954) implying that the export of the amount x^* requires the shipment of the amount τx^*. Additionally, the importing domestic region may charge a gross tariff on industrial imports T_I such that consumer prices in the importing region are $\tau(1-T_I)^{-1}$ times the producer price p^* of the exporting foreign region.

On the costs side production of variety x requires fixed and variable costs. Fixed costs stem from the fixed input of one skilled worker per firm each earning the wage w. This implies that the regional number of firms corresponds to the regional skilled-labor supply given by L and $(1-L)$ in the foreign region, respectively. Variable costs are given by the unskilled wage level of unity and assuming the unit input of unskilled labor to be $(\sigma-1)/\sigma$ firms costs are given by

$$C(x) = w + (\sigma-1)/\sigma x. \tag{2}$$

Individual firms are assumed to be too small to influence the aggregate price level. Then, profit maximizing with respect to (1) and (2) yields a producer price of $p = 1$ which is equal for all firms in the domestic region. Since consumer prices differ by corresponding tariffs and other trade costs, prices P, P^* for the composites X and X^* are given by:

$$\begin{aligned} P = & \left[L + (1-L)\frac{\Theta}{1-T_I}\right]^{\frac{1}{1-\sigma}} \\ P^* = & \left[L\frac{\Theta^*}{1-T_I^*} + (1-L)\right]^{\frac{1}{1-\sigma}} \\ \text{with: } & \Theta = (1-T_I)^{\sigma}\tau^{1-\sigma}, \Theta^* = (1-T_I^*)^{\sigma}\tau^{1-\sigma}. \end{aligned} \tag{3}$$

The zero-profit condition implies that in equilibrium revenues equal costs. This condition fixes each firms output to $x = \sigma w$, while each firm employs $(\sigma - 1)w$ unskilled employees and one skilled employee.

Nominal regional income Y consists of three components, wage income of the unskilled and skilled workers as well as government income G:

$$Y \quad = \quad 1 + Lw + G. \tag{4}$$

Government income can be separated further in tariff revenues G_I from imported varieties and tax revenues G_A from agricultural consumption. Tariff revenues can be derived by determining the import demand from the utility (1), using the producer price of $p = 1$ as well as trade costs τ. Since government receives the share T_I of the value of imported varieties, tariff revenues are given by

$$G_I = T_I(1-L)\frac{\Theta}{1 - T_I}P^{\sigma-1}\gamma Y \tag{5}$$

with Θ defined in (3). Agricultural tax revenues are easier to determine since government receives the share T_A of regional expenditure for agricultural goods, namely $G_A = T_A(1 - \gamma)Y$. Combining tax and tariff revenues government income is given by:

$$G = \left[T_I(1-L)\frac{\Theta}{1 - T_I}P^{\sigma-1}\gamma + T_A(1 - \gamma)\right] Y \tag{6}$$

Since government income G depends on nominal income Y and vice versa according to (4), both equations can be solved simultaneously for Y and G to yield:

$$\begin{aligned} Y = \; & \frac{1}{T}(1 + Lw), \qquad G = \frac{1 - T}{T}(1 + Lw), \\ \textit{with} \;\; & T = 1 - T_I(1-L)\frac{\Theta}{1 - T_I}P^{\sigma-1}\gamma - T_A(1 - \gamma). \end{aligned} \tag{7}$$

The parameter $(1/T)$ denotes the factor by which nominal income is increased by tariffs and taxes.

3 Equilibrium

Two kinds of equilibrium are determined by the model, a short-run equilibrium and a long-run equilibrium. The short-run equilibrium is characterized by a given distribution of skilled workers, L and $1-L$, on the domestic and foreign region. Then, the model above determines prices and wages clearing product and labor market. If these short-run prices and wages imply an interregional real wage difference skilled workers face an incentive to migrate to the region with higher earnings. Therefore, the long-run equilibrium is reached if no incentive for migration exists anymore. This can be the case either if real wages are equalized or if all skilled locate already in one region (L=0 or $1 - L$=0) such that any further migration is impossible.

Calculating the real wage difference, which is the crucial determinant of migration, requires first the derivation of nominal wages. They can be determined from the product market equilibrium by equalizing supply and demand. Each firm produces an equilibrium amount of σw and faces foreign and domestic demand for its variety which can be derived from the utility function (1). Equalizing supply and demand yields that product market equilibrium is guaranteed if:

$$\begin{aligned} \sigma w &= \gamma Y P^{\sigma-1} + \Theta^* \gamma Y^* P^{*\sigma-1} \\ \sigma w &= \Theta \gamma Y P^{\sigma-1} + \gamma Y^* P^{*\sigma-1} \end{aligned} \tag{8}$$

with Y and Y^* defined by (7) and Θ defined by (3). Both equations depend linerarly on the wage rates w and w^*. Solving the system yields:

$$\begin{aligned} w &= \frac{\sigma\gamma \left[P^{1-\sigma} T \Theta^* + P^{*1-\sigma} T^*\right] + \gamma^2 (1-L)\left[\Theta\Theta^* - 1\right]}{(\sigma P^{*1-\sigma} T^* - \gamma(1-L))(\sigma P^{1-\sigma} T - \gamma L) - \gamma^2 \Theta\Theta^* (1-L) L} \\ w^* &= \frac{\sigma\gamma \left[\Theta P^{*1-\sigma} T^* + P^{1-\sigma} T\right] + \gamma^2 L \left[\Theta\Theta^* - 1\right]}{(\sigma P^{*1-\sigma} T^* - \gamma(1-L))(\sigma P^{1-\sigma} T - \gamma L) - \gamma^2 \Theta\Theta^* (1-L) L} \end{aligned} \tag{9}$$

