Unilateral trade liberalisation and the spatial distribution of economic activity within a country

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(Preliminary Version)

1. Introduction

Most of the literature dealing with the regional effects of trade liberalisation considers that each country or region engaged in the process is internally homogeneous (e.g. Krugman, 1991; Krugman and Venables, 1995 and 1996; Venables, 1996; Helpman, 1998; etc.). A related, but to some extent different question, is what would be the potential effects on the regional economic structure when a country opens or reduces barriers to external trade. Does the promotion of trade intensify or reduce regional disparities inside the country? Are these effects the same across agents in each region, or will there be different responses? Here the analysis is much more limited, some exceptions being Hanson (1994), Krugman and Livas Elizondo (1996) and Fujita, Krugman and Venables (1999).

In Hanson (1994) the structure of the model is less general. It aims to explain why when some LDCs reduces their barriers on trade, it is observed that the country tends to specialise in the production of goods that may be produced in series using less skilled workers, losing the production of elaborated good with a large value added. More precisely, the model is intended to explain the process observed in Mexico in the late ‘80s and after the NAFTA. Krugman and Livas Elizondo (1996), also inspired by the case of Mexico, develop a three-region model where the first two regions belong to a home or domestic country, while the third region represents the rest of the world (ROW). As in Krugman (1991), and most models built up on similar principles, the domestic country has only two stable equilibria, with all population agglomerated in a single region, or symmetrically distributed

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between them. Krugman and Livas Elizondo (1996) show that trade liberalisation makes the later equilibrium more likely, since a greater share of imports in consumption reduces the advantages of agglomeration. Fujita, Krugman and Venables (1999) extend this model to allow for more than one manufactured sector, and also for intermediate input demands.

This paper is an extension of Helpman's (1998) two regions model. As in Krugman and Livas Elizondo (1996), a third region, representing the ROW, is added. Helpman's model is more tractable in some respects than Krugman and Livas Elizondo's, and also more general in that once a stable equilibrium with unequal (but non-zero) regional shares is achieved, further trade costs reductions still may affect regions' relative size.

The rest of the paper is organised as follows. The next section briefly reviews the two models that serve as a reference for our model, Helpman (1998) and Krugman and Livas Elizondo (1996). In section 3 the main features of the model are stated. Section 4 shows how the model is solved. In section 5 the stability properties are analysed, with section 6 addressing the potential effects of changing the level of trade barriers. Section 7 concludes.

2. Background

Helpman (1998) assumes a model with two symmetric regions. In each region consumers have a utility function defined over the consumption of housing, which is supplied inelastically and is not tradable, and manufactured varieties that are produced under increasing returns to scale (IRS) using the only factor of production, labour. Trade in manufactured varieties is subject to transport costs. As we can realise, the dispersion forces are generated by the assumption that there is a fixed and nontradable supply of housing in each region. In this case, *ceteris paribus*, people would prefer to move to the region where housing services are cheaper. On the other hand, as in Krugman (1991), the agglomeration forces are generated by the assumption that manufactured varieties are produced under IRS. As Helpman (1998) shows, reductions in trade costs may induce, under certain circumstances (a low share of housing consumption into total expenditure, and a low elasticity of substitution between manufactured varieties), a dispersed equilibrium, while agglomeration is achieved if trade costs are high enough. If the weight of housing consumption in total expenditure and the elasticity of substitution between manufactured varieties are high enough, a dispersed equilibrium is always stable. These results are the opposite of Krugman (1991), where the reduction of transport costs induces a core-periphery outcome. Helpman (1998) concludes that the difference is explained by the assumption that housing services are not tradable. As Helpman (1998) points out, in Krugman's model the dispersion forces are generated by the assumptions that the homogeneous good produced by the primary sector is freely traded across regions, and "peasants", which can be only employed in the primary sector, are not inter-regionally mobile. The second assumption generates region-specific demands, since the income generated by the primary sector is spent entirely in the region where it is generated. As transport costs decrease, the dispersion forces fall faster than the agglomeration ones, with manufacturing concentrating in only one region. On the other hand, in Helpman (1998), as transport costs fall, the driving force determining consumer location is housing costs. So, *ceteris paribus*, people would prefer to move to the region where housing services are cheaper, which happens to be the less populated region. Moreover, if the share of housing in consumer expenditure and/or the elasticity of substitution between manufactured varieties is large enough, a core-periphery outcome is not possible for any level of trade costs.

In the case of Krugman and Livas Elizondo (1996) the model considers three regions, with two of them belonging to the same country, while the third one plays the role of the ROW. As usual in this type of model, the agglomeration forces are generated by introducing a manufactured sector that produces under IRS using the only factor of production, labour. On the other hand, the dispersion forces are generated by assuming that as the population of a region increases, workers incur commuting costs, which are, in effect, a form of congestion costs. As Krugman and Livas Elizondo (1996) point out, "*in a relatively closed economy, the forward and backward linkages are strong enough to create and support a single large metropolis. As the economy is opened, these forces are weakened and the offsetting centrifugal* *forces make a less concentrated urban system first possible and then necessary*”.[1,2]

Fujita, Krugman and Venables (1999) extend the former model allowing for the existence of more than one industry where, as in Krugman and Venables (1996), firms in each industry use as intermediate inputs the goods produced by its own industry as well as the varieties produced by the other industry. The question they deal with is if firms in a particular industry tend to cluster in a single location or to be dispersed among locations. Starting from a situation where one location has a larger population and hosts most of both industries, with the smaller region hosting only one industry, the effect of a reduction of trade costs with the ROW are the following. As the economy opens to trade, backward linkages from final consumption become weaker, and at the same time the centrifugal forces created by congestion costs induce a dispersion of population across the two domestic regions. In this way, the larger region loses population to the smaller one. Secondly, the increased importance of external trade facilitates the industrial specialisation driven by intra-industry linkages. Eventually, for trade costs low enough, each domestic region specialises in the production of one of the industries, with population equally distributed between them. Thus, trade liberalisation brings dispersion of population and concentration of industries inside the domestic economy.

3. The Model

Let us assume that the world is composed of three regions (1, 2, and 3), with regions 1 and 2 belonging to the same country (the domestic economy) and region 3 playing the role of the rest of the world (ROW). In

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[1] Since the two domestic regions are symmetric, in the sense that commuting costs are the same, the dispersed equilibrium, stable or not, means domestic populations are always equal in all regions. If commuting costs are not equal, the dispersed equilibrium, stable or unstable, means both regions having an identical population net of commuting costs. Then, if commuting costs are not affected by trade costs, the population distribution in a dispersed equilibrium is independent of the level of trade costs.

[2] Fujita, Krugman and Venables (1999) replace the assumption of commuting costs by assuming that as a region becomes larger its real wage falls by the effects of congestion costs. Congestion costs are designed such that no region concentrates the entire population. The main change with respect to Krugman and Livas Elizondo (1996) is that now, as trade costs with the ROW are reduced, regions’ sizes converge smoothly.

each region, consumers have a two-tier utility function. The upper tier, which takes a Cobb-Douglas form, determines the consumer's division of expenditure between manufactured goods and housing services. The second tier takes the usual "love for variety" form (Spence, 1976 and Dixit and Stiglitz, 1977), and dictates consumer preferences over manufactured varieties. Manufactured goods are traded internally (between regions 1 and 2) and internationally (between regions 1 and 2 and the ROW). Trade between domestic regions is subject to transport costs that take the well known Samuelson's iceberg form[3]. In the case of trade with the ROW, exports to the ROW are frictionless, while imports are subject to iceberg costs. Manufactured varieties are produced using only labour, with the sector being organised as a monopolistic competitive one, and production showing increasing returns to scale (IRS). Housing services are not tradable, with the supply in each region being fixed. Finally, labour is mobile between domestic regions but immobile internationally. All of these assumptions are similar to those of Helpman (1998), except that in our model the country that reduces trade on imports, the domestic economy, is composed by two regions. In Helpman (1998) the two regions or countries are internally homogeneous. Helpman's model is easier to use than that of Krugman and Livas Elizondo (1996) because the assumption that dispersion forces are generated by a fixed and nontradable supply of housing permit an easier estimation of the parameters of the model[4]. Also, as said before, in Krugman and Livas Elizondo (1996) model, changes in barriers on imports from the ROW do not affect the result that the dispersed equilibrium, stable or not, means always a constant population distribution between domestic regions.

