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Thede, Susanna

2002

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

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Susanna Thede†

May 27, 2002
JEL Codes: F12, F13
Keywords: New economic geography, endogenous trade policies, agricultural trade costs.

Abstract

This study examines the economic role of trade protection in a new economic geography model where countries have no inherent differences in endowments, preferences or technologies. This is done in two ways. First, the effects of agricultural and manufacturing protection on the set of equilibria are obtained. Second, the endogenous trade policy positions obtained in a game between national welfare-maximising governments are identified. The model used is a Krugman & Venables (1995) model modified to incorporating agricultural trade costs. Therefore, an additional contribution is the examination of the effect of agricultural trade costs on the equilibrium structure of the model.

*Part of this paper was written while visiting the University College Dublin on a Marie Curie fellowship. Foremost, I gratefully acknowledge the valuable comments and suggestions made by Fredrik Andersson. In addition, I thank Hanna Norberg and Peter Neary for discussions on important model features. In acting as discussants on this paper, Rasha Gustavsson and Karin Olofsdotter have provided notable remarks. I also thank Rikard Forslid for his comments. Financial support for this study has been provided by the Tore Browald & Jan Wallander foundation.

†Department of Economics, Lund University, P.O.Box 7082, S-220 07 Lund, Sweden.

1 Introduction

Within the new economic geography framework, trade costs have an important role in determining the international specialisation of production. In fact, the framework provides a setting in which an entirely different production pattern can be triggered by a marginal trade cost alteration. This suggests that there is an important role for trade policy in determining the international production pattern and the international distribution of welfare. Put differently, the new economic geography framework seems to potentially provide economic justifications for the use of trade protection. The motivation for this paper is to explore the economic role of trade protection in a new economic geography setting without inherent country differences in endowments, preferences and technologies. This is done by examining the protection effects on the equilibrium structure and through identifying Nash-equilibria of a trade-policy game between welfare-maximising governments.

The setting used in this paper is a Krugman & Venables (1995) model modified to incorporating trade costs in the homogenous goods sector and country-specific protection levels. The first modification is done in order to examine the role of protection in the homogenous goods sector as well as in the differentiated goods sector. Moreover, as indicated by Davis (1998) and Fujita, Krugman & Venables (1999), the trade cost level in the homogenous goods sector affects the equilibrium structure in a new trade setting and a regional new economic geography setting. If this consequence results in an international new economic geography setting as well, the trade policy effects on the international distribution of industry types are likely to be affected. If so, the welfare consequences of different trade policy positions are also altered, thereby changing the optimal trade policies for a welfare-maximising government. In focusing on unilateral protection effects on the existence of agglomerated equilibria in a new economic geography setting, this study is related to a paper by Puga & Venables (1999), in which one of the questions considered is whether a small agricultural goods producing country can acquire domestic manufacturing production by choice of an appropriate trade-policy position.[1] The main differences in the model used in this paper are that trade partners have identical endowments and that agricultural trade

[1]Puga & Venables (1998) treats the issue of how the formation of a preferential trade agreement affects the structure of equilibria.

costs exist.[2] Moreover, in endogenising the level of protection, this paper is related to Fisher & Serra (1996). While the endogenising tool used in this paper is to interpret the trade-policy positions as strategies in game between national welfare-maximising governments, Fisher & Serra (1996)'s new trade model incorporates a political trade-policy formation structure. In a broad context, this study is related to the strategic trade-policy literature and to the new economic geography strand of research focusing on countries as political units (in examining the effects of taxes on the equilibrium structure).[3]

The rest of this paper is structured as follows. The model is presented in section 2. Section 3 provides an examination of the protection effects on the stability of equilibria. In section 4, the Nash-equilibrium strategies and outcomes in the trade-policy game are identified. A concluding discussion of the main findings of the paper is provided in section 5.

2 The model

There are two countries with identical factor endowments, consumer preferences and production technologies. For simplicity, the labour endowment of each country is normalised to 1. There are two product types, one differentiated product with a market characterised by monopolistic competition and one homogeneous good produced under perfectly competitive market conditions. Henceforth, the differentiated goods production is referred to as manufacturing and the homogenous goods production is referred to as agriculture. There are two input types, labour and intermediate inputs. Labour is mobile between sectors and immobile across country borders. The economic conditions in the home country are presented below. The same conditions prevail in the foreign country, which is depicted by *.

