TRADE POLICY AND URBAN-RURAL INEQUALITIES IN LDCS: A SIMULATION EXPERIMENT WITH A NEW ECONOMIC GEOGRAPHY MODEL

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Abstract

This paper follows the new economic geography approach to model the relationships between trade policy and spatial agglomeration of production in the context of a small open developing economy. We construct a general equilibrium model with interactions between centripetal forces and centrifugal forces that determine linkages between urban and rural regions. Centripetal forces such as labour migration, increasing returns, and transport costs tend to concentrate economic activities and population in the urban region. This causes the inequality between urban and rural areas to increase. On the other hand, centrifugal forces such as congestion and urban land rents favour dispersion of firms and workers. This favours a balanced urban system that is conducive for rural development. We concentrate on explaining how trade policy affects the interactions between these forces by implementing the theoretical model through numerical simulations. The results suggest that trade liberalization can improve urban-rural inequalities as long as the country that implements trade policy reform does not face any trade restrictions in the external market.

JEL classification: F12; F13; F15; R12

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1 INTRODUCTION

Less developed countries have experienced a rapid urbanization process during the last few decades. Half a century ago just 41 of the world's 100 largest cities were in developing countries. This number had increased to 64 by 1995. This proportion is predicted to rise with more and more population moving from rural to urban areas and nearly 90 percent of the world's future urban population living in developing countries (World Bank, 1999). Moreover, there is a growing body of empirical literature that indicates the structures of cities in developing countries are much more dominated by metropolitan regions compared to the experiences of developed countries at similar stage of economic development (Venables, 2000; Puga, 1996, 1994).

The new economic geography literature has focused on two interrelated aspects. The first strand concentrates on theoretical explanations of the underlying causes of the patterns of urbanization in developing countries and seeks answers for such questions as: Why do such uneven distributions of population and economic activities exist regardless of large spatial differences in costs of production and cost of living? Why do firms choose to locate close to each other? What are the consequences of choosing peripheral locations rather than in existing large cities? Studies considering these aspects include Fujita and Mori (1999); Fujita, Krugman and Venables (1999); Puga (1999); and Henderson (1996). The second strand explains how the current patterns of urbanization in developing countries is likely to be affected by changes in trade policy regimes (Paluzie, 2001; Venables, 2000, 1996; Krugman and Livas, 1996). In spite of the difference in emphasis, the two strands fall in the New Economic Geography literature.

The motivation for this paper comes from Krugman and Livas (*This Journal, Volume 49, 1996*) that developed a formal model and demonstrated the effect of trade policy on the third world metropolis. The Krugman and Livas' model (henceforth the KL model) was inspired by the experience of Mexico City, the world's largest urban centre. "Prior to the late 1980s, Mexico followed a classic strategy of industrial development through import-substitution industrialization; the result was the emergence of an inward-looking economic base; much of it concentrated in the immediate vicinity of Mexico City." (Fujita, Krugman and Venables (1999, p. 329). The extent of concentration of production in Mexico City was given as "40% of the nation's manufacturing employment, more than half its manufacturing value-added" (Krugman and Livas, 1996, p. 138).

Fujita, Krugman, and Venables (1999, p. 329) observe that:

> In the second half of the 1980s, however, Mexico began a dramatic process of trade liberalization, culminating in the North American Free Trade Agreement. Associated with this process was a noticeable decentralization of the Mexican Industry, away from Mexico City and toward centers in the north of the country. This decentralization was obviously linked to a shift in focus away from domestic market and toward exports to the United States.

Krugman and Livas explain the underlying cause of the shift in the regional distribution of Mexico's industry as follows. The concentration of industries in Mexico City was the result of an inward-looking industrialization strategy followed during the previous decades. Manufacturing firms were producing mainly for domestic market and hence had an incentive to choose production sites with good access to customers: the relatively affluent population concentrated at Mexico City (backward linkages through markets for goods and services) and firms as input suppliers (forward linkages). The advantages from these backward and forward linkages have outweighed the disadvantages of high land rents, wages, congestion and pollution. Thus, the KL model was developed to formalise the observation of Mexico City's experience.

The purpose of this paper is to examine the applicability of the KL model to the circumstances of other developing countries. As in the KL model, we assume a small open developing economy with two domestic regions and one external region. In each region there is an aggregate industry producing a composite good using one factor of production, labour. The nationally fixed labour force is allowed to move between the domestic regions but not internationally. All regions interact in the product market with shipments of goods from one region involving costs that are broadly understood as "trade costs". The latter includes transport costs as well as any other barrier to trade that businesses face to access the external market.

We relax one critical assumption of the KL model. The latter assumes that only foreign firms face trade costs in accessing the domestic market but domestic firms incur no such costs in accessing the external market. Given the circumstance of Mexico whose trade liberalization culminated in the establishment of NAFTA, and also noting that industrial location in Mexico favoured regions bordering the US, the zero-export trade cost assumption in the KL model could be realistic in the context it is set-up. However, these conditions are not likely to apply to the rest of developing countries that have implemented trade policy reforms. Thus, we drop this assumption but implement the model without any other modification. The numerical simulation results we have obtained indicate that trade liberalization is not likely to change the pattern of urbanization and regional inequalities in the domestic economy as long as the external region imposes some trade restriction.

The remainder of this paper is structured as follows. Section 2 develops a formal model. Section 3 presents numerical simulation results. We end with concluding remarks in Section 4.

2 THE MODEL

2.1 Overview

We use the new economic geography approach to set-up the model. This involves tensions between "centripetal" forces that tend to concentrate people and businesses into urban areas and "centrifugal" forces that tend to disperse them to peripheral regions. Centripetal forces include both pure external economies and market size effects (forward and backward linkages). Centrifugal forces could be pure external diseconomies such as congestion, pollution, urban land rents, the attraction of moving away from highly competitive urban locations to less competitive rural ones (Krugman and Livas, 1996, p. 141). For the sake of analytical tractability, the model here focuses on centripetal forces that result from the interaction between market size, economies of scale and trade costs. Similarly, the only centrifugal force allowed is land rent.

We imagine an open economy with two domestic regions: rural and urban. Each domestic region interacts with the rest of the world in product markets. Each region (including the external region) has one aggregate production sector that uses only one factor of production, labour. The domestic economy is characterised by full employment of the labour force, given as L, which is mobile between domestic regions but not internationally. At any point in time, the labour force share of each domestic region is denoted by λ_r. We represent regions generically by r (the reference region) and s (the other regions) or specifically as 1, 2 or 0 to mean the centre, the periphery or the rest of the world respectively.