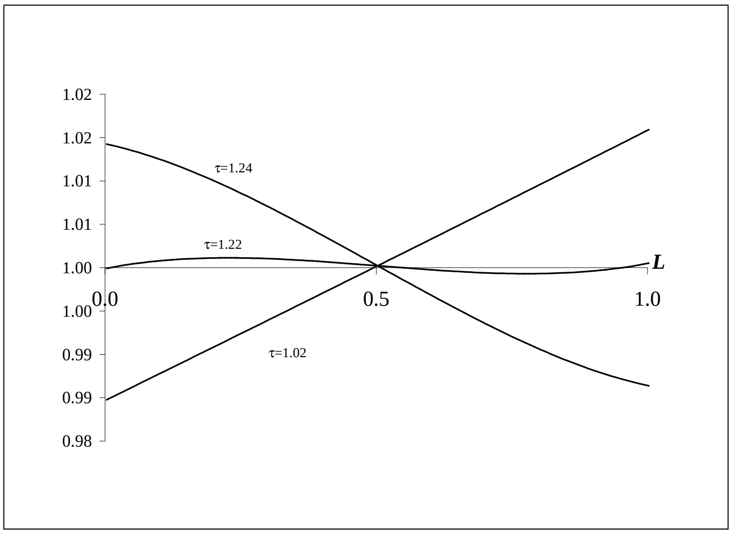
with P, T, Θ and the corresponding foreign variables defined in (3) and (7).

The real wage relation can be determined now easily and is given by:

$$\frac{w_R}{w_R^*} = \frac{\sigma\gamma\left[P^{1-\sigma}T\Theta^* + P^{*1-\sigma}T^*\right] + \gamma^2(1-L)\left[\Theta\Theta^*-1\right]}{\sigma\gamma\left[\Theta P^{*1-\sigma}T^* + P^{1-\sigma}T\right] + \gamma^2 L\left[\Theta\Theta^*-1\right]} \times \frac{P^{*\gamma}(1-T_A^*)^{1-\gamma}}{P^{\gamma}(1-T_A)^{1-\gamma}} \quad (10)$$

where the last term denotes the relative regional price level.

As a reference case, figure 1 presents the real wage relation of (10) if policy is inactive (T_I=T_I^*=T_I=T_I^*=0). In all cases the real wage relation gets unity at $L = 0.5$ indicating that the symmetric equilibrium is also a long-run equilibrium. But, the stability of this long-run equilibrium depends on the real wage relation in case of small disturbances. Consider for instance a labor share slightly above 0.5 in one region as in the case of $\tau = 1.02$. Since this deviation of the symmetric equilibrium implies a short-run wage relation above unity even more firms and skilled migrates to this region. Agglomeration occurs and the symmetric equilibrium is unstable. Technically, the symmetric equilibrium is unstable if the slope of the corresponding real wage curve is positive. The critical trade cost level, below which instability of the symmetric equilibrium occurs, is usually called 'breakpoint'.



Parameters: $\gamma = 0.5, \sigma = 4$

Figure 1: Domestic real wage relation and skilled labor share

If the symmetric equilibrium is unstable other stable long-run equilibria must exist with agglomeration in one of the two regions. If, like in the case of $\tau = 1.02$, an initial distortion of the symmetric equilibrium leads to migration, this process continues until all skilled labor and all firms locate in the foreign region. This so called core-periphery equilibrium is stable as long as no real wage incentive exists to migrate back. Analogous to the breakpoint the critical trade cost level, below which the core- periphery equilibrium is stable is called 'sustainpoint'.

There are two agglomeration forces within this model at work, a forward and a backward linkage. The forward linkage stems from the fact that the more firms locate in one region the more varieties are available, which reduces the price level and increases real wages. The backward linkage describes the additional regional demand firms are creating since now, because of trade costs, more expensive imports can be substituted by domestically produced varieties. Simultaneously also dispersion forces in terms of product and labor market competition exist. The relative importance of agglomeration and dispersion forces depends on the parameters of the model. Usually parameters are chosen such that prohibitive trade barriers (autarky) correspond to a dominance of dispersion forces. This assumption rules out the possibility of a collapse of the general equilibrium where, independent of the trade cost level, all economic activity is always concentrated in one region (cf. the no-black-hole condition of Fujita et al. (1999)). Therefore, under normal conditions, a reduction of trade costs (integration) reverses the relative weight of agglomeration and dispersion forces such that core-periphery equilibria are stable at least for a range of trade costs.

4 Maximizing welfare without cooperation

The general equilibrium model derived above considers two policy instruments by which each regional government may affect welfare and the real wage relation determining the long-run development of the corresponding region. Since there are two regions with two governments it can be distinguished between non-cooperative and cooperative policies. In the non-cooperative case each region maximizes its welfare depending on the policy choice of the other region. Analyzing this non-cooperative policy is the subject of this section. The cooperative case and ist consequences will be treated in the subsequent sections.