3.1. Consumers

Consumers' utility in region i takes the following form:

$$u_i = h_i^{\beta} d_i^{1-\beta} \qquad 0 < \beta < 1 \tag{1}$$

where h_i is the consumption of housing, and d_i makes reference to the CES composite of manufactured varieties. In particular, d_i is given by:

[3] The notion of iceberg costs means that for each unit of an imported variety that is consumed, more than 1 unit must be shipped from the exporter region.
[4] Hanson (1998) and Brakman, et. al (2002) are two examples where the structural parameters of Helpam's model are estimated.

$$d_i = \left[\sum_n c_i^\alpha \right]^{\frac{1}{\alpha}} \qquad 0 < \alpha < 1 \qquad (2)$$

where c_i is the consumption of each variety, and n is the total number of available varieties produced by the three regions ($n=n_1+n_2+n_3$). Under this specification, the elasticity of substitution between any two varieties, as well as the elasticity of demand of each variety, is:

$$\varepsilon = \frac{1}{1-\alpha} > 1 \qquad (3)$$

The Cobb-Douglas utility function together with the CES function for d_i mean that the consumption of each manufactured variety in region i is equal to:

$$c_i = \frac{\left(p_i^j\right)^{-\varepsilon}}{\left(P_{di}\right)^{1-\varepsilon}}\left(1-\beta\right)E_i \qquad (4)$$

where p_i^j is the consumer price in region i of a variety produced in region j, E_i is the total expenditure in region i, and P_{di} is the price index of the differentiated goods in region i.

Finally, due to the assumption that trade between regions 1 and 2 is subject to iceberg costs equal to $t > 1$, while imports from the ROW incur in costs equal to τ, with $\tau \geq t > 1$, we have the following relationships between producer (p_i) and consumer $\left(p_i^j\right)$ prices:[5,6]

$$\begin{aligned} p_i^i &= p_i && \text{for } i = 1,2,3 \\ p_i^j &= tp_j && \text{for } i \neq j, \quad i,j = 1,2 \\ p_i^3 &= \tau p_3 && \text{for } i = 1,2 \\ p_3^i &= p_i && \text{for } i = 1,2 \end{aligned}$$

[5] t (τ) is the quantity of each variety that must be sipped by a domestic (foreign) firm for 1 unit to arrive to the importing region.

[6] As Krugman and Livas Elizondo (1996) point out, t should be interpreted as "natural" transport costs, while τ is a combination of natural transport costs and artificial trade barriers.

3.2. Producers

As stated above, production of each manufactured variety uses only labour, and is subject to IRS. More specifically, the demand for labour by each firm in region *i* is assumed to be equal to:

$$l_i = a + x_i \qquad (5)$$

where a>0 is a fixed requirement of labour that gives origin to IRS, x_i is the quantity produced by the firm.

Assuming that firms seek to maximise profits, the producer price (p_i) of each variety produced in region *i* is equal to:

$$p_i = \frac{1}{\alpha} w_i = \left(\frac{\varepsilon - 1}{\varepsilon} \right) w_i \qquad (6)$$

where w_i is the wage rate in region *i*. Additionally, assuming free entry and exit of firms, the zero profit condition means that in equilibrium the producer price of each variety is:

$$p_i = \left(\frac{a}{x_i} + 1 \right) w_i \quad \Rightarrow \quad x_i = x = \frac{\alpha a}{1 - \alpha} = (\varepsilon - 1) a \ \text{ and } \ l_i = a\varepsilon \qquad (7)$$

As equation (7) shows, the scale of production is constant, and identical for all firms independently of where they are located.

Finally, the equilibrium condition for the labour market means that in each region labour supply (L_i) must equalise labour demand $(l_i n_i)$:

$$L_i = (a + x) n_i \quad \Rightarrow \quad n_i = \frac{1 - \alpha}{a} L_i = \frac{L_i}{a\varepsilon} \qquad (8)$$

As equation (8) shows, n_i, the number of varieties (firms) in each region is proportional to the population of each region.

4. Solving the model

The equilibrium for each manufactured variety produced either in region 1 or 2 requires supply and demand to be equal. For region 1 we have that the equilibrium condition means:

$$x_1 = \frac{p_1^{-\varepsilon}}{P_{d1}^{1-\varepsilon}}(1-\beta)E_1 + \frac{t(tp_1)^{-\varepsilon}}{P_{d2}^{1-\varepsilon}}(1-\beta)E_2 + \frac{p_1^{-\varepsilon}}{P_{d3}^{1-\varepsilon}}(1-\beta)E_3 \qquad (9)$$

where the terms on the right hand side are, respectively, the total demand (including the quantity that melts in transit) by consumers of regions 1, 2 and 3, of each variety produced in region 1.

Due to the assumption that in equilibrium firms make zero profits, firms' total revenue in region *i* must be equal to labour income, $n_i x_i p_i = w_i L_i$, then condition (9) can be re-expressed as:

$$w_1 L_1 = n_1 \left[\frac{p_1^{1-\varepsilon}}{P_{d1}^{1-\varepsilon}}(1-\beta)E_1 + \frac{(tp_1)^{1-\varepsilon}}{P_{d2}^{1-\varepsilon}}(1-\beta)E_2 + \frac{p_1^{1-\varepsilon}}{P_{d3}^{1-\varepsilon}}(1-\beta)E_3 \right] \qquad (10)$$

A similar condition holds for region 2:

$$w_2 L_2 = n_2 \left[\frac{(tp_2)^{1-\varepsilon}}{P_{d1}^{1-\varepsilon}}(1-\beta)E_1 + \frac{p_2^{1-\varepsilon}}{P_{d2}^{1-\varepsilon}}(1-\beta)E_2 + \frac{p_2^{1-\varepsilon}}{P_{d3}^{1-\varepsilon}}(1-\beta)E_3 \right] \qquad (11)$$

The CES index for the consumption of manufactured varieties implies that, in each domestic region, the manufactured price index is given by:

$$P_{di} = \left[n_i p_i^{1-\varepsilon} + n_j (tp_j)^{1-\varepsilon} + n_3 (\tau p_3)^{1-\varepsilon} \right]^{1/(1-\varepsilon)} \qquad i \neq j \text{ and } i,j = 1,2 \qquad (12)$$

For region 3, P_{d3} is equal to:

$$P_{d3} = \left[n_1 p_1^{1-\varepsilon} + n_2 p_2^{1-\varepsilon} + n_3 p_3^{1-\varepsilon} \right]^{1/(1-\varepsilon)} \qquad (13)$$

Following Helpman (1998) we assume that housing is equally owned by all individuals, such that income from housing by residents of region *i* is equal to the fraction L_i/L of total housing income. Then, with each individual expending a fraction β of his income on housing, the aggregate value of housing services is equal to βE, where $E=E_1+E_2$. With aggregate spending equal to aggregate income, which is composed of labour income ($w_1L_1+w_2L_2$) plus income from housing βE, we get that total expenditure by residents of region *i* is equal to:

$$E_i = w_i L_i + \frac{\beta}{1-\beta}\frac{L_i}{L}\left(w_i L_i + w_j L_j\right) \qquad i \neq j, \text{ and } i,j = 1,2 \qquad (14)$$