2.2 Commuting Cost

We use the notion of a mono-centric urban structure to show the relationships between wages, commuting cost and labour time (Fujita and Krugman, 1995). Figure 1 provides a simplified structure that assumes a long and narrow economy, one dimensional, with a business district at the centre (C) and residential spaces stretching effectively along a line (OO′). Production takes place at a single central place (at point C). Workers' residential places are spread on both sides of central business district with a unit of land per worker. The commuting distance of the last workers living at the outskirts of the city (at O and O′) is given by the following relationship:

$$L = \frac{d}{2} \tag{1}$$

L is total number of workers in the city and d is the distance (OO′).

[Insert Figure 1 here]

The highest land rent is paid at point C but the level of land rent declines with distance from the central business district. The last worker who lives at the outskirts of the city does not pay any land rent. This creates an incentive for workers to live nearer to the outskirts of the city (further away from the centre) where land rent is cheaper. However, it takes time to travel the distance to their workplace in the city.

Given that a worker has a unit of labour available for work, if she commutes between a place of residence and a place of work in the central business district, then she arrives with a net amount of labour to sell of only

$$S = 1 - 2\gamma d \tag{2}$$

γ is the ratio of labour time spent per unit distance.

Eq (2) suggests that commuting cost is incurred in terms of potential labour earnings. With a given regional wage rate (W_r), a worker commuting from a certain location receives a net wage of only $(1-\gamma L_r)W_r$. A worker who lives closer to the city centre, however, receives almost the full amount of the regional wage rate, W_r, but she pays a land rent that exactly offsets the amount they have saved by avoiding commuting. Thus, the wage net of commuting and land rents is $(1-\gamma L_r)W_r$ for all workers.

The total labour input in each region is given as

$$Z_r = L_r(1 - 0.5\gamma L_r) \tag{3}$$

L_r is labour force in region r and Z_r is labour input net of commuting time.

We assume that land rents are spent in the regions they are generated. Thus, regional income, including land rent is given as:

$$Y_r = Z_r W_r \tag{4}$$

2.3 Consumer Behaviour

We assume that every consumer in each region shares the same preference. The level of utility, *U*, is given as a function of the quantity of varieties consumed. The quantity index is defined by a constant elasticity of substitution (CES) as:

$$U = \left[\sum_{i}^{n} C_i^{\rho} \right]^{\frac{1}{\rho}} \tag{5}$$

C_i stands for the consumption of each available variety. *i* and *n* denote, respectively, specific and range (number) of varieties produced in all regions. $\rho = 1-(1/\sigma)$, where σ is the elasticity of substitution between varieties.

The consumer utility maximization problem takes the following form:

$$\text{Maximise } \; U = \left[\sum_{i}^{n} C_i^{\rho} \right]^{\frac{1}{\rho}} \quad \text{subject to} \quad \sum_{i=1}^{n} P_i C_i = Y \tag{6}$$

Given income, *Y*, and prices of each manufacturing variety, P_i, the solution to this problem is obtained in two steps. The first order condition to this problem is satisfied by equating the marginal rate of substitution to the price ratios for any two varieties i and j:

$$\frac{C_i^{\rho-1}}{C_j^{\rho-1}} = \frac{P_i}{P_j} \tag{7}$$

The optimal consumption level of variety *i* is:

$$C_i = \left(\frac{P_j}{P_i}\right)^{\frac{1}{1-\rho}} C_j \qquad (8)$$

This gives the usual inverse relationship between own-price and quantity of a variety demanded, i.e., the higher P_i, other things being equal, the smaller C_i and vice versa. If we substitute eq (8) into the original constraint, eq (6), and re-arrange the terms, we get the compensated demand function for the j[th] variety. This is given as:

$$C_j = \frac{P_j^{\frac{1}{\rho-1}}}{\left[\sum_{i=1}^{n} P_i^{\frac{\rho}{\rho-1}}\right]^{\frac{1}{\rho}}} U \qquad (9)$$

The relationship that defines the minimum cost of attaining *U* is derived as follows. Given that $P_j C_j$ is total expenditure on the j[th] variety, we sum over all varieties and get:

$$\sum_{j=1}^{n} P_j C_j = \left[\sum_{i=1}^{n} P_i^{\frac{\rho}{\rho-1}}\right]^{\frac{\rho-1}{\rho}} U \qquad (10)$$

The term multiplying *U* on the right-hand side of eq (10) is the price index in that the price index times the composite quantity gives total expenditure. If we denote the price index by *G* (and recalling that $\rho = (\sigma - 1)/\sigma$ or $\sigma = 1/(1-\rho)$), then we obtain:

$$G = \left[\sum_{i=1}^{n} P_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{11}$$

If we substitute eq. (11) into eq. (9) and re-arrange the terms, the demand functions for each manufacturing variety becomes:

$$C_j = \left[\frac{G}{P_j} \right]^{\sigma} U \tag{12}$$

While *U* denotes composite quantity index for varieties, *G* represents the minimum cost of purchasing the aggregate consumer good. In other words, *U* is a utility function and *G* is an expenditure function. Given the price index, eq. (11), and the level of income, eq. (4), the indirect utility function takes the following form:

$$U = \frac{Y}{G} \tag{13}$$

It is straightforward from eq. (13) that utility (or welfare) is given as a function of real income that, in turn, is defined by the ratio of nominal income to the level of the price index. In line with conventional demand theory, with a given level of income, the lower the price index the higher the level of welfare. From eq. (11), we note that the larger the number of manufacturing varieties on offer, *n*, the lower the level of the price index, *G*. This is the most important relationship in the monopolist competition model (or, more specifically, the Dixit-Stiglitz model) where the number of manufacturing varieties is endogenously determined.

The relationship between n and G can be most clearly seen if we assume that all manufactures are sold at the same price, P_m. Thus, eq.(11) becomes:

$$G = \left[\sum_{i=1}^{n} P_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}} = P_m n^{\frac{1}{1-\sigma}} \qquad (14)$$

This suggests that the responsiveness of the number of varieties depend on the elasticity of substitution between varieties, σ. The lower the value of this parameter, the more differentiated are the product varieties, the greater is the reduction in the price index (caused by increases in the product varieties), and hence the higher the level of welfare (as shown by the indirect utility function).

2.4 Trade Costs

Shipments of goods between locations involve costs. The transport costs are the most commonly cited as shipment costs of moving goods between locations. In order to avoid modelling a separate transport industry, the "iceberg" form of transport cost is usually assumed in the New Economic Geography literature. If a unit of a variety of good is shipped from region r to region s, then only $1/T_{rs}$ of the original unit actually arrives at the destination. A broader view of shipment cost includes

> all of the costs of doing business at a distance – lack of face-to-face contact, more complex and expensive communication and information gathering, and possibly also different languages, legal systems, product standards, and culture. These things are difficult to measure but are revealed in the trade data: if the volume of trade between a pair of locations is lower the further apart they are, then presumably this is because the full cost of making the trade is higher (Fujita, Krugman, and Venables, 1999, p. 98).