In the non-cooperative case, maximizing welfare is synonymical to maximizing regional real income:

$$\max_{T_I,T_A}\left[\frac{YP^{-\gamma}}{(1-T_A)^{\gamma-1}}\right], \tag{11}$$

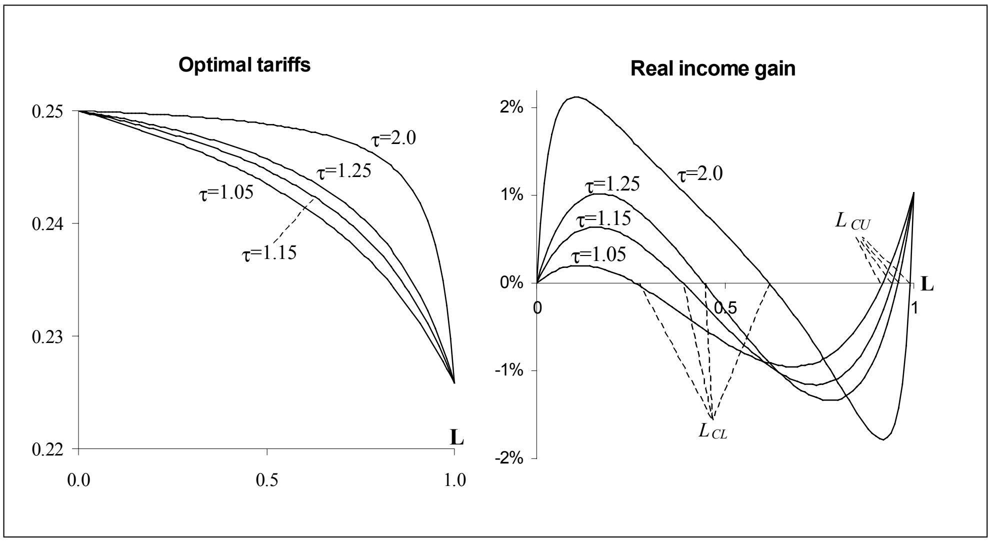
where nominal income Y is divided by the regional price level. For any given foreign tariff T_I^* and tax rate T_A^* optimal policy can be now derived by setting the partial derivatives of the real income with respect to T_I and T_A equal to zero (cf. appendix). Then, domestic optimal tax and tariff rates are given by:

$$\begin{aligned} T_{I,Opt} &= \frac{\sigma P^{*1-\sigma}T^* - \gamma(1-L) - \gamma L\Theta^*}{\sigma^2 P^{*1-\sigma}T^* - \gamma\sigma(1-L) - \gamma L\Theta^*} > 0, \\ T_{A,Opt} &= \frac{1}{\sigma} > 0. \end{aligned} \tag{12}$$

As long as the standard assumptions about the parameters of the previous section are fulfilled $\gamma < 1 < \sigma$ both optimal rates are always positive, independent of the policy choice of the other region (cf. appendix). Regarding the optimal tariff, $T_{I,Opt}$, this result here for a model of economic geography confirms the well known home market effect of the new trade theory (e.g. Brander (1995)). By a tariff, demand is shifted from foreign to domestic varieties such that the domestic backward linkage is strengthened. The additional demand generates additional profits of the monopolistic firms resulting in higher wages and, therefore, in higher income. But, although this nominal wage effect is always positive, the welfare gain is restricted by the simultaneously increasing price level.

Regarding the optimal tax rate, $T_{A,Opt}$, the result corresponds to the social optimum analysis of Dixit and Stiglitz (1977) in their original paper on monopolistic competition. Taxes on agricultural consumption shift demand towards industrial varieties. By this way the monopolistic market distortion of supplying too expensive and too less varieties can be at least partly corrected. Partly, because the resources for subsidizing the industrial sector are received by taxing the agricultural sector, which itself creates a distortion. However, the positive sign of the optimal rates of (12) indicates an overall regional welfare gain of taxing agricultural consumption.

Optimal tax and tariff of (12) depend on the chosen policy of the foreign region, which itself depend on the decision of the domestic region. Policy Nash-equilibrium is achieved, if (12) is fulfilled for both regions. Unfortunately, this equations system is non-linear, such that only numerical solutions can be derived. Figure 2 illustrates the percental welfare gain of such regional policies compared with the case of zero taxes and tariffs for certain distributions of skilled labor on both regions.



Parameters: $\gamma = 0.5, \sigma = 4$

Figure 2: Domestic optimal tariffs and real income gain at Nash-equilibrium

Quite surprising, if governments follow the optimal policy rule of (12) there is no automatic gain for both regions. Denoting the lower critical level of development by L_{CL} and the upper critical level by L_{CU} the domestic region gains only if the relative number of industries is below L_{CL} or above L_{CU}. Furthermore, falling transport costs imply a decrease of L_{CL} and L_{CU}. Integration in the sense of falling trade costs (except tariffs) reduces the opportunity for less developed regions and improves the opportunity of high developed regions to achieve regional welfare gains by corresponding optimal taxes and tariffs. The reason for this outcome is mainly the terms of trade effect. Since less developed regions rely relatively more on industrial imports also the impact of industrial tariffs is relatively stronger. And by playing the Nash-game the stronger player maintains its advantage also in equilibrium.

5 Maximizing welfare under cooperation

Looking to reality falling transport as a result of technological progress are accompanied by falling trade barriers almost all over the world. In the majority of cases these falling trade barriers are a result of negotiations between participating countries. The fact that negotiations are necessary indicates that welfare gains are not the automatic consequence of unilateral trade cost reductions. In this sense, the aim of this section is an analysis of the welfare consequences if both regions cooperate to maximize aggregated welfare.