For region 3 we have:

$$E_3 = \frac{w_3 L_3}{1-\beta} \tag{15}$$

Substituting equations (6), (8), (12), (13), (14) and (15) into (10) and (11), we are able to obtain:

$$\begin{aligned} w_1 = & \frac{w_1^{1-\varepsilon}\left[(1-\beta)w_1L_1 + \beta\frac{L_1}{L}(w_1L_1+w_2L_2)\right]}{L_1w_1^{1-\varepsilon} + L_2(tw_2)^{1-\varepsilon} + L_3(\tau w_3)^{1-\varepsilon}} \\ & + \frac{(tw_1)^{1-\varepsilon}\left[(1-\beta)w_2L_2 + \beta\frac{L_2}{L}(w_1L_1+w_2L_2)\right]}{L_1(tw_1)^{1-\varepsilon} + L_2w_2^{1-\varepsilon} + L_3\left(\tau w_3^{1-\varepsilon}\right)^{1-\varepsilon}} \\ & + \frac{w_1^{1-\varepsilon}(w_3L_3)}{L_1w_1^{1-\varepsilon} + L_2w_2^{1-\varepsilon} + L_3w_3^{1-\varepsilon}} \end{aligned} \tag{16}$$

$$\begin{aligned} w_2 = & \frac{(tw_2)^{1-\varepsilon}\left[(1-\beta)w_1L_1 + \beta\frac{L_1}{L}(w_1L_1+w_2L_2)\right]}{L_1w_1^{1-\varepsilon} + L_2(tw_2)^{1-\varepsilon} + L_3(\tau w_3)^{1-\varepsilon}} \\ & + \frac{w_2^{1-\varepsilon}\left[(1-\beta)w_2L_2 + \beta\frac{L_2}{L}(w_1L_1+w_2L_2)\right]}{L_1(tw_1)^{1-\varepsilon} + L_2w_2^{1-\varepsilon} + L_3(\tau w_3)^{1-\varepsilon}} \\ & + \frac{w_2^{1-\varepsilon}(w_3L_3)}{L_1w_1^{1-\varepsilon} + L_2w_2^{1-\varepsilon} + L_3w_3^{1-\varepsilon}} \end{aligned} \tag{17}$$

For a given population distribution between domestic regions, equations (16) and (17) give a system of two equations in two unknowns. Then, for any levels of L_1 and L_2, and choosing w_3 as numeraire, we are able to find a pair (w_1,w_2) such that equations (16) and (17) are satisfied. Two properties of equations (16) and (17) are that nominal wages do not depend directly on housing, and that for L_1=L_2 we get w_1/w_2=1 independently of trade costs.

With labour being mobile between domestic regions, we have that in equilibrium real wages in regions 1 and 2 must be equal. For the Cobb-Douglas utility function, the general price index for the consumption of manufactures and housing services (P_{ui}) is given by:

$$P_{ui} = \frac{P_{hi}^{\beta} P_{di}^{1-\beta}}{\beta^{\beta} \left(1-\beta\right)^{1-\beta}} \quad (18)$$

where P_{hi} is the price of housing services in region *i*.

In each domestic region we have that the equilibrium of the housing market means $H_i = \frac{\beta E_i}{P_{hi}}$, then using equation (14) we get:

$$P_{hi} = \frac{\beta}{H_i}\left[w_i L_i + \frac{\beta}{1-\beta} \frac{L_i}{L}\left(w_i L_i + w_j L_j \right) \right] \qquad i \neq j \text{ and } i,j = 1,2 \quad (19)$$

By using (18) the indirect utility functions or real incomes for regions 1 and 2 are:

$$V_1 = M_1 \frac{\beta^{\beta} \left(1-\beta\right)^{1-\beta}}{P_{h1}^{\beta} P_{d1}^{1-\beta}} \quad (20)$$

$$V_2 = M_2 \frac{\beta^{\beta} \left(1-\beta\right)^{1-\beta}}{P_{h2}^{\beta} P_{d2}^{1-\beta}} \quad (21)$$

where $M_i = E_i / L_i$ is the nominal income of each consumer in region *i*.

Finally, in equilibrium, and if the two domestic regions have a positive population, we have:

$$\bar{V} = \frac{V_1}{V_2} = \frac{M_1}{M_2} \left(\frac{P_{h2}}{P_{h1}} \right)^{\beta} \left(\frac{P_{d2}}{P_{d1}} \right)^{1-\beta} = 1 \quad (22)$$

5. Characterising the equilibrium[7]

In this section we proceed to characterise the stability properties of the equilibrium. As is usual with this kind of model we have two alternative results depending on whether the equilibrium is stable or unstable. In both cases, the equilibrium could imply both regions having a positive population, or population can agglomerate in a single region. The first case we refer to as a dispersed equilibrium, while the second case we refer to as an agglomerated equilibrium.

As is the case with the Helpman's model, a critical element is given by the values of the share of income expended on housing (β) and the elasticity of substitution between varieties (ε). A high elasticity of substitution means that consumers take little care about the available number of manufactured varieties and therefore are not particularly attracted to the larger region, where as equation (8) shows, the number of varieties is larger. At the same time, as housing consumption is relatively more preferred than that of the differentiated products (high β), each individual is attracted to the region where housing services are cheaper, which happens to be the one where L_i/H_i is the lowest. On the other hand, if consumers have a high preference for the consumption of the differentiated goods (low β), and the elasticity of substitution between varieties (ε) is low (the love for varieties is high), consumers are attracted to the more densely populated region, where the number of varieties is larger. These two alternative scenarios can be summarised by $\beta\varepsilon$ being larger or smaller than 1 respectively.

For $\beta\varepsilon>1$, the main variable determining the location choice of consumers in the domestic economy is the price of housing. Then, independently of the level of transport costs (t and τ), a dispersed equilibrium is stable (Figure 1). As Figure 1 shows, for any other population distribution than when $\bar{V}=1$ the real income is larger in the less populated region, which induces people from the larger region to migrate to the region with the higher real income. Simulations using t=3 and t=100 show the same pattern of behaviour, with the stable equilibrium being a disperse one.

When $\beta\varepsilon<1$ the results are sensitive to the values of transport costs. As said before, $\beta\varepsilon<1$ means that, when choosing where to locate, consumers pay more attention to the availability of manufactured varieties, and the larger region becomes more attractive since consumers save on transport costs when consuming varieties produced in another region. In this case, for certain levels of transport costs consumers may find it profitable to agglomerate in a single region.[8] As Figure 2 shows, for low enough domestic trade costs only the dispersed equilibrium is stable. This result is explained by the fact that, even when consumers care relatively more about the

[7] Due to the complexity of equations (16) and (17) the analysis of sections 5 and 6 is carried out through the use of numerical simulations. The following parameters values were used: a=1, β=0.2, ε=2.2 and 6.7, L=8, L_3=100, H_1=15, H_2=10.

availability of manufactured varieties, a low level of t makes the prices of the varieties imported from the other domestic region not much different from those produced domestically, so consumers allocate themselves in order to minimise the costs of housing. As in the case of $\beta\varepsilon>1$, we have that for any other population distribution than when $\bar{V}=1$, the real income is larger in the smaller region, with people migrating from the larger region to smaller one.

On the other hand, if t is high enough, any potential gain produced by a low housing price obtained by consumers located in the smaller region is outweighed by the transport costs incurred by the consumption of imported varieties, so, there are two stable equilibrium with population agglomerating in a single region. In this case, the dispersed equilibrium is unstable, since for any other population distribution than when $\bar{V}=1$ the real income is higher in the larger region, which induces people to agglomerate there (Figure 3).

Finally, when t takes intermediate values (Figure 4) the characteristics of the equilibrium depend on the level of transport costs with the ROW. For τ high enough the stable equilibrium means all population concentrates in a single region, with the dispersed equilibrium being unstable. As τ is reduced there are three dispersed equilibria, with the one where the population distribution is more symmetric being unstable. Finally, as τ is further reduced, there is only one dispersed stable equilibrium.

An interesting result that emerges from the above simulations is that when the domestic regions are asymmetric, in the sense that the housing supply is not equal between domestic regions, the dispersed equilibrium means a population distribution different from that of housing. Two cases can be identified according to whether the equilibrium is stable or unstable. In the first case, the larger region hosts a population share larger than its housing share, $L_1/L>H_1/H$. On the other hand, when the equilibrium is unstable we have the opposite case, with $L_1/L<H_1/H$.[9] These opposite results

[8] More precisely, population tends to agglomerate in a single region.