We adopt a broader definition of trade costs incurred in moving goods between different locations. Accordingly, we use the term "trade cost" rather than "transport cost". The "iceberg" formulation of trade cost implies that delivery prices or c.i.f. prices ($P_{r,s}$) are $T_{r,s}$ times mill prices or f.o.b. prices ($P_{r,r}$). Algebraically,

$$P_{r,s} = P_{r,r} T_{r,s} \tag{15}$$

The introduction of trade cost to the model causes discrepancy not only between delivery prices and mill prices but also it causes price indices to take different values in each region. Thus, eq. (14) becomes:

$$G_s = \left[\sum_r n_r \left(P_{r,r} T_{r,s} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{16}$$

The quantity of good *j* produced in region *r* and consumed in region *s* is given as:

$$C_{s,j} = \frac{Y_s}{\left(P_{r,r} T_{r,s} \right)^{\sigma} G_s^{1-\sigma}} \tag{17}$$

On the other hand, if this amount has arrived for consumption in region *s*, then the suppying regions, *r*, must have supplied $T_{r,s}$ times as much. If we sum across all such locations in which the product is sold, then we obtain the total sale of a single location *r* variety:

$$q_r = \sum_s \frac{Y_s}{P_{r,r}{}^{\sigma} T_{r,s}^{\sigma-1} G_s^{1-\sigma}} \tag{18}$$

This relationship suggests that sales depend on the level of income in each location, the price index in each location, trade costs between locations, and the mill price.

2.5 Producer Behaviour

Commuting cost and land rents are centrifugal forces or diseconomies of city size. The forces of agglomeration are explained by compensating advantages of concentration. These arise from economies of scale, which in turn, lead to imperfect competition. Economies of scale could be either internal or external to the firm. The new economic geography models (e.g. Fujita, Krugman, and Venebles, 1999) focus on the former while traditional urban development theory (e.g., Henderson, 1996) concentrates on the latter. Fan (2000) presents an interesting comparison of these views. As noted earlier, we follow the new economic geography approach that employs a modelling trick developed by Dixit and Stiglitz (1977) to formulate a tractable explanation of imperfect competition. This is based on the assumption of monopolistic competition with "a large number of potential symmetric products… Each producer acts as a profit maximising monopolist, free entry drives profits to zero" (Krugman and Livas, 1996, p. 143).

The production process involves economies of scale at the level of variety. Furthermore, we assume producers use the same technology in each region with a fixed input, α, and marginal input, β. Further assuming, that the only factor of production is labour, the production of a quantity, q, of a variety at a given location is given as:

$$z = \alpha + \beta q \tag{19}$$

z is net labour input per variety.

A combination of increasing returns, consumers' love for variety, and the unlimited number of potential varieties suggest that firms would not choose to produce the same variety supplied by another firm. Thus, there is only one specialised firm that produces a certain variety and supply to consumers in all locations. This implies that the number of firms is equal to the number of available varieties.

Each producer faces an elasticity of demand equal to the elasticity of substitution and hence charges a mill price, P_r, that is a constant mark-up over marginal cost, W_r. This relationship is given as:

$$P_r = \frac{\sigma}{\sigma - 1}\beta W_r \qquad (20)$$

Free entry drives profits to zero in the manufacturing sector. Given the pricing rule, eq (20), we have a unique zero-profit output level, q^*, that is a constant and common to all regions:

$$q^* = \frac{\alpha}{\beta}(\sigma - 1) \qquad (21)$$

It should be noted that eq.(21) holds only when $\sigma > 1$; otherwise the relationship is meaningless. The fact that output of a variety is a constant suggests that the number of goods produced in each region, n_r, is proportional to its labour input net of commuting:

$$n_r = \frac{Z_r}{\alpha\sigma} \qquad (22)$$

Eq (22) reveals an essential feature of increasing returns at the level of the firm. It embeds the fact that a location with a large net labour input produces a greater variety of goods than one with smaller net labour input.

We choose units so that $\alpha\sigma$ is equal to unity and hence n_r is equal to Z_r. Therefore,

$$\lambda_r = \frac{n_r}{\sum_s n_s} = \frac{Z_r}{\sum_s Z_s} \tag{23}$$

This means that the share of manufacturing variety in each region is equal to the share of the region in the total manufacturing labour force.

The relationships between the zero-profit level of output (eq. (21)), the demand-supply equilibrium condition (eq. (18)), and the pricing rule (eq. (20)) determine the equilibrium wage level, which is given as:

$$W_r = \sum_s \frac{Y_s}{T_{r,s}^{\sigma-1} G_s^{1-\sigma}} \tag{24}$$

This is referred to as the wage-equation and it gives the wage rate at which firms in each location break-even. The wage rate is higher the higher are incomes in the producers' markets, Y_s, the better is the firm's access to these markets (the lower $T_{r,s}$), and the less competition firms face in these markets (the smaller σ).

We obtain the real wage of workers in each location, r, as a function of nominal wages, W_r (weighted by commuting cost), the labour force share (λ_r), and the level of price index, G_r. This is given as,

$$\omega_r = \frac{(1-\gamma\lambda_r)W_r}{G_r} \tag{25}$$

2.6 Determination of Equilibrium

The instantaneous equilibrium of the model can be determined by simultaneously solving for income equations (4), price index equations (16), the nominal wage equations (24), and the real wage equations (25).

We follow Fujita, Krugman and Venables (1999, Chapter 18.1) in setting up the system of equations for numerical simulations. Since labour is mobile only between the domestic regions, we take the labour force in the external region as given, Z_0. We use λ_1 and λ_2 as shares of the central and peripheral regions in the domestic labour force. The wage rate of the external sector is used as a numeraire, $W_0 = 1$. Therefore, the income equations for the three regions can be written as,

$$Y_0 = Z_0 \tag{26}$$

$$Y_1 = \lambda_1 W_1 \tag{27}$$

$$Y_2 = \lambda_2 W_2 \tag{28}$$

The formulation of the price indices in each region is straightforward, with equation (16) being elaborated to become,

$$G_0 = \left[Z_0 + \lambda_1 \left(W_1 T_{1,0} \right)^{1-\sigma} + \lambda_2 \left(W_2 T_{2,0} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{29}$$

$$G_1 = \left[Z_0 T_{0,1}{}^{1-\sigma} + \lambda_1 W_1^{1-\sigma} + \lambda_2 \left(W_2 T_{2,1} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{30}$$

$$G_2 = \left[Z_0 T_{0,2}{}^{1-\sigma} + \lambda_1 \left(W_1 T_{1,2} \right)^{1-\sigma} + \lambda_2 W_2{}^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{31}$$

The price indices tend to be lower the higher the share of economic activity in the location. The reason is that a larger proportion of locally consumed goods does not bear trade cost. This makes the region an attractive location for workers implying that business and household location decisions tend to re-enforce each other.