Maximizing aggregated real income can be written formally as:

$$\max_{T_I, T_I^*, T_A, T_A^*} \left[\frac{Y}{(1-T_A)^{\gamma-1} P^{\gamma}} + \frac{Y^*}{(1-T_A^*)^{\gamma-1} P^{*\gamma}} \right], \tag{13}$$

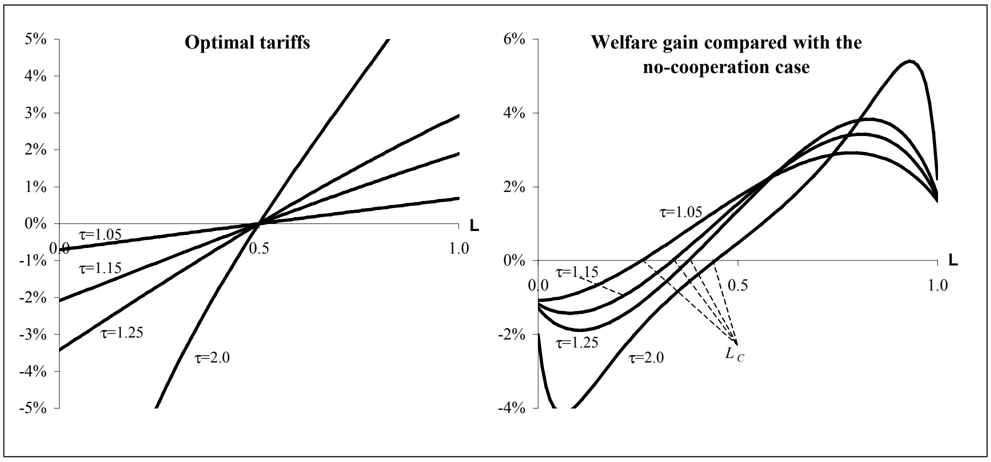
with Y defined in (7). Again, partial derivatives have to be set to zero (cf. appendix) to get for the optimal agricultural tax rate the already known result of:

$$T_{A,Opt} = T_{A,Opt}^* = \frac{1}{\sigma}. \tag{14}$$

For the optimal tariffs an analytical expression cannot be derived. Instead, optimal tariffs are the result of the following non-linear equation system:

$$\begin{aligned} &\frac{\gamma\Theta^* L}{\sigma-1} + P^{\gamma} P^{*1-\sigma-\gamma} - \frac{1-\sigma T_I}{1-T_I}\left[(1-\gamma)P^{*1-\sigma} + \gamma(1-L) + \frac{\gamma\sigma L\Theta^*}{\sigma-1}\right] = 0, \\ &\frac{\gamma\Theta(1-L)}{\sigma-1} + P^{*\gamma} P^{1-\sigma-\gamma} - \frac{1-\sigma T_I^*}{1-T_I^*}\left[(1-\gamma)P^{1-\sigma} + \gamma L + \frac{\gamma\sigma(1-L)\Theta}{\sigma-1}\right] = 0. \end{aligned} \tag{15}$$

Figure 3 shows the numerical solution to this system where the left graph displays optimal domestic tariffs and the right graph the percental real income gain compared with the no-cooperation Nash-equilibrium of (12).



Parameters: $\gamma = 0.5, \sigma = 4$

Figure 3: Domestic optimal tariffs and real income gain under cooperation

At the symmetric equilibrium (L=0.5) all optimal tariffs are zero while to the right and to the left optimal tariffs are becoming positive and negative, respectively. This result is mainly a consequence of the trade costs and the corresponding different price levels in both regions. The more developed a region is, the lower the price level and from this perspective rent creating tariffs improve welfare by more in the developed region than they reduce income in the poorer region. From the perspective of the less developed region argumentation is exactly opposite. Although import subsidies reduce domestic welfare, foreign welfare compensates this loss by additional earnings of the exporting firms. Furthermore, the lower the trade costs the smaller are the corresponding tariffs. In case of full integration with zero trade costs optimal tariffs are even zero and the corresponding curve in figure (3) overlaps the x-axis. Thus, only if trade costs differ from zero the home market effect can be existent and optimal tariffs of (15) maximize aggregated welfare.

Concerning the welfare gain (right graph) the interesting results arrives that a region my gain by cooperation only if its level of development is high enough, more precise if $L > L_C$. Because of symmetry both regions gain only if $L_C < L < 1 - L_C$. As in the non-cooperation case L_C shifts leftwards as integration proceeds such that corresponding losses of the less developed region melt away. Thus, welfare gains in both regions as a result of cooperation are the more likely, the less unequal regions are and the further integration has proceeded.