[9] The same results are achieved in Helpman's model once we allow for an asymmetric distribution of housing. Also, as in Helpman's model, if we assume $H_1=H_2$, we get that in the dispersed equilibrium population is distributed exactly as housing ($L_1/L_2=H_1/H_2=1$).

are driven by the different rates at which w_1/w_2, P_{d1}/P_{d2} and P_{h1}/P_{h2} evolve as the regions' relative size change.

The result that for all dispersed equilibria population is not distributed in the same proportion as housing can be explained as follows. For $L_1/L_2>1$ we have $w_1/w_2>1$ and $P_{d1}/P_{d2}<1$, so, in order for the real incomes to be equal, we need $P_{h1}/P_{h2}>1$. Looking at the expression for the relative real income we have that for $\bar{V}=\frac{V_1}{V_2}=\frac{M_1}{M_2}\left(\frac{P_{h2}}{P_{h1}}\right)^{\beta}\left(\frac{P_{d2}}{P_{d1}}\right)^{1-\beta}=1$, a necessary condition is $\frac{P_{h1}}{P_{h2}}>\left(\frac{w_1+A}{w_2+A}\right)^{1/\beta}$, where $A=\frac{\beta}{1-\beta}\bar{w}$, and $\bar{w}$ is the weighted average wage in the domestic economy. Using equation (19), and assuming $H_1/H=L_1/L$, we are able to obtain that the relative price of housing in region 1 is:

$$\frac{P_{h1}}{P_{h2}}=\frac{w_1+A}{w_2+A} \tag{23}$$

Looking at equation (23) we find out that for $H_1/H=L_1/L>0.5$, the relative price of housing in the larger region (region 1) is not large enough to compensate for the higher nominal wage ($w_1/w_2>1$) and for the lower price index of the manufactured goods ($P_{d1}/P_{d2}<1$), then for $H_1/H=L_1/L$ the real income in region 1 is larger than in region 2.

When the dispersed equilibrium is stable, the simulations show that as L_1/L increases, the relative price of housing increases at a rate large enough to compensate for the increase of the relative nominal wage of region 1 and the fall of the relative price of manufacture goods in region 1, with the real incomes being equal for $L_1/L>H_1/H$. On the other hand, if when $L_1/L=H_1/H$ consumers migrate to the smaller region (region 2), we have that w_1/w_2 falls, P_{d1}/P_{d2} increases and P_{h1}/P_{h2} falls. The first two effects decrease the relative real income of region 1, while the third one increases it. However, in this case the change of P_{h1}/P_{h2} more than compensates for the changes in w_1/w_2 and P_{d1}/P_{d2}, then, the relative real income of region 1 increases as L_1/L falls.

If the dispersed equilibrium is unstable, the opposite scenario takes place. With $\bar{V}>1$ for $L_1/L=H_1/H$ a reduction of L_1/L induces the following changes: w_1/w_2 falls, P_{d1}/P_{d2} rises and P_{h1}/P_{h2} falls; with the first two effects being relatively more important than the third one, such that as L_1/L falls the relative real income of region 1 falls. As we can see from Figures 3 and 4, this case takes place for $\beta\varepsilon<1$ and trade costs high enough. This outcome can be explained as follows. When $\beta\varepsilon<1$ consumers care relatively more about the availability of a large number of manufactured varieties, and if t and τ are high enough this implies a relatively large incidence of transport costs. Then, consumers locate such that in the smaller region, where most of manufactures need to be imported, housing costs are low enough to compensate for the burden of transport costs, with the larger region paying a higher price for housing, but reducing the impact of transport costs. With P_{hi} increasing as L_i increases, the former condition is achieved only if population locates in the opposite direction of housing shares, with $N_1/N<H_1/H$.

6. Unilateral trade liberalisation

In this section we proceed to analyse the effects that a reduction of trade costs on imports from the ROW has on the regional pattern of production, that in the case of our model is the same as the effects on the size of each region (see equation 8). We also look at the effects on relative wages. In the analysis that follows we restrict our attention to those cases where a single dispersed equilibrium is stable.

As previously mentioned, if housing is equally distributed between the two regions, $L_1=L_2$ is always an equilibrium, stable or unstable. Then, in order to allow for changes in τ to affect the spatial structure of the domestic economy we need to introduce an element of asymmetry between regions. We do this allowing for H_1 be different from H_2.

A reduction of trade costs on imports from the ROW has two potential effects. On the one hand, a reduction of trade costs means, *ceteris paribus*, a fall of nominal wages in both regions. The simulations show that when t is low enough, a reduction in τ decreases proportionally more the wage rate of the larger region, whilst when τ is large the smaller region is the one which experiences the larger reduction of w_i.[10] On the other hand, a change of transport costs affects the location choice of consumers and, *ceteris paribus*, the region that increases its size experiences an increase in its relative nominal wage. These two effects induce further changes in the prices of housing and manufactured goods, such that consumers migrate until real incomes are the same in both regions.

As is logical to expect from the results of section 4, the effects driven by changes in τ depend on the magnitude of the elasticity of substitution between manufactured varieties, as well as on the share of housing in the total expenditure.

For $\beta\varepsilon>1$, the effects of changes in τ depend on the level of domestic trade costs (t). When t is large enough a reduction of τ does not affect the distribution of population between the domestic regions (Figure 5). In this case, as was said before, $\beta\varepsilon>1$ means that consumers care relatively more about the price of housing. In addition, with t large enough, and under the assumption that $\tau>t$, the consumption of manufactured varieties produced by the ROW is almost nil. Then, changes in τ do not affect the spatial distribution of firms between domestic regions. On the other hand, when t is low enough (Figure 6) changes in τ may affect the spatial distribution of manufactured production. For τ large enough, we have the same result as before: with the consumption of Region 3's varieties by domestic consumers being almost nil, reductions of τ do not affect the population distribution between domestic regions. However, when τ is low enough, further reductions in transport costs on imports from the ROW reduce the size of the larger region, inducing also a convergence of nominal wages. This result can be explained by the fact that when τ is low enough, domestic consumption of foreign varieties is relatively more important, with consumers migrating in order to reduce the incidence of housing costs. Finally, a less obvious result is achieved when t takes intermediate values. As Figure 7 shows, a fall of τ induces a reduction in the size of the larger region; however, in this case, the reduction of τ for a given population distribution reduces relatively more the nominal wage of the smaller region,

[10] When t can be considered large or not depends on $\beta\varepsilon$ being smaller or larger than one. Also, for $\beta\varepsilon<1$ and L_i/L small enough, it may be possible to find the opposite results, especially when τ is large.

with this effect more than compensating for the effect caused by the fall of L_1/L_2, which as Figure 7 shows is almost nil; the result is an increase in the relative wage of the larger region. Finally, when τ is below a critical value, the changes in regions' size are large enough to induce an increase in w_2/w_1.

When $\beta\varepsilon<1$ (Figure 8) the changes of the different variables when τ is modified are independent of the level of domestic trade costs. With consumers being more sensitive to the number of manufactured varieties, the consumption of imported varieties is relatively more important. As imported varieties become relatively cheaper, consumers of both domestic regions substitute consumption of varieties produced by the ROW for local varieties. Then, a reduction of τ increases the relative importance of housing costs, inducing a migration from the larger to the smaller region. This behaviour produces a convergence of nominal wages. In this case, the change in the population distribution is the dominant force, with w_1/w_2 decreasing as L_1/L_2 falls.

7. Conclusions

Krugman and Livas Elizondo (1996) argue that the import substitution policy followed by many LDCs during most of the second part of the past century generated, or at least intensified, a process of population and production concentration. This process led to the emergence of huge industrial centres whose production was mainly intended for the domestic market. Can the process of trade liberalisation slow or reverse this geographical structure?