Noting that the wage rate of the external region is the numeraire in this model, the wage equations become,

$$W_1 = \left[Y_0 G_0{}^{\sigma-1} T_{1,0}{}^{1-\sigma} + Y_1 G_1^{\sigma-1} + Y_2 G_2{}^{\sigma-1} T_{1,2}{}^{1-\sigma} \right]^{\frac{1}{\sigma}} \tag{32}$$

$$W_2 = \left[Y_0 G_0{}^{\sigma-1} T_{2,0}{}^{1-\sigma} + Y_1 G_1{}^{\sigma-1} T_{2,1}{}^{1-\sigma} + Y_2 G_2{}^{\sigma-1} \right]^{\frac{1}{\sigma}} \tag{33}$$

The wage equations exhibit an important property of the model. Other things being equal, the nominal wage rate in a region is higher if the level of income in the region is high. In other words, a location with larger home market has a more than proportionate share in number of businesses and hence is in a position to export goods and services to other regions.

Thus, a location with a larger market does not only pay higher nominal wages to workers but it also exports goods to other locations.

The real wage in each region takes into account differences in price indices, the nominal wage rate, and the commuting cost (land rents).

$$\omega_1 = \frac{W_1\left(1-\gamma\lambda_1\right)}{G_1} \tag{34}$$

$$\omega_2 = \frac{W_2\left(1-\gamma\lambda_2\right)}{G_2} \tag{35}$$

The changes in relative real wages cause labour mobility across regions. This leads to variations in the distribution of economic activity across locations over time.

$$\dot{\lambda}_1 = -\dot{\lambda}_2 - \theta(\omega_1 - \omega_2) \tag{36}$$

The dots over λ denote time derivative while θ represents speed of adjustment in labour mobility that depend on such conditions as movement costs and forward-looking behaviour of migrants.

Although the logic of this model is intuitive, the relationships between the variables are complicated enough to make it impossible to solve it analytically. At this point we resort to numerical simulations.

3 NUMERICAL SIMULATIONS

We set out to accomplish three tasks in the numerical simulations. These are further elaboration of the logic of the model; mimicking the KL model results; and relaxing the KL assumption and them provide alternative explanations for the relationships between trade policy and regional inequalities.

To begin with, it is essential to build up on the theoretical discussions in the previous section and use numerical solutions to explain the logic of the model. We use graphical methods to display numerical solutions. The real wage differential between the two domestic regions, given as ω_1 / ω_2, is plotted against the labour force share of region 1, λ_1. Any point where $\omega_1 / \omega_2 = 1$ and $\lambda_1 = 1$ represents an equilibrium condition. This is because if satisfies the condition for an even distribution of the labour force (and hence businesses) between the two domestic regions.

This equilibrium is stable if the curve is downward sloping because it represents an inverse relationship between the real wage differentials and the labour force shares. Whenever a region takes a lead in terms of its share of the labour force, the real wage there falls below that of the other region and hence workers would migrate from the former to the latter region thereby removing the wage differential.

In contrast, if the curve slopes upwards, i.e., if the wage rate ratio ω_1 / ω_2 is positively related to λ_1 at the point of equilibrium, then the equilibrium is unstable because workers would migrate to the region that has already more workers. This may lead to a corner solution, where workers fully concentrate in one region and stay there as long as the real wage there remains higher than that of the other region.

The numerical simulations are undertaken by normalising the size of domestic population to unity, i.e., $L = 1$. The remaining exogenous variables take the following values: $\sigma = 7$, $\gamma = 0.2$, $T_{1,2} = T_{2,1} = 1.5$, $Z_0 = 10$, and $\theta = 1$. We vary the trade cost parameters that stand for barriers between the domestic economy and the external region.

We distinguish between trade barriers that the rest of the world faces in accessing the domestic market and those that the domestic economy faces in the external market. Trade barriers are mainly related to import tariffs although they can also be understood to mean any obstacle to foreign firms selling goods in the domestic regions. We assume that $T_{0,1} = T_{0,2} = T_m$ where T_m stands for an average trade barrier parameter in the domestic market. This suggests that foreign firms face the same trade restriction in both domestic regions. Similarly, we assume equal export trade cost for both internal locations implying that we do not allow one domestic region to have the advantage of proximity to the rest of the world. This means that $T_{1,0} = T_{2,0} = T_e$, where T_e stands for an average export trade costs to domestic firms in accessing the external market. We take up each of these cases separately and discuss them with the numerical results in sections that follow.

3.1 Reducing Domestic Trade Barriers

We concentrate on the effect of reductions in import tariffs on regional distribution of production activity and the labour force. Here we effectively mimic results obtained by

Krugman and Livas (1996). This enables us to discuss the arguments involved and explain the properties of the model at the same time. We then relax the zero-export trade cost assumption of Krugman and Livas (1996) and repeat the simulation runs.

Thus, we begin by concentrating on Figure 2, which has three panels. In Figure 2a, we assume a relatively high import tariff of $T_m = 2.25$. Such a high trade cost represents a closed economy, reminiscent of the import substitution industrialization strategy. The equilibrium condition that allows even distribution of population between the two locations is unstable because the curve slopes strictly upwards indicating a strong agglomeration. The only stable equilibria are the corner solutions, i.e., full concentration in one region or the other.

[Insert Figures 2a, 2b, 2c here]

Panel 2b represents the intermediate case with $T_m = 2.0$. In the context of import trade liberalization, this amounts to slightly opening the economy. It shows a rather complicated picture. As in panel 2a, the symmetric equilibrium (even population allocation) is stable but this is surrounded by two unstable equilibria. If the share of the labour force in one region starts from a sufficiently high or a sufficiently low initial value, then the economy converges not to the symmetric equilibrium but to a core-periphery pattern with all production in only one region. There are five equilibria that characterise this intermediate case: three stable (one at the point of symmetry and two corner solutions) and two unstable. The key point here is that the agglomeration force (denoted by the intermediate size of the trade cost parameter) is still too weak to destabilise the symmetric equilibrium. However, it is strong enough to ensure that if all firms were concentrated in one region this would be a locally stable equilibrium as well (Puga, 1999, p. 334).