6 Transfers

The last section has demonstrated that maximizing aggregated welfare may go ahead with losses of the less developed region. Therefore the question arises why regions who loose by cooperation may agree in common tariff reductions. One possible answer can be that the loosing regions are somehow compensated for the expected welfare loss, for instance by corresponding monetary transfers. Introducing transfers in the model requires some changes of the basic assumptions. To hold these changes as simple as possible transfers R are assumed to be paid from the foreign to the domestic region. Then, a positive sign of R indicates transfers to and a negative sign indicates transfers from the domestic region. Furthermore, these transfers are financed by government revenues such that government spending is given by $G = G_I + G_A + R$ in the domestic region and by $G^* = G_I^* + G_A^* - R$ in the foreign region. Under these assumptions the wage rates from (9) change to:

$$
\begin{aligned}
w &= \gamma \frac{\sigma(1+R)P^{1-\sigma}T\Theta^* + (1-R)\left[\sigma {P^*}^{1-\sigma}T^* + \gamma(1-L)(\Theta\Theta^* - 1)\right]}{(\sigma {P^*}^{1-\sigma}T^* - \gamma(1-L))(\sigma P^{1-\sigma}T - \gamma L) - \gamma^2\Theta\Theta^*(1-L)L} \\
w^* &= \gamma \frac{\sigma(1-R)\Theta {P^*}^{1-\sigma}T^* + (1+R)\left[\sigma P^{1-\sigma}T + \gamma L(\Theta\Theta^* - 1)\right]}{(\sigma {P^*}^{1-\sigma}T^* - \gamma(1-L))(\sigma P^{1-\sigma}T - \gamma L) - \gamma^2\Theta\Theta^*(1-L)L}
\end{aligned}
\tag{16}
$$

and income from (7) modifies to

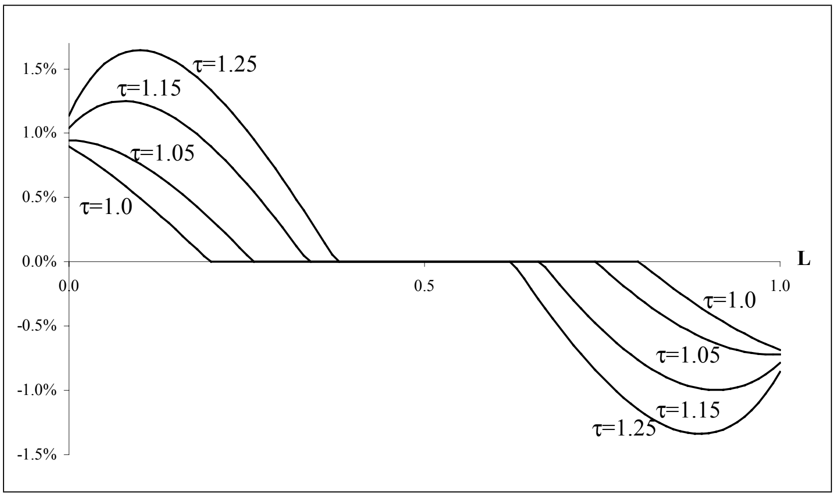
$$
Y(R) = \frac{1}{T}\left[1 + Lw + R\right], \qquad Y^*(R) = \frac{1}{T}\left[1 + (1-L)w^* - R\right], \tag{17}
$$

depending now on the level of transfers. Optimal tariffs and taxes with and without cooperation, (12, 14, 15) stay valid and do not have to be modified as can be prooved easily.

The interesting question is now whether optimal policy under cooperation generates enough additional wealth to finance transfers compensating the respective loosing region. Denoting by Y_R^N and Y_R^{N*} the real income at the Nash-equilibrium without cooperation and by $Y_R^C(R)$ and $Y_R^{C*}(R)$ the real income under cooperation for given transfers, the necessary amount of transfers can be derived as follows:

$$\begin{aligned} Y_R^C(R) - Y_R^N &= 0, \quad \text{if} \quad Y_R^C(0) > Y_R^N, \\ Y_R^{C*}(R) - Y_R^{N*} &= 0, \quad \text{if} \quad Y_R^{C*}(0) > Y_R^{N*}, \\ R = 0 \ &, \quad \text{otherwise.} \end{aligned} \tag{18}$$

Figure 4 display the necessary transfers according to (18) guaranteeing each region to reach at minimum the welfare level of the no-cooperation case. Two important results can be derived from this figure. First, if regions are not too dissimilar, both gain from cooperation and compensating transfers are unnecessary. Furthermore, this range widens if trade costs decrease and integration proceeds. Second, even at full integration with zero trade costs (τ=0) transfers to much less developed regions must be granted.



Parameters: $\gamma = 0.5, \sigma = 4$

Figure 4: Necessary transfers under cooperation avoiding welfare losses

Altogether, transfers are an appropriate policy to reach the goal of maximizing aggregated welfare while simultaneously the welfare loosing regions are compensated for their loss. Concerning less developed regions this result implies that joining a customs union may be useful from a welfare point of view only if appropriate transfers are granted by the richer regions.

7 Stability and agglomeration

While the last section has analyzed the welfare effects of taxes and tariffs the aim of this section is an analysis of the consequences of these policies for the stability of core-periphery equilibria. Since the real wage relation had been determined to be the crucial variable characterizing stability of any equilibrium, the remainder of this section will concentrate on the effects of the derived optimal policies on this variable.

If policy is inactive, as demonstrated in section 3, the model generates an intermediate range of transport costs, for which core-periphery equilibria become stable. This result has been explained by the relative large weight of corresponding forward and backward linkages outweighing dispersion forces. Now, optimal policies concerning tariffs and taxes, affect the forward linkage by their impact on prices and the backward linkage by reallocating demand. The interplay of these effects determine in which direction policies shifts the real wage relation

Consider first the non-cooperation case where both regions goal is the maximization of regional welfare by choosing policies according to (12). In general, as mentioned above, the corresponding tax-tariff equilibrium can be determined only numerically, but for the extreme core-periphery distribution of $L = 0$ or $L = 1$ also analytical results can be derived. Fortunately, the core-periphery distribution is also of special interest since the question whether agglomeration is sustainable can be answered by analyzing the sustainpoint.