In order to throw some light on these questions, we have adapted the Helpman's (1998) model to analyse the case where a domestic economy composed of two asymmetric regions reduces trade barriers on imports from the ROW. As usual with many NEG models, the agglomeration forces are generated through the inclusion of a sector that produces manufactured varieties under IRS whose trade is subject to transport costs, and assuming labour is mobile between domestic regions. Dispersion forces are generated, as in Helpman (1998), by introducing a fixed supply of housing, which is not tradable between regions.

In this environment, a reduction in trade costs on imports from the ROW induces, other thing held constant, a dispersion of population between the two domestic regions. With only one productive sector, and a fixed scale of production, the dispersion of population as a consequence of trade liberalisation means that manufactured production becomes less concentrated. This result is explained by the fact that, as imports becomes cheaper, consumers look to minimise the burden of housing costs, which are larger in the more populated region. The strength of this effect is larger the lower the share of housing consumption on consumers' expenditure, and the lower the elasticity of substitution between manufactured varieties. When the share of housing consumption is large enough, population distribution is mainly determined by the distribution of housing, with trade costs having a minor effect.

With respect to the effects on labour returns, in most cases, the reduction of international trade barriers induces a convergence of nominal wages. However, it is possible to observe the opposite result for some intermediate levels of internal trade costs.

A further result is that, as shown in section 5, when the distribution of housing is not symmetric, in any dispersed stable equilibrium the larger region has a population proportionally larger than its housing endowment, so the convergence in regions' size is only partial.

Finally, it is worth mentioning some limitations of the model. In the first place, in order to make the model more manageable we need to assume specific functional forms, so the scale of production of each manufactured firm is equal and fixed, independently of trade costs. This is a common problem shared by most NEG models. A second drawback is that, since we are assuming only one production sector, we are unable to derive any results about the share of the manufactured sector in total employment.[11]

[11] Under the assumption that consumers distribute their expenditure according a Cobb-Douglas utility function, the share of manufactures in GDP is constant and equal to 1-β.

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Figure 1
Relative Real Income (Region1/Region2) and Regional Population Shares
$\beta\varepsilon>1$, H_1=60% of total, t=1.5

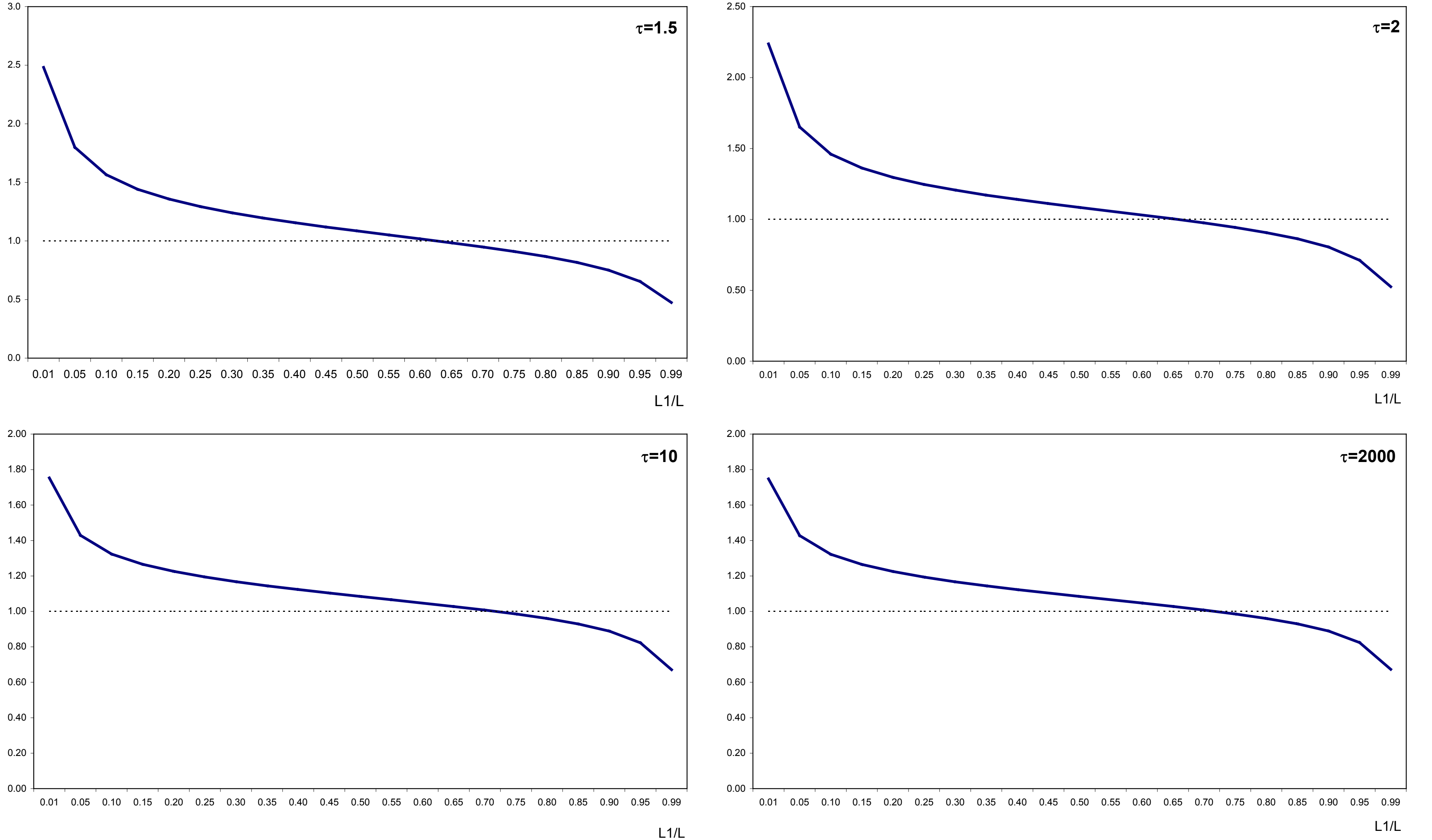


Figure 2
Relative Real Income (Region1/Region2) and Regional Population Shares
$\beta\varepsilon<1$, H_1=60% of total, t=1.5