Panel 2c is plotted for a relatively low trade cost parameter, $T_m = 1.75$. This gives a unique and stable equilibrium with even distribution of population between the two locations. This implies trade liberalization leads to even distribution of population between domestic regions and hence reduces regional inequalities.

These results explain the line of argument developed and the simulation results obtained by Krugman and Livas (1996), whose overall conclusion was given as follows:

> In a relatively closed economy, the forward and backward linkages are strong enough to create and support a single metropolis. As the economy is opened, these forces are weakened and the offsetting centrifugal forces make the less concentrated urban systems first possible and them necessary (p. 149).

3.2 Export trade costs to domestic firms in the external market

The simulation results discussed in the previous section were obtained by assuming that domestic firms do not face any trade barrier in the world market. This means that we have varied trade costs for imports to mimic the degree of openness of the domestic economy ($T_m > 0$). However, we have followed Krugman and Livas' (1996, p. 143) and assumed that domestic firms incur no exports costs in accessing the external market ($T_e = 0$). In this section, we relax this assumption. We keep the import trade cost parameter at the sufficiently low level of $T_m = 1.75$ as in figure 2c. This means that the economy is assumed to remain open in this simulation run. However, we vary the export trade cost parameter, $T_e \neq 0$, and see the effect of this change on the distribution of population between the two domestic regions.

In Figure 3a, we have plotted results of two simulation runs. The solid line is the same as the results displayed in Figure 2c (with $T_m = 1.75$ and $T_e = 0$). For the broken line, however, $T_e = 1.05$. Both curves represent a stable equilibrium with even distribution of population between the two locations. However, it is useful to observe that the broken line is flatter than the solid line, tending to be less stable than the solid line.

[Insert Figures 3a, 3b, 3c here]

In Figure 3b, we show what happens when the external market access problem (export trade cost) is slightly higher, $T_e = 1.2$ (with T_m still at $1.75)$. The results here are similar to those displayed in Figure 2b. Although the domestic market is sufficiently liberalised to guarantee even distribution of population between the two locations, the existence of trade barriers in the external market is likely to inhibit the development of peripheral regions in the domestic economy.

In Figure 3c, we assume a relatively high external trade cost, 3 (again T_m is still equal to $1.75)$. This shows a complete unravelling of the results discussed in Section 3.1. As long as there are some trade restrictions that hinder access of domestic firms to the external market, trade liberalisation is not likely to affect the current pattern of spatial pattern in developing countries. A comparison of Figures 3c with 2a brings an interesting point to light. Both figures represent a core-periphery relationship. However, Figure 2a suggests that a closed economy with a protectionist trade policy experiences uneven spatial development or a polarised pattern of relationship between rural and urban areas. On the other hand, Figure 3c implies that a small open economy with a relatively low tariff rate may have a polarised regional development if it encounters a market access problem for its output in the rest of the world.

4 CONCLUSIONS

There has been a growing interest in trade policy reforms in developing countries. The KL model is an influential piece of work that illuminated the relationship between spatial agglomeration and trade policy in this context. It was inspired by the impact of Mexico's trade liberalization on the county's regional inequalities. This study set out with a modest objective of examining the relevance of the KL model to the conditions of other developing economies.

The numerical simulations suggest that trade liberalization can contribute to the objective of reducing regional inequalities in a developing country. However, we have shown that the KL model's conclusion critically depends on their assumption of "zero-export trade costs". As noted earlier, given that Mexico's trade liberalization was accompanied by the establishment of NAFTA, the KL model could be suitable to explain similar situations where a developing economy enjoys free access to a large external market for its exports.

The simulation experiments we have undertaken illuminates the relationships between trade policy reform and the core-periphery pattern of regional development in developing economies. In order to capture the conditions of trade reforms and structural adjustment programmes, we began with a relatively high external trade barriers in a hypothetical developing economy and reduced tariffs unilaterally and gradually in two scenarios. In the first scenario, as in the KL model, we have assumed that there were no restrictions for domestic firms to access the external market. The results from our numerical simulations are similar to those from the KL model in that trade liberalization reduces inequalities between the domestic regions. In the second scenario, we have assumed the existence of trade barriers in the external region. In this case, our numerical simulation gave an outcome diametrically opposite to that of the KL model. Although the size of parameter values we have chosen to represent the extent of trade barrier in the external region is relatively low, this was enough to upset and reverse the KL model results with trade liberalization not being able to improve regional inequalities.

This study draws attention to the potential of reciprocal policy reforms in trading arrangements, particularly between developing economies and advanced economies, to ameliorate core-periphery relationships between urban and rural areas in developing economies. We have argued that market access problems faced by developing economies is an issue that cannot be ignored in evaluating the success of economic reform programmes. Hoekman (2001, p.3) observes that despite the low average manufacturing tariff rates that apply in developed economies, tariffs for some commodities are over 100 percent, with most tariff peaks often concentrating in products that are of exporting interest to less developed economies, (e.g. textiles and clothing). Hoekman cites a specific case of the US trade during 1999, when imports originating from developing countries generated tariff revenue amounting to 11.6 percent of the value of their exports to the US and 15.7 percent of dutiable imports. Eliminating such market access barriers can help boost investment incentives, expand trade related employment opportunities, reduce urban-rural imbalances and contribute to poverty alleviation programmes.

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Figure 1 Mono-centric city structure