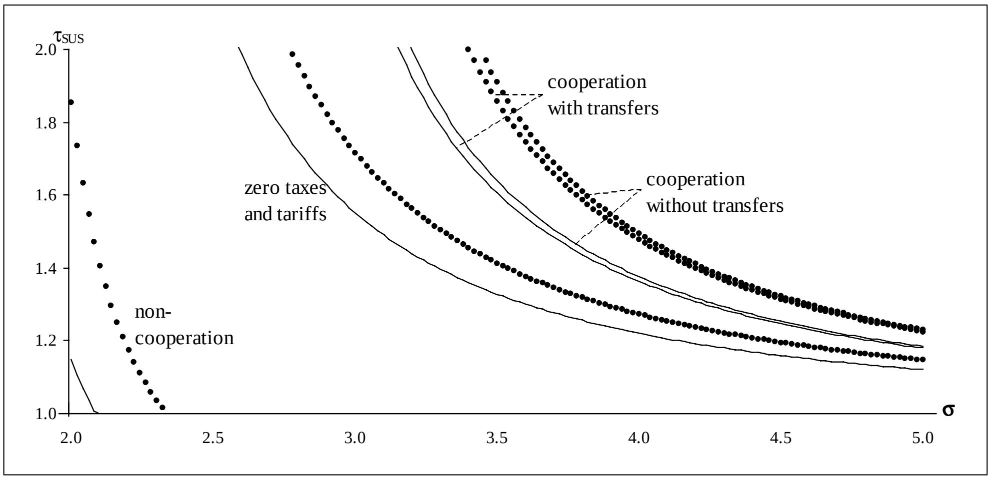
Concentrating on the arbitrary case of $L = 0$, where all industry is concentrated in the foreign region, welfare optimizing policies can be derived from (12) and are given by:

$$T_{I,Opt} = T_{A,Opt} = T^*_{A,Opt} = \frac{1}{\sigma}, \qquad T^*_{I,Opt} = \frac{\sigma - \gamma}{\sigma^2 - \gamma}. \tag{19}$$

Substituting (19) in (10) yields the real wage relation:

$$\frac{w_R}{w^*_R} = \frac{\tau^{2-2\sigma}(\sigma+\gamma)(\sigma-1)^{\sigma+\gamma}(\sigma^2-\gamma)^{-\sigma} + (\sigma-1)^{\gamma-\sigma+1}}{\tau^{1+\gamma-\sigma}(2\sigma-1+\gamma)\,\sigma^{\gamma-\sigma}}, \tag{20}$$

which has to be set equal to one to calculate the sustain point. Again, because of non-linearities in τ only numerical solutions can be derived. Figure 5 presents these sustainpoints for different parameters σ and γ. For comparison also the sustainpoints of the of the case without any government intervention and the case of non-cooperation are presented.



Parameters: —: $\gamma = 0.5$, $\cdots : \gamma = 0.6$

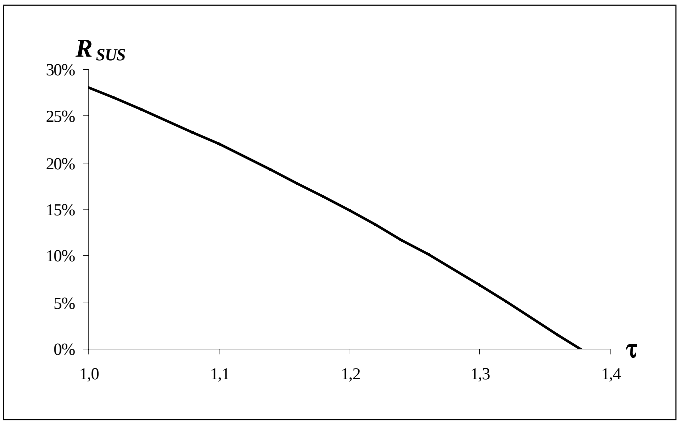
Figure 5: Sustain points for different parameters

In all cases τ_{sus} increases with γ and decreases with σ. A larger share of industrial varieties within the consumption bundle strengthens the agglomeration (backward) linkage while a lower σ increases industry profits by a larger mark-up. Mostly striking is the fact that sustain points of the non-cooperation cases are strictly below the reference cases of zero policies and even more below the sustain points in case of cooperation. This is mainly a result of the (positive) optimal tariffs that protect the domestic market and enables firms to pay higher wages. In case of cooperation optimal tariffs of the less developed region (at L=0) are even negative and strengthen the real wage advantage of the already developed region. Furthermore, also transfers which compensate for the welfare loss cannot improve real wage disadvantage of the less developed region sufficiently.

However, so far the result has been derived that cooperation damages the real wage relation and the long-run prospect of convergence of less developed regions. Since this result maintains even if tranfers compensate for the welfare loss the final question arises which level of transfer may guarantee a real wage relation of unity. At the sustain point the necessary level of transfers,R_{SUS}, can be calulated by setting (20) to one and solving for R_{SUS} to get:

$$R_{SUS} = 1 - \frac{2(1 - T_I)(1 - \Theta P^\gamma)}{1 - \Theta\Theta^* + T_I \left[\Theta\Theta^*\gamma - 1 + \Theta P^\gamma(1 - \gamma)\right]} \tag{21}$$

Substituting now the optimal tariffs of (15) yields the necessary amount of transfers to guarantee a long-run income convergence at L=0. Figure 6 presents this result with the simple outcome that transfers must increase continuously as integration proceeds and trade costs decrease. Furthermore, the volume of transfers is considerable higher than the level which has to be paid to compensate only the welfare loss.