[2] They also use a new economic geography model based on input-output linkages between firms. Their underlying model assumptions differ in four respects. First, the agricultural good is produced with labour and capital. Second, there is a subsistence level of agricultural consumption. Third, different country endowments are allowed for. Fourth, agricultural trade costs are not allowed for.

[3] See Brander (1995) for a survey of the strategic trade-policy literature. Issues regarding the effects of different tax structures on the equilibrium structure in new economic geography settings have been considered by Andersson & Forslid (1999), Baldwin & Krugman (2000), and Kind, Midelfart-Knarvik & Schelderup (2001), amongst others.

The demand side of the model is based on the Dixit-Stiglitz model of monopolistic competition. All agents share identical Cobb-Douglas preferences for the two types of goods:

$$U = M^{\mu} A^{1-\mu}, 0 < \mu < 1, \tag{1}$$

where M is a composite consumption index for varieties of the manufactured good, A is the agricultural consumption, and μ is the manufacturing expenditure share. Consumers share identical preferences for manufacturing varieties. Specifically, the composite manufacturing consumption index takes the form of a symmetric constant-elasticity-of-substitution (CES) function:

$$M = \left[\int_0^{n+n^*} m(i)^{\rho} di \right]^{1/\rho}, \ \rho = \frac{\sigma - 1}{\sigma}, \ \sigma > 1, \tag{2}$$

where $m(i)$ is the consumed quantity of variety i, n is the number (mass) of domestically produced varieties, n^* is the number (mass) of varieties produced in the foreign country, ρ captures the preference for variety and σ is the elasticity of substitution between any two varieties of the manufactured good. In equilibrium, the price index of M equals:

$$G = \left[n p_M^{1-\sigma} + n^* (p_M^* t_M)^{1-\sigma} \right]^{1/(1-\sigma)}, \tag{3}$$

where p_M is the domestic equilibrium price of each variety, p_M^* is the foreign equilibrium price of each variety, and t_M is the total trade cost encountered by manufactured imports from the foreign country. These trade costs take the Samuelson iceberg form, so that a fraction $(t_M - 1)/t_M$ of the imports are lost in the trade transaction. In addition, trade costs include both natural trade costs (in the form of transport costs, language differences etc.) τ_M, and politically induced trade costs (in the form of protection) π_M. The Krugman & Venables (1995) model is modified to allow for unilateral protection. Specifically, the level of natural transaction costs is assumed to be independent of the direction of trade (i.e. $\tau_M = \tau_M^*$), while political trade costs are assumed to be set independently by the governments. The natural trade cost level is at least equal to one while the political trade costs are added to natural trade costs, thereby increasing the share of imports lost in the transaction.

The agricultural good is produced with a constant returns to scale technology with labour as the sole production factor. Combined with the assumptions that the unit labour requirement in agricultural production equals one and that the agricultural goods market is perfectly competitive, this implies that the agricultural wage equals the agricultural goods price. The foreign agricultural good is used as numeraire.

Each variety of the manufacturing good is produced with labour and a composite intermediate input factor. Specifically, the manufacturing production function is a Cobb-Douglas with intermediate input share α. In turn, the intermediate input is a composite variety index identical to that specified by the consumers' preferences (in (2)), implying that the varieties demanded as final goods by consumers are also demanded as intermediate goods by producers. The price of the intermediate input composite therefore equals G, and $w_M^{1-\alpha}G^{\alpha}$ is the input unit cost. This cost is part of the fixed costs as well as the marginal costs in manufacturing production. The total cost function of a representative manufacturing producer equals:

$$TC(q) = w_M^{1-\alpha}G^{\alpha}(f + cq) \tag{4}$$

where f is the fixed input requirement, c is the marginal input requirement, and q is the output level. Since there are fixed setup costs and a constant marginal cost of production, increasing returns to scale exist at the firm level. No additional costs are incurred by a firm choosing to produce a new variety and there is an unlimited number of potential varieties. Since all varieties are demanded, and there is increasing returns to scale at the firm level, this implies that each firm chooses to produce a variety different from all other produced varieties.