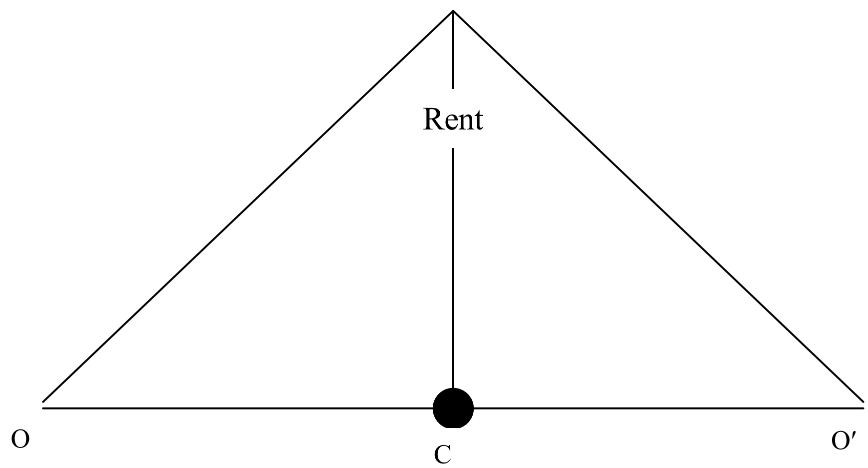

Figure 2a **Closed economy case:** $T_m = 2.25$ **and** $T_e = 1.0$

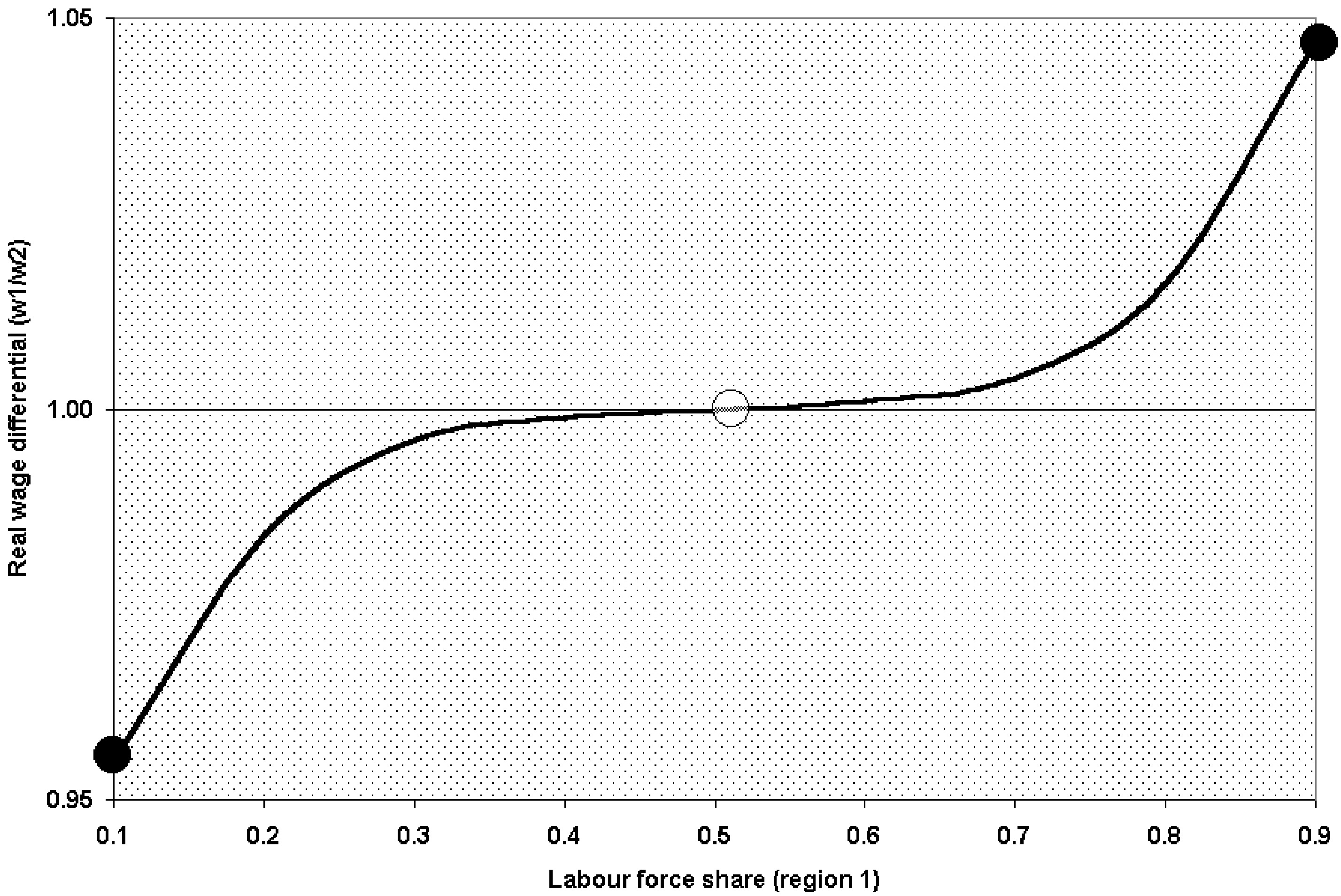

Figure 2b   Slightly open economy case: $T_m = 2.0$ **and** $T_e = 1.0$