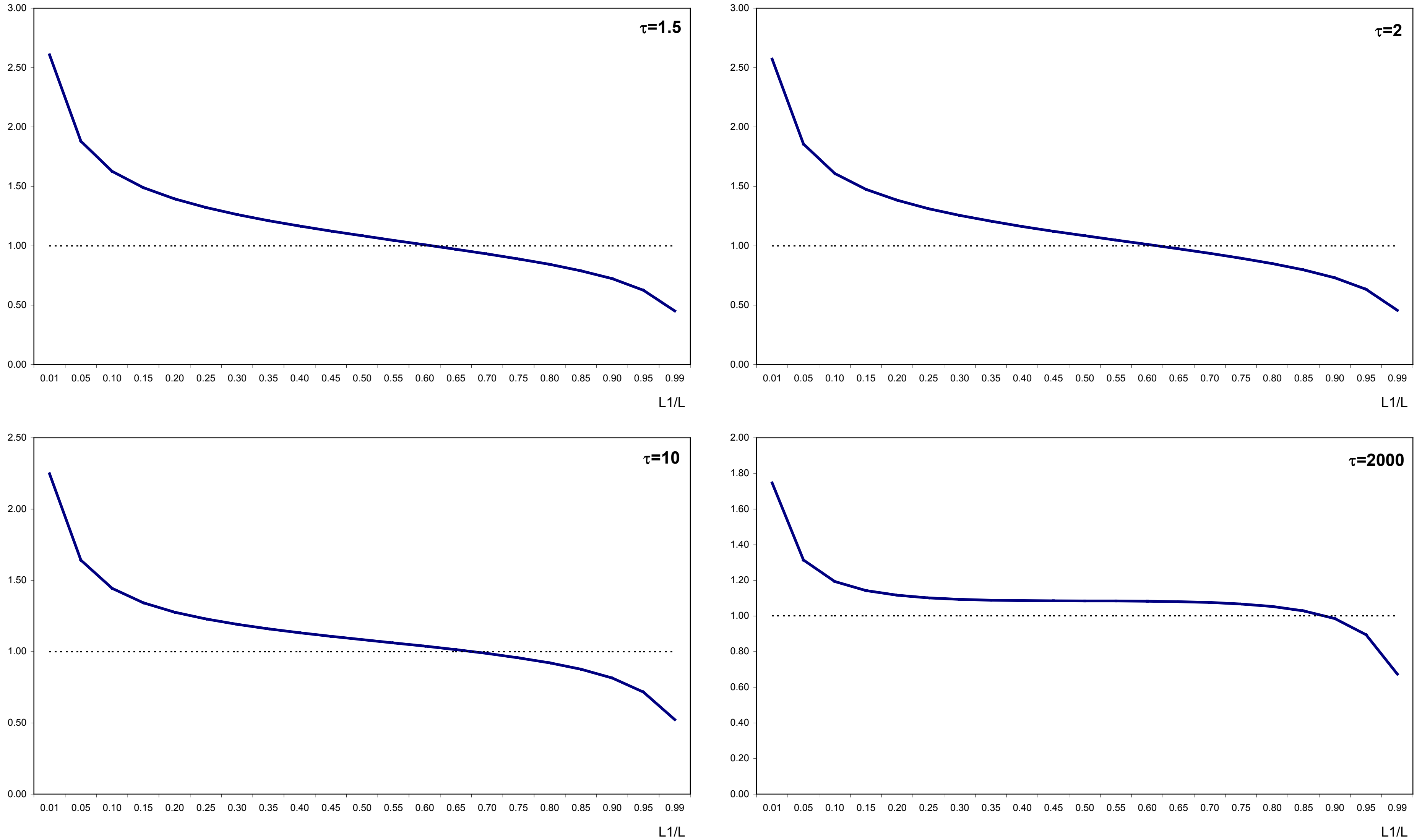


Figure 3
Relative Real Income (Region1/Region2) and Regional Population Shares
$\beta\varepsilon<1$, H_1=60% of total, t=100

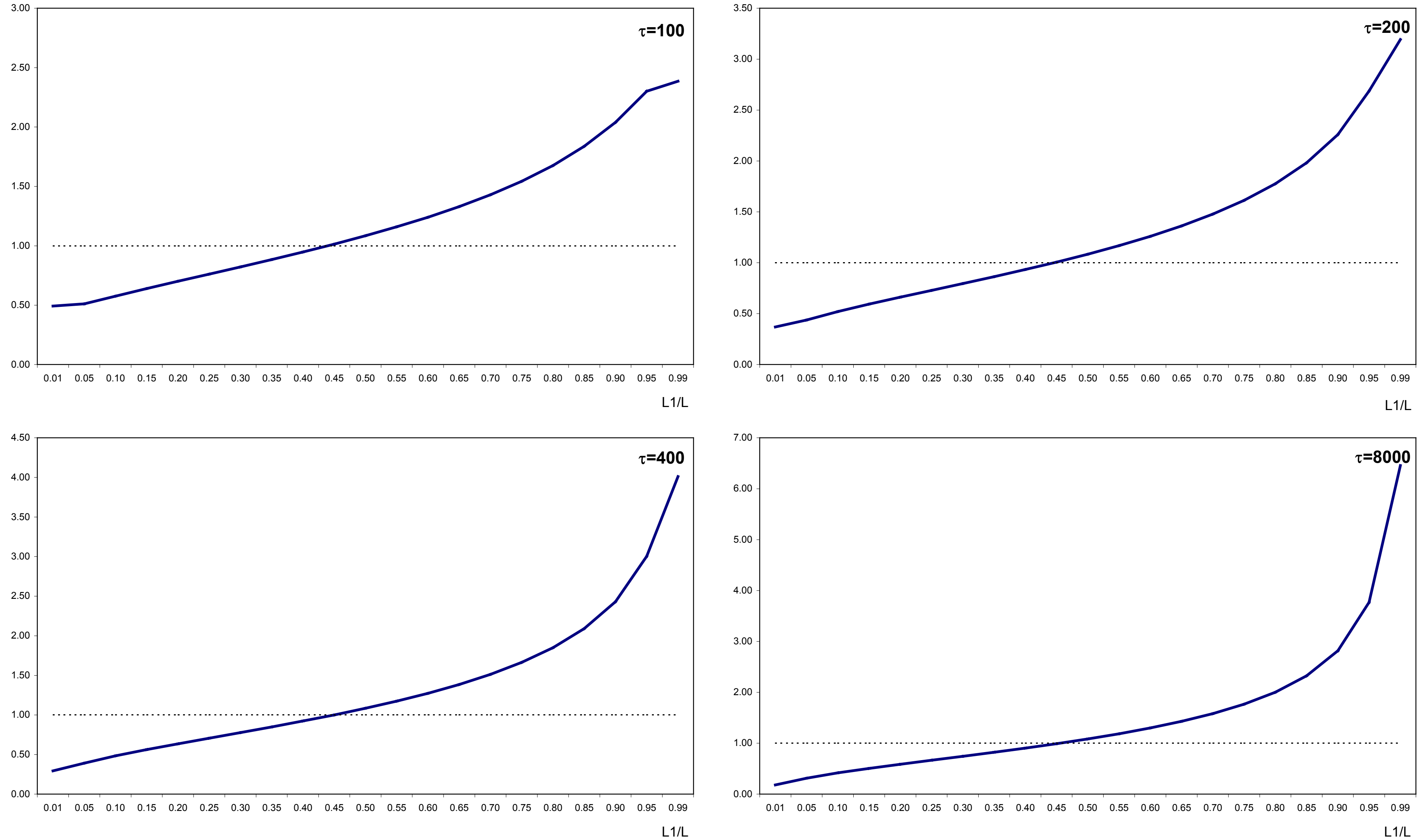


Figure 4
Relative Real Income (Region1/Region2) and Regional Population Shares
$\beta\varepsilon<1$, H_1=60% of total, t=3