There are no strategic interactions between firms. Instead, firms take the price index G as given and thus σ is the perceived elasticity of demand. Profit maximisation implies that marginal revenue equals marginal costs:

$$p_M \frac{(\sigma-1)}{\sigma} = w_M^{1-\alpha} G^{\alpha} c, \; 0 < \alpha < 1. \tag{5}$$

There is free entry and exit into the manufacturing market, implying that a representative firm makes zero profits in equilibrium. For simplicity, units are chosenso that $c = (\sigma - 1)/\sigma$. Combined with the zero profit model implication, this normalisation implies that price of a variety equals the input unit cost in equilibrium. In addition, the fact that a representative manufacturing producer makes zero profits in equilibrium implies that a share $(1-\alpha)$ of the total manufacturing revenues accrues as salaries by manufacturing workers:

$$w_M \lambda_M = (1-\alpha) npq^e, 0 \leq \lambda_M \leq 1, \tag{6}$$

where λ_M is the manufacturing share of the labour force and q^e is the equilibrium output of each variety. For simplicity, units are chosen so that $q^e = 1/(1-\alpha)$. Using this choice of units and (5) in (3), yields:

$$G = \left[\lambda_M w_M^{1-\sigma(1-\alpha)} G^{-\sigma\alpha} + \lambda_M^* w_M^{*1-\sigma(1-\alpha)} G^{*-\sigma\alpha} t_M^{1-\sigma} \right]^{1/(1-\sigma)} \tag{7}$$

where λ_M^* is the manufacturing labour share in the foreign country, w_M^* is the foreign manufacturing wage and G^* is the foreign manufacturing price index. The home country's level of income contains the total domestic labour returns in agricultural and manufacturing production:

$$Y = w_M \lambda_M + w_A (1 - \lambda_M) \tag{8}$$

where w_A is the domestic agricultural wage. Since the share α of total manufacturing revenues is used to purchase the composite intermediate input and μ is the manufacturing consumption share, the total domestic manufacturing expenditure equals:

$$E = \mu Y + \alpha npq^e \tag{9}$$

where the first term is the consumers' manufacturing expenditure and the second term is the producers' manufacturing expenditure. By expressing the second term in the alternative way indicated by (6) and using that q^e equals $1/(1-\alpha)$, (9) can be rewritten as:

$$E = \mu Y + \frac{\alpha}{1-\alpha} w_M \lambda_M. \tag{10}$$

In equilibrium, the output level of a variety equals the total domestic and foreign demand for the variety:

$$q^e = p_M^{-\sigma} G^{\sigma-1} E + p_M^{-\sigma} G^{*\sigma-1} t_M^{*1-\sigma} E^* \tag{11}$$

where t_M^* is the foreign level of manufacturing trade costs, and E^* is the total foreign manufacturing expenditure. Inserting the previously specified normalisations of q^e and c while using the fact that the variety price equals the manufacturing unit input cost yields the following expression:

$$\frac{\left(w_M^{(1-\alpha)} G^{\alpha}\right)^{\sigma}}{1-\alpha} = G^{\sigma-1} E + G^{*\sigma-1} t_M^{*1-\sigma} E^*. \tag{12}$$

An equilibrium is characterised by the domestic equilibrium equations (7),(8),(10),(12) and their foreign counterparts. There are two types of equilibria. Dispersed equilibria are characterised by domestic and foreign manufacturing production while only one country produces the manufacturing good in an agglomerated equilibrium. Henceforth, the dispersed equilibrium characterised by identical variable values in the two countries is referred to as the symmetric equilibrium while the agglomerated equilibrium is referred to as domestic if it is characterised by the domestic specialisation in manufacturing production and as foreign otherwise.

Labour mobility occurs in response to wage differences between sectors. Specifically, workers are assumed to gradually move into the sector providing the highest wage. υ denotes the excess wage to manufacturing labour above that paid to agricultural labour,

$$\upsilon = w_M - w_A. \tag{13}$$

A wage structure is an equilibrium if no worker gains from changing employment. This implies that (13) must equal zero in a stable equilibrium unless the country is completely specialised in the production of one good (i.e. in the case of a corner solution). That is, an equilibrium can incorporate a strictly positive excess manufacturing wage only if the home country is completely specialised in manufacturing production and a strictly negative manufacturing excess wage only if it is completely specialised in agricultural production. This paper is restricted to examining the type of agglomerated equilibria in which the manufacturing sector is sufficiently small for both countries to produce agricultural goods. This restriction, which will henceforth be referred to as "the small-manufacturing-sector condition", is imposed because it enables us to supplement the simulation results with the analytical tools developed by Krugman & Venables (1995) in examining the stability and utility outcomes of agglomerated equilibria.