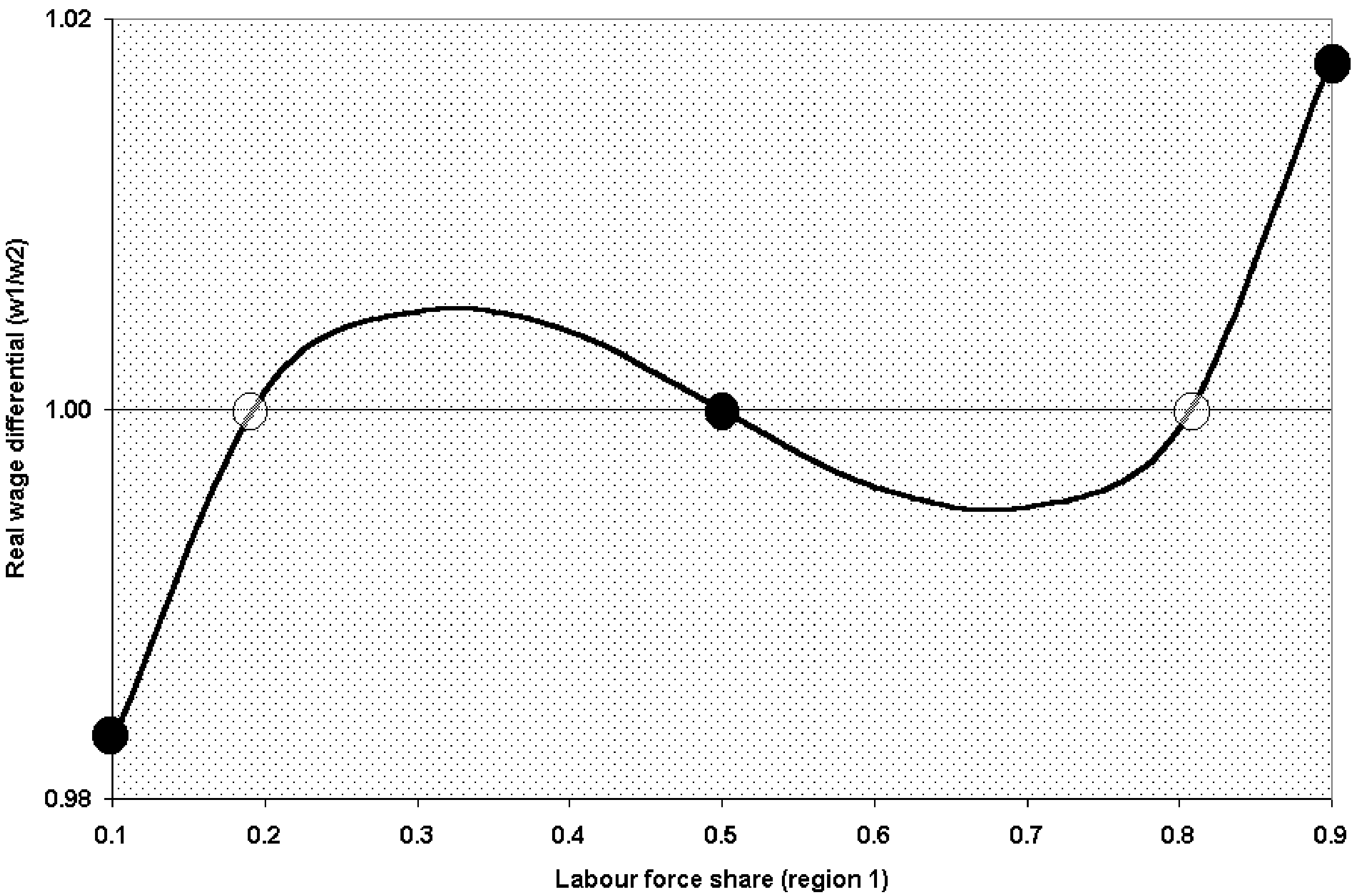

Figure 2c Open economy case: $T_m = 1.75$ **and** $T_e = 1.0$

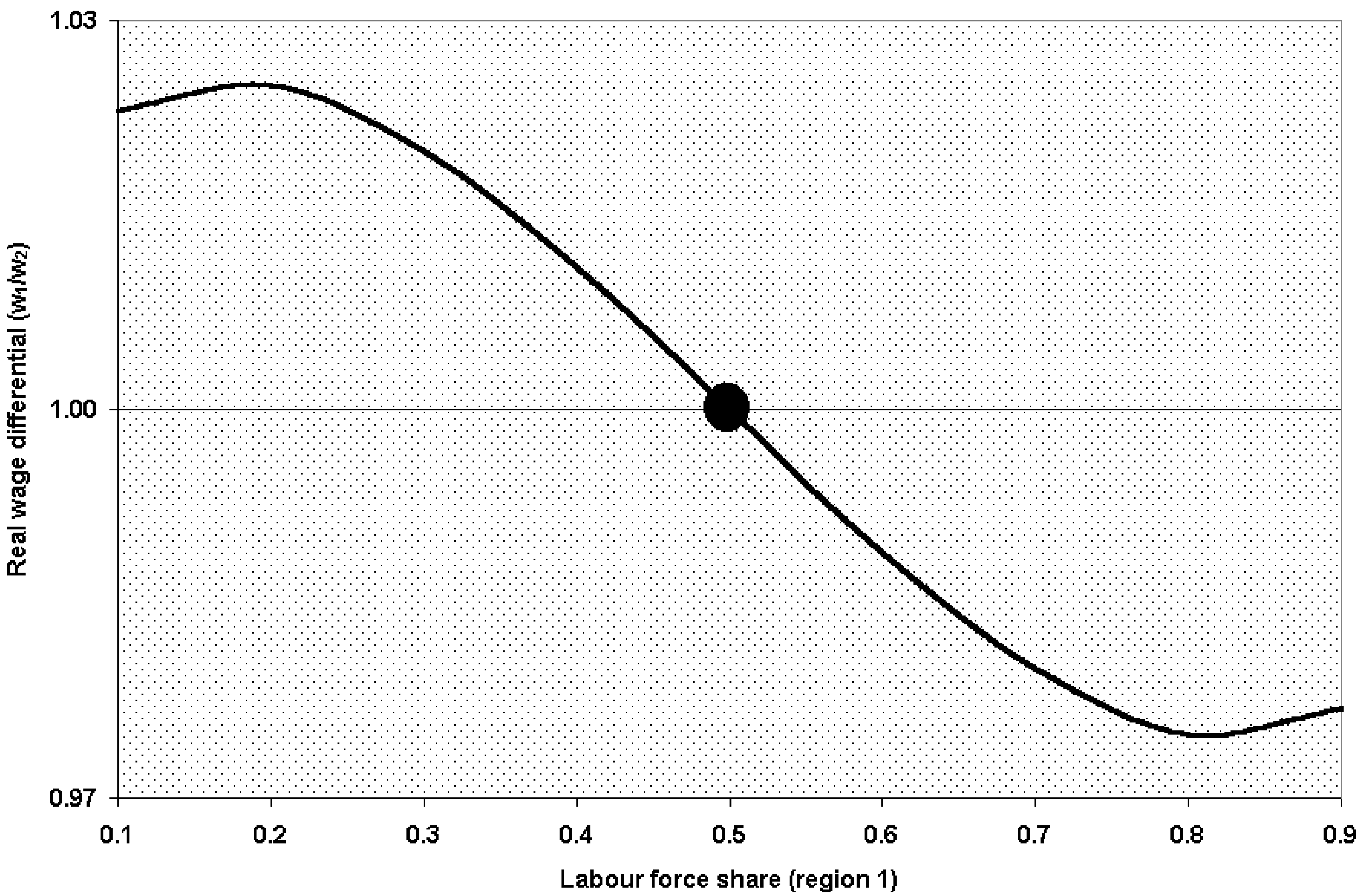

Figure 3a **Open economy with slight export trade cost:** $T_m = 1.75$ **and** $T_e = 1.05$