Parameters: $\gamma = 0.5, \sigma = 4$

Figure 6: Necessary transfers (in % of Y) to guarantee convergence for L=0

8 Conclusion

This paper has shown that within an agglomeration model countries or regions face an incentive for taxing the competitive sector and protecting domestic monopolistic industries by corresponding tariffs. Two cases have been compared, policies with and without cooperation, while the goal is maximizing aggregated welfare in the former case and regional welfare in the latter case. The main result is that under cooperation especially less developed regions are worse off in two respects. They loose welfare even in the short-run and worsen their comparative advantage such that sustainable income differences in the long-run get more likely.

Monetary transfers may solve this trade off between equity and efficiency by redistributing wealth from the richer to the poorer regions. If only the welfare loss should be compensated relatively low transfers in terms of 1-2% of regional income are sufficient. But, if transfers should guarantee also convergence in the long-run, substantially higher transfers up to 30% of regional income are necessary.

Combining these results transfers are not only an instrument of 'social policy' to reach the political goal of equity, but necessary during an integration process to make less developed regions removing their tariffs such that an aggregated efficient distribution of economic activity is reached.

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Appendix

Optimal taxes and tariffs without coop., eq.(12):

To derive the optimal tax and tariff rates the corresponding partial derivatives of the real income $Y_R = (1 + Lw)T^{-1}(1 - T_A)^{1-\gamma}P^{\gamma}$ must be set to zero:

$$\frac{dY_R}{dT_A} = \frac{(1-T_A)^{1-\gamma}\,P^{-\gamma}}{T}\left(L\frac{dw}{dT_A} - Y\left[\frac{dT}{dT_A} + \frac{(1-\gamma)T}{(1-T_A)}\right]\right) = 0, \tag{12.1}$$

$$\frac{dT}{T_A} = -(1-\gamma), \tag{12.2}$$

$$\frac{dw}{dT_A} = -\frac{(1-\gamma)Y\gamma\left(\gamma(1-L)\,(1-\Theta\Theta^*) - \sigma P^{*1-\sigma}T^*\right)}{\left((\sigma P^{*1-\sigma}T^* - \gamma(1-L))(\sigma P^{1-\sigma}T - \gamma L) - \gamma^2\Theta\Theta^*(1-L)L\right)}. \tag{12.3}$$

Substituting (12.3) and (12.2) in (12.1) and solving for the optimal agriclutural tax T_A^{Opt} yields:

$$T_A^{Opt} = \left[\frac{T_I(1-L)\Theta}{(1-T_I)} + \frac{\gamma\Theta^* L(1-L)\Theta}{\sigma\left(\sigma P^{*1-\sigma}T^* - \gamma(1-L)\right)} + \frac{L}{\sigma}\right]P^{\sigma-1}. \tag{12.4}$$

The partial derivatives with respect to T_I are given by:

$$\frac{dY_R}{dT_I} = \frac{(1-T_A)^{1-\gamma}\,P^{-\gamma}}{T}\left[L\frac{dw}{dT_I} - Y\left(\frac{dT}{dT_I} + \gamma T P^{-1}\frac{dP}{dT_I}\right)\right] = 0, \tag{12.5}$$

$$\frac{dP}{dT_I} = \frac{P^{\sigma}(1-L)\Theta}{(1-T_I)^2}, \tag{12.6}$$

$$\frac{dw}{dT_I} = \frac{-\gamma Y\Theta(1-L)}{P^{1-\sigma}(1-T_I)^2} \times \frac{\left[\begin{array}{l}[(1-\sigma)(1-\gamma)(1-T_A) - \gamma\sigma(1-T_I)] \\ \times\left(\sigma P^{*1-\sigma}T^* + \gamma(1-L)\,[\Theta\Theta^* - 1]\right) \\ +\sigma\gamma P^{1-\sigma}\Theta^* T(1-T_I)\end{array}\right]}{\left[\begin{array}{l}(\sigma P^{*1-\sigma}T^* - \gamma(1-L))(\sigma P^{1-\sigma}T - \gamma L) \\ -\gamma^2\Theta\Theta^*(1-L)L\end{array}\right]}, \tag{12.7}$$

$$\frac{dT}{dT_I} = \frac{-\gamma(1-L)\Theta P^{\sigma-1}}{(1-T_I)^2}\left(1-\sigma T_I + \frac{T_I}{1-T_I}(\sigma-1)P^{\sigma-1}(1-L)\Theta\right). \quad (12.8)$$

Substituting (12.6)-(12.8) in (12.5) yields:

$$\begin{array}{l} \sigma P^{1-\sigma}\left[\begin{array}{l} L\Theta^*\gamma(1-T_I) \\ +\left[\sigma T_I - 1 + T - (\sigma-1)\frac{(1-L)\Theta T_I}{1-T_I}P^{\sigma-1}\right]\left[\sigma P^{*1-\sigma}T^* - \gamma(1-L)\right] \end{array}\right] \\ +(1-\sigma-\gamma)\left(\sigma L P^{*1-\sigma}T^* + \gamma(\Theta\Theta^*-1)(1-L)L\right) = 0. \end{array} \quad (12.9)$$