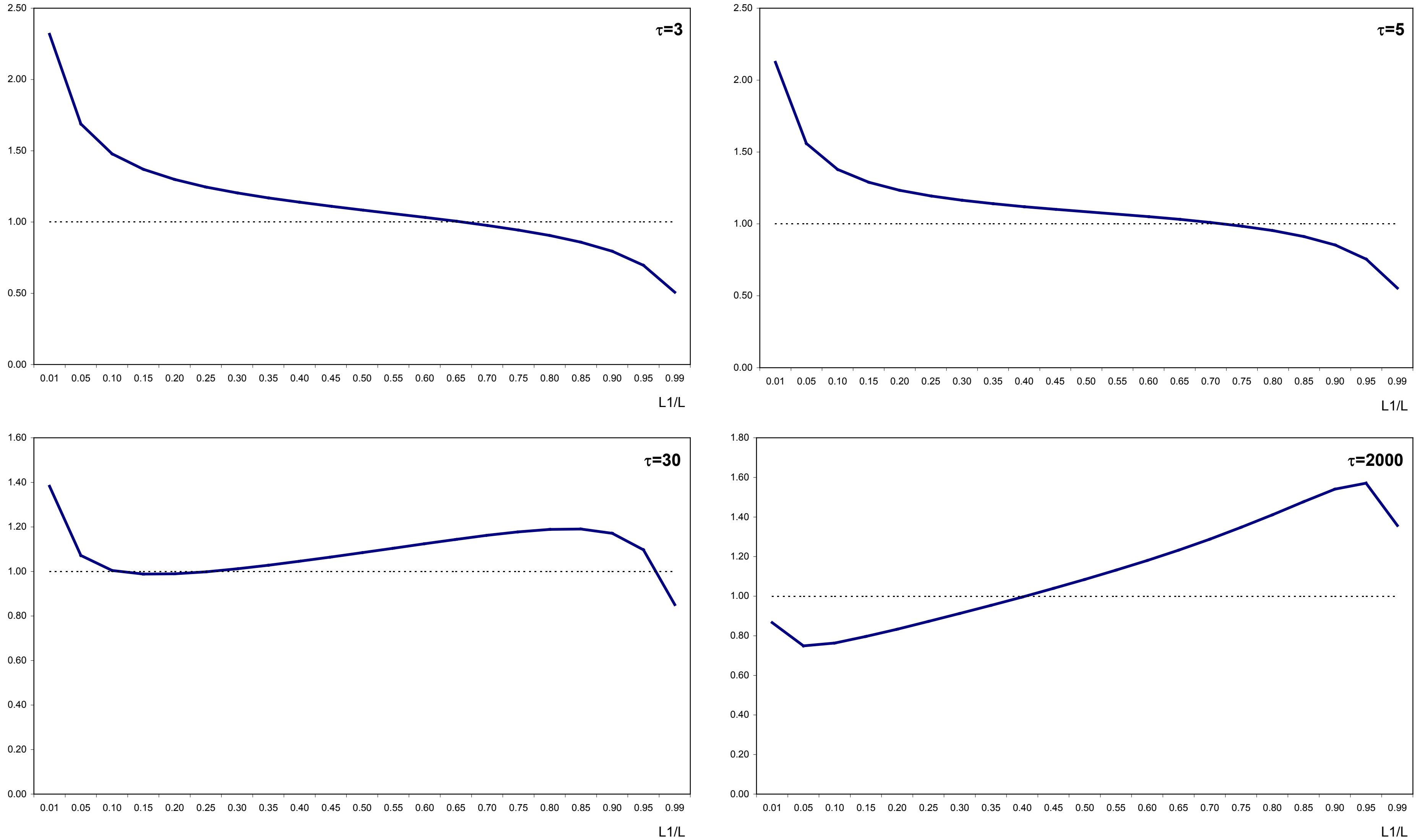
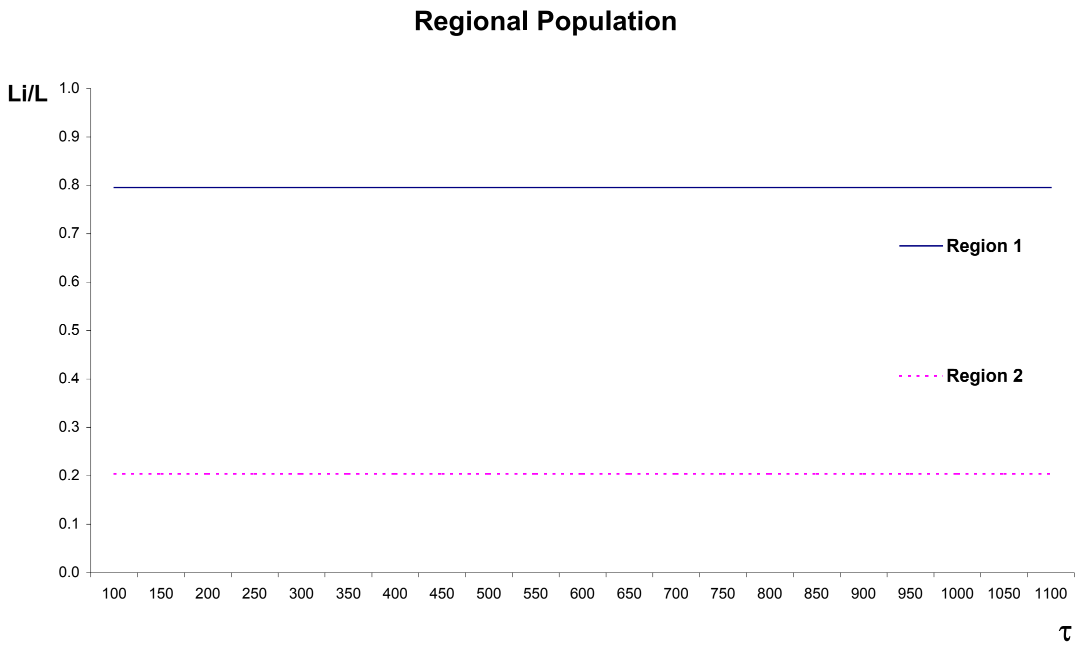


Figure 5
Effects of changes in τ
βε>1, H1=60% of total, t=100



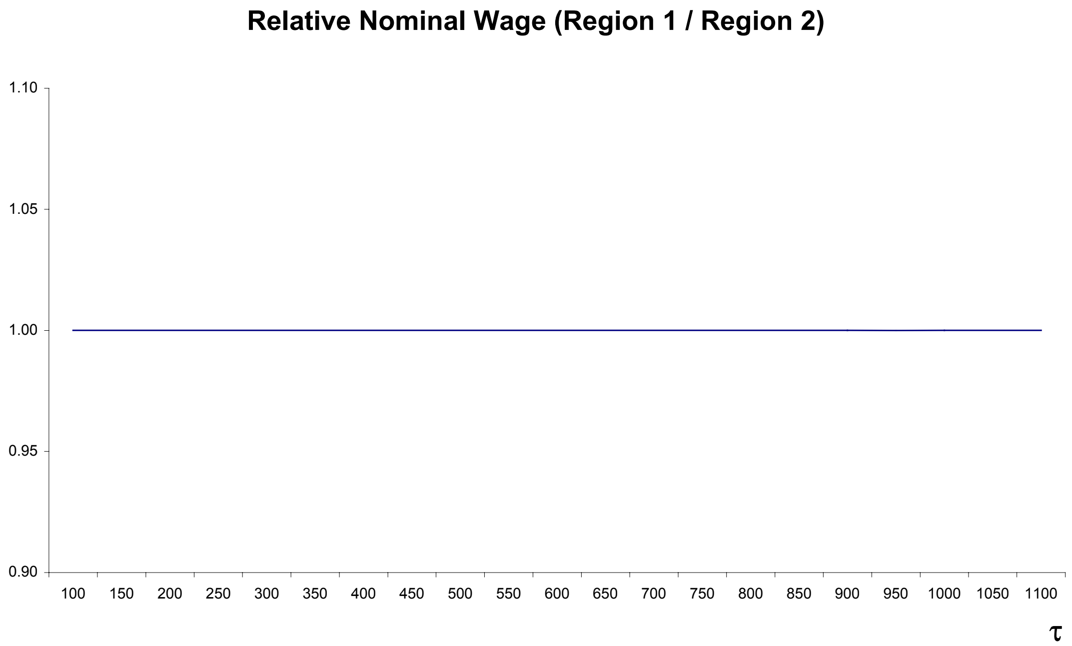
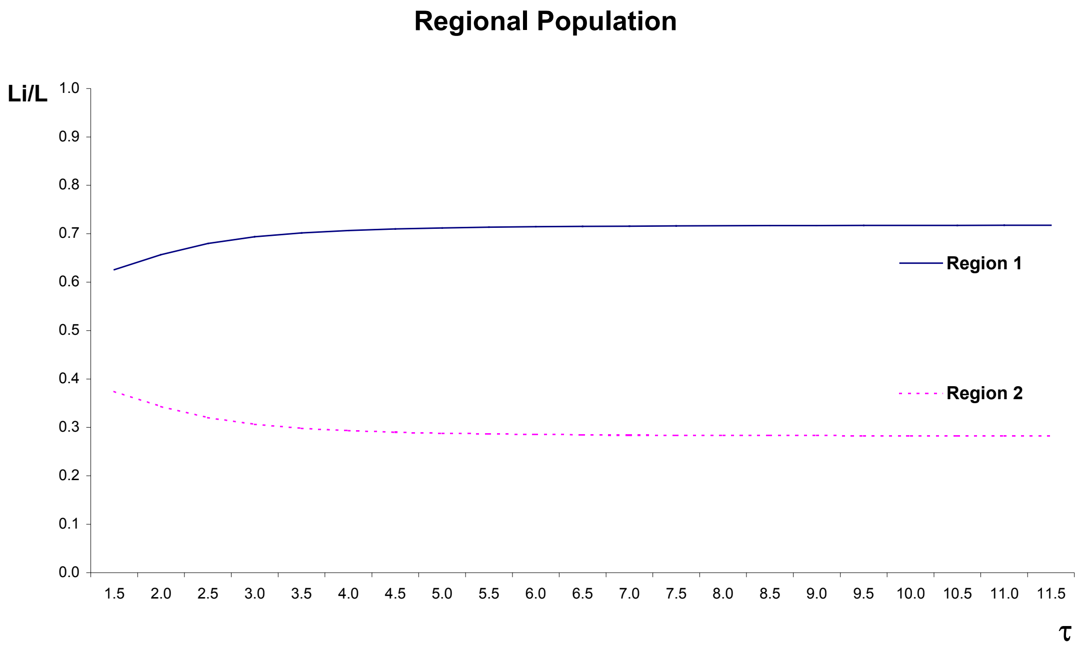