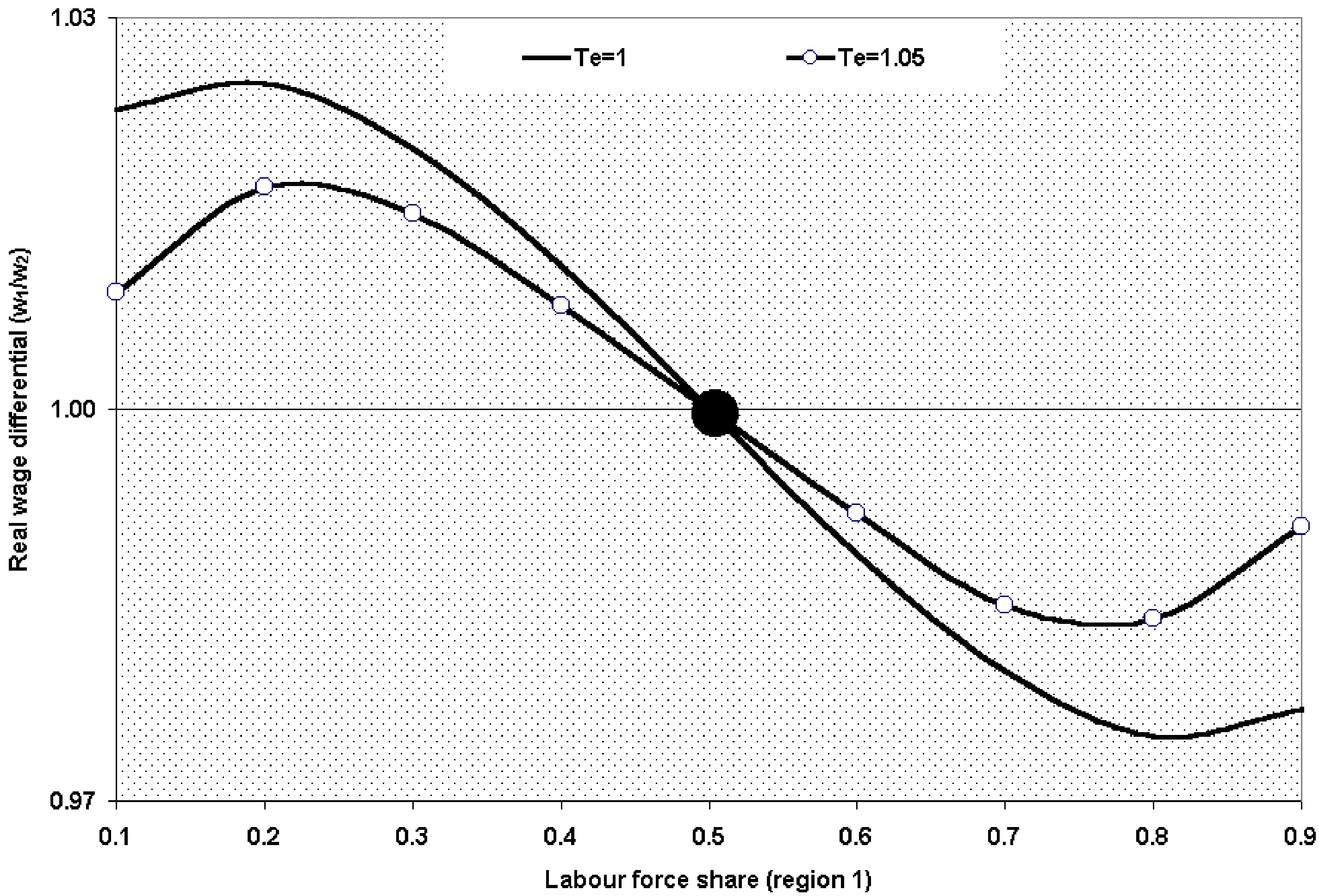

Figure 3b Open economy with moderate export trade cost: $T_m = 1.75$ and $T_e = 1.2$

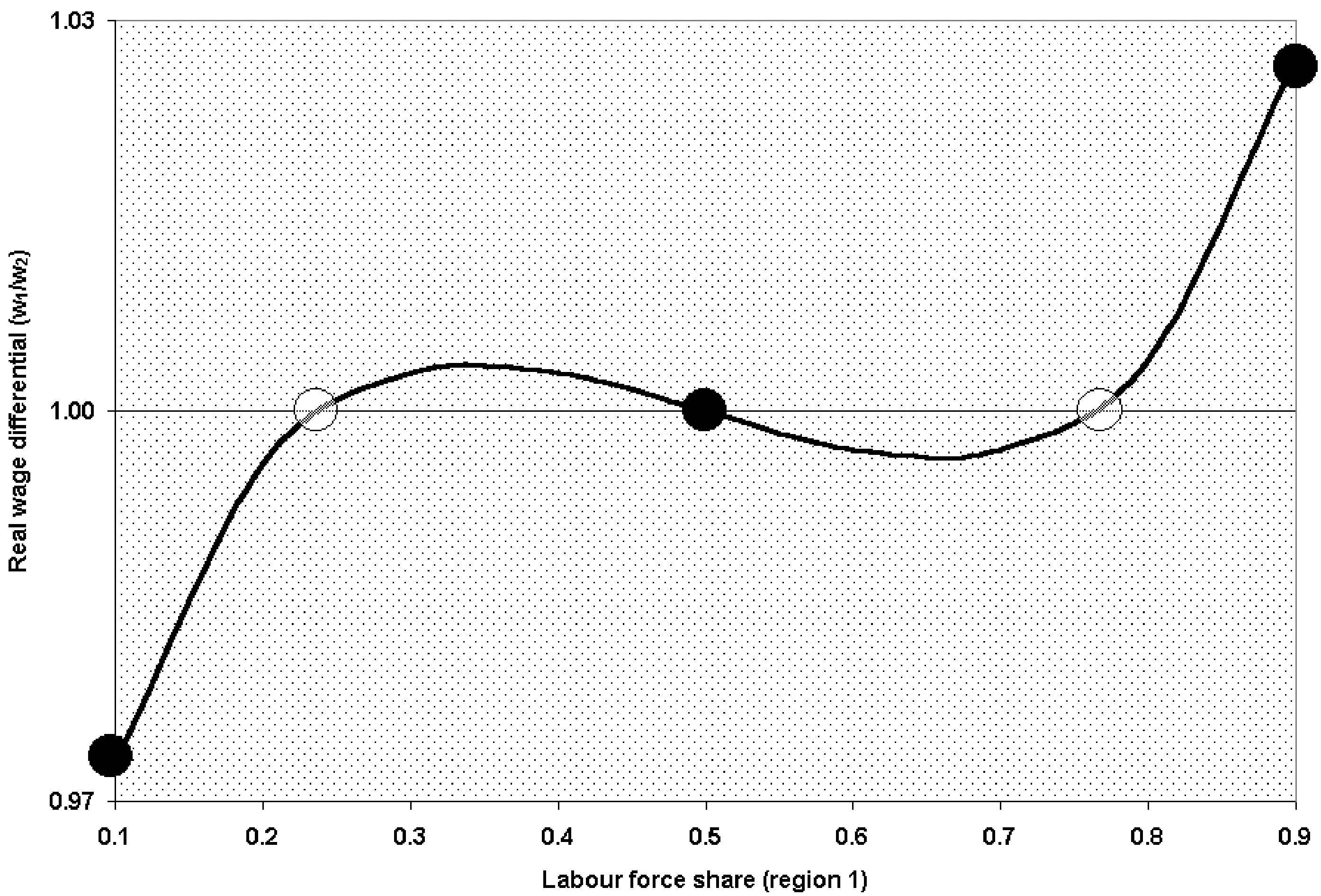

Figure 3c Open economy with high export trade cost: $T_m = 1.75$ and $T_m = 1.30$