If both, tax rate and tariff, are chosen to optimize welfare (12.4) and (12.9) must be solved simultaneously for T_I and T_A:

$$\begin{aligned} T_{I,Opt} &= \frac{\sigma P^{*1-\sigma}T^* - \gamma(1-L) - \gamma L\Theta^*}{\sigma^2 P^{*1-\sigma}T^* - \gamma\sigma(1-L) - \gamma L\Theta^*}, \\ T_{A,Opt} &= \frac{1}{\sigma}. \end{aligned} \quad (12)$$

Resubstituting φ and T from (3) and (7) and simplifying yields:

$$T_I = \frac{(1-L)\left(\gamma(\sigma-1)+\sigma(1-\gamma)(1-T_A^*)\right)+L\Theta^*\left(\sigma(1-\gamma)\frac{1-T_A^*}{1-T_I^*}+\gamma(\sigma-1)\right)}{(1-L)\sigma\left(\gamma(\sigma-1)+\sigma(1-\gamma)(1-T_A^*)\right)+L\Theta^*\left(\sigma\sigma(1-\gamma)\frac{1-T_A^*}{1-T_I^*}+\gamma(\sigma^2-1)\right)} > 0,$$

which is positive as long as $\gamma < 1 < \sigma$.

Optimal taxes and tariffs under coop., eqs. (14,15):

The partial derivatives of the the overall welfare (13) with respect to domestic taxes and tariffs are given by:

$$L\frac{dw}{dT_I} - Y\left[\frac{dT}{dT_I} + \gamma T P^{-1}\frac{dP}{dT_I}\right] + \frac{(1-T_A^*)^{1-\gamma}\,P^{*-\gamma}T}{(1-T_A)^{1-\gamma}\,P^{-\gamma}T^*}(1-L)\frac{dw^*}{dT_I} = 0, \quad (14.1)$$

$$L\frac{dw}{dT_A} + Y(1-\gamma)\left(1-T\,(1-T_A)^{-1}\right) + \frac{(1-T_A^*)^{1-\gamma}\,P^{*-\gamma}T}{(1-T_A)^{1-\gamma}\,P^{-\gamma}T^*}(1-L)\frac{dw^*}{dT_A} = 0. \quad (14.2)$$

Substituting the partial derivatives yields:

$$\begin{aligned}
&\sigma P^{1-\sigma}\left[(1-\sigma)(1-\gamma)(1-T_A)-\gamma\sigma(1-T_I)\right]\left[\sigma P^{*1-\sigma}T^{*}-\gamma(1-L)\right]\\
&+\sigma\gamma\gamma P^{1-\sigma}\Theta^{*}(1-T_I)L\\
&+(\sigma-1+\gamma)\Big[[\sigma P^{*1-\sigma}T^{*}-\gamma(1-L)][\sigma P^{1-\sigma}T-\gamma L]-\gamma^2\Theta\Theta^{*}(1-L)L\Big]\\
&+\gamma\sigma\frac{\left(1-T_A^{*}\right)^{1-\gamma}P^{*1-\sigma-\gamma}}{(1-T_A)^{1-\gamma}P^{-\gamma}}\begin{bmatrix}(1-T_I)\left(\sigma P^{1-\sigma}T-\gamma L+\gamma\sigma\Theta(1-L)\right)\\+(1-\sigma)(1-\gamma)(1-T_A)\Theta(1-L)\end{bmatrix}=0,
\end{aligned} \tag{14.3}$$

$$\frac{P^{\gamma}}{P^{*\gamma}}=\frac{\begin{array}{c}\left[\gamma(1-L)-\sigma P^{*1-\sigma}T^{*}\right][\sigma P^{1-\sigma}\left(1-T_A-T\right)+\gamma L]\\+\gamma^2\Theta\Theta^{*}(1-L)L\end{array}}{P^{*1-\sigma}\gamma\sigma\left(1-T_A^{*}\right)^{1-\gamma}\left(1-T_A\right)^{\gamma}(1-L)\Theta.} \tag{14.4}$$

Substituting (14.4) in (14.3) and simplifying yields:

$$T_{A,Opt}=T^{*}_{A,Opt}=\frac{1}{\sigma}, \tag{14}$$

while resubstituting (14) in (14.4) or (14.3) yields for $T_{I,Opt}$ and $T^{*}_{I,Opt}$ the following non-linear equation system:

$$\begin{aligned}
&\frac{\gamma\Theta^{*}L}{\sigma-1}+P^{\gamma}P^{*1-\sigma-\gamma}-\frac{1-\sigma T_I}{1-T_I}\left[(1-\gamma)P^{*1-\sigma}+\gamma(1-L)+\frac{\gamma\sigma L\Theta^{*}}{\sigma-1}\right]=0,\\
&\frac{\gamma\Theta(1-L)}{\sigma-1}+P^{*\gamma}P^{1-\sigma-\gamma}-\frac{1-\sigma T_I^{*}}{1-T_I^{*}}\left[(1-\gamma)P^{1-\sigma}+\gamma L+\frac{\gamma\sigma(1-L)\Theta}{\sigma-1}\right]=0.
\end{aligned} \tag{15}$$