Figure 6
Effects of changes in τ
$\beta\varepsilon>1$, H1=60% of total, t=1.5



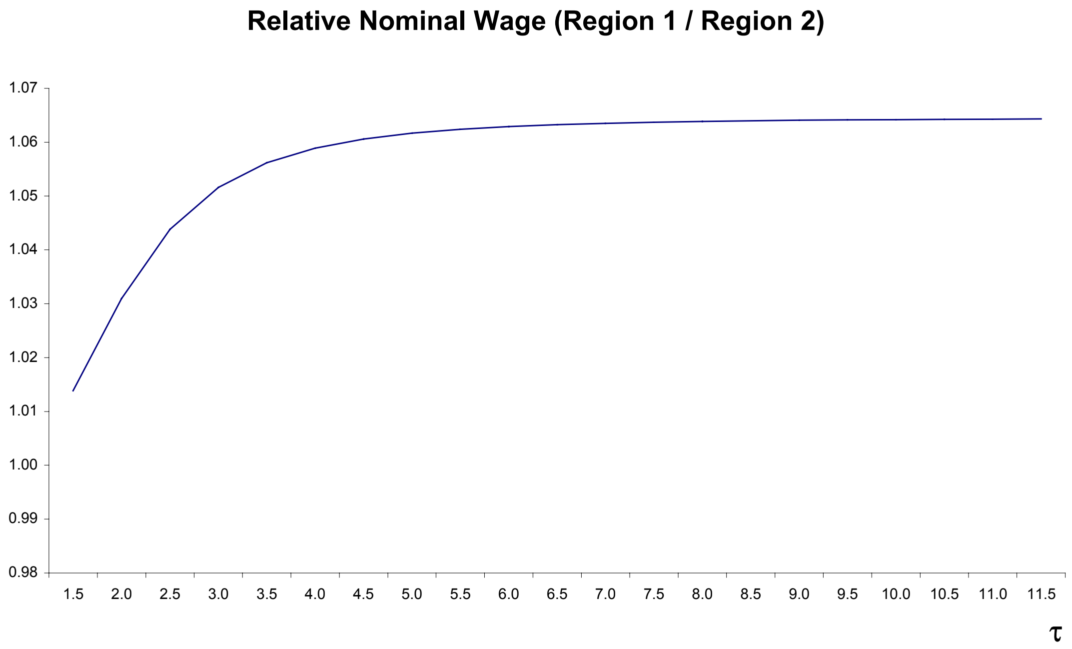
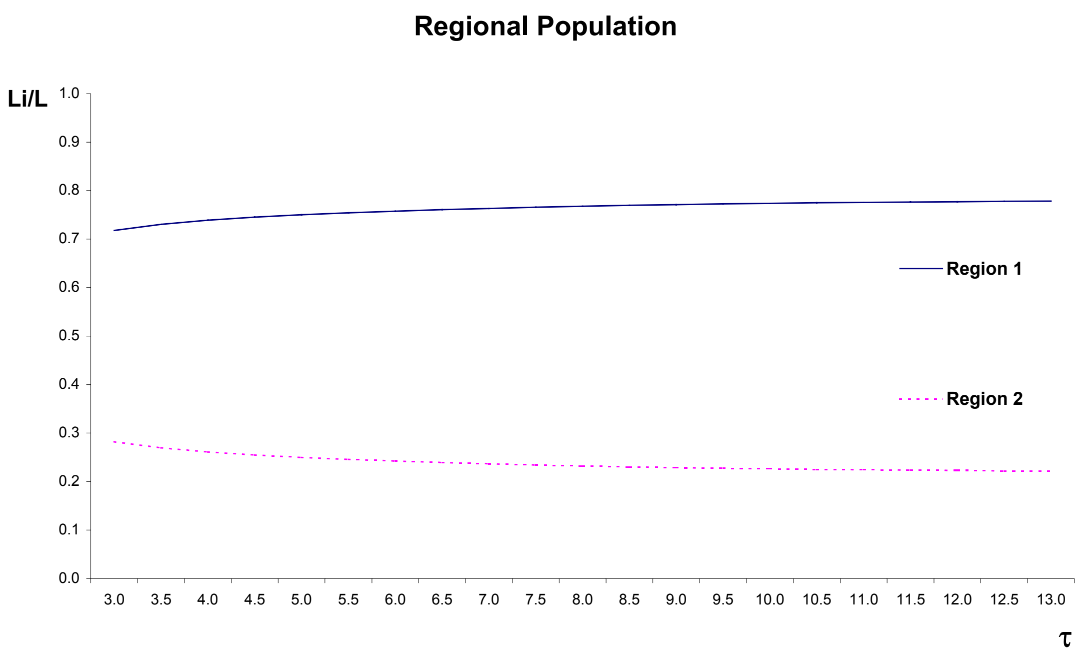


Figure 7
Effects of changes in τ
βε>1, H1=60% of total, t=3



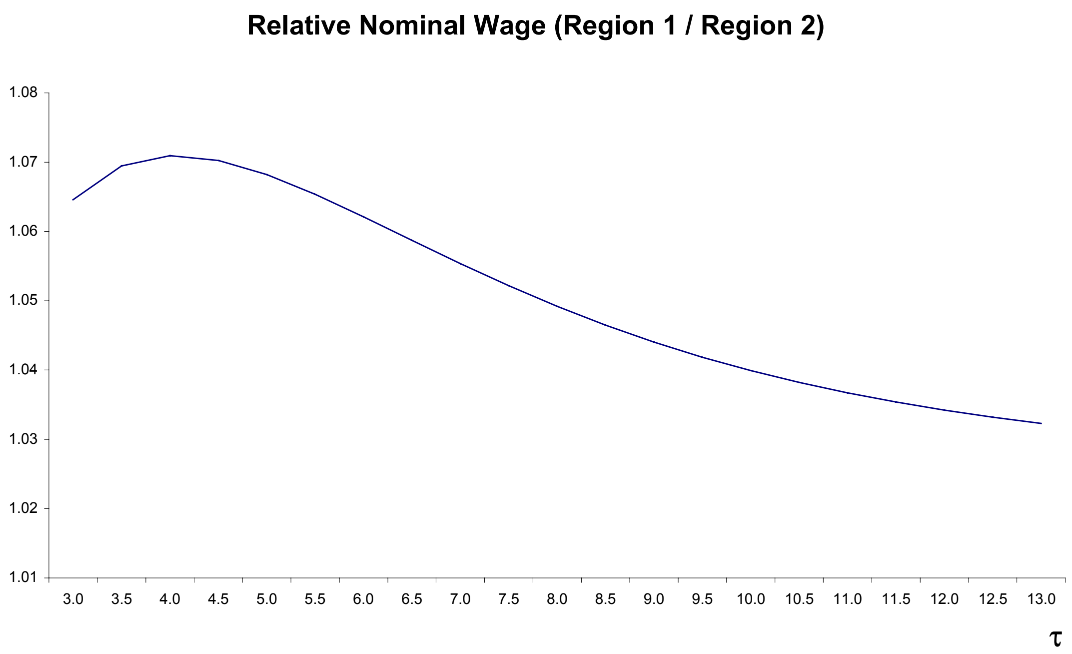


Figure 8
Effects of changes in τ
$\beta\varepsilon<1$, H1=60% of total, t=1.5