The Krugman & Venables (1995) model is modified to incorporate agricultural trade costs. Agricultural trade costs are specified in the same way as manufacturing trade costs. Since domestic and foreign agricultural products are perfect substitutes, consumption of domestic and foreign agricultural goods requires that the agricultural import price equals the price of home-produced agricultural products. In combination with the model implication that the agricultural wage equals the agricultural goods price in a country and the assumption that the foreign agricultural good is numeraire, this implies that the following wage condition holds in a dispersed equilibrium characterised by the domestic specialisation in manufacturing production:

$$t_A = w_A \geq 1/t_A^*, \tag{14}$$

where t_A is the domestic agricultural trade cost level, and t_A^* is the foreign agricultural trade cost level. In addition, a stable dispersed equilibrium characterised by the domestic specialisation in agricultural production is instead characterised by the following wage condition:

$$t_A \geq w_A = 1/t_A^*. \tag{15}$$

For agricultural trade to take place in the symmetric equilibrium, the equality conditions in (14) and (15) must hold simultaneously, which is impossible for positive agricultural trade costs. In turn, this indicates that no agricultural trade can take place in the symmetric equilibrium in the presence of agricultural trade costs.

The wage condition required for the domestic agglomerated equilibrium to be stable equals:

$$w_M \geq w_A \geq 1/t_A^*, w_A = t_A, \tag{16}$$

where the domestic manufacturing wage exceeds the domestic agricultural wage only in the case of complete specialisation (which requires the small-manufacturing-sector condition to be valid.

3 Protection effects on the equilibrium structure

In this section, the protection effects on the equilibrium structure are examined with the analytical and simulation tools provided by Krugman & Venables (1995) and Fujita, Krugman & Venables (1999). We follow previous research in the field by assuming that the agglomeration forces are sufficiently weak for the parameter combination $\sigma(1-\alpha)$ to exceed a threshold value of one (alternatively, ρ is assumed to exceed α), or as stated in the literature, the no-black-hole condition is assumed to be valid.[4] This restriction is made in order for the results and outcomes to be comparable to those obtained in the standard new economic geography setting on international trade and is kept throughout the paper. In addition, only the home country's situation is examined since the symmetry of the model implies that corresponding outcomes would be obtained if considering the foreign country's situation.

3.1 The stability of agglomerated equilibria

Since the small-manufacturing-sector condition is valid, a necessary condition for the existence of the domestic agglomerated equilibrium is that $\upsilon^* \leq 0$.

[4] In the absence of agricultural trade costs, the no-black-hole condition implies that only agglomerated equilibria exists at symmetric trade costs.

Combined with the model implication that the agricultural wage equals the agricultural goods price in a country and the assumption that the foreign agricultural good is numeraire, this condition becomes equal to $w_M^* \leq 1$. By using the eight equilibrium equations to solve for the foreign manufacturing wage as a function of exogenous and trade cost variables, the obtained expression can be used to examine the parameter combinations for which the domestic agglomerated equilibrium is stable (a method discussed in detail by Fujita, Krugman & Venables (1999), pp.248-249).

3.1.1 Without agricultural trade costs

If the small-manufacturing-sector condition is valid and a domestic agglomerated equilibrium prevails, the foreign manufacturing wage expression (i.e. the foreign counterpart of (12)) can be rewritten as:[5]

$$w_M^* = t_M^{*-\alpha/(1-\alpha)} \left[\frac{(1-\alpha)}{2} t_M^{*\sigma-1} + \frac{(1+\alpha)}{2} t_M^{1-\sigma} \right]^{1/(\sigma(1-\alpha))} . \qquad (17)$$

The first factor, $t_M^{*-\alpha/(1-\alpha)}$, captures the downward pressure on the foreign manufacturing wage caused by the positive foreign trade cost effect on the foreign intermediate input price. That is, foreign trade costs reduce the wage that a potential foreign manufacturing producer can pay its employed labour by raising the foreign manufacturing price index. The second factor captures the pressure on the foreign manufacturing wage caused by trade cost effects on the overall expenditure placed on a potential foreign manufacturing variety. Trade costs imply that a wedge prevails between the domestic and foreign manufacturing expenditure level as well as between the expenditure placed on home-produced and imported goods. In (17), $\frac{(1-\alpha)}{2}$ and $\frac{(1+\alpha)}{2}$

[5] The expression is derived as follows: First, values characterising this equilibrium is inserted in the equilibrium equations (6),(8),(10),(17) and the foreign counterparts of (6),(8), and (17). Second, these equations are used to solve for Y,Y^*,E,E^*,G,G^* and λ_M expressed in terms of exogenous and trade cost variables. Third, the foreign wage expression is derived by inserting the resulting expressions into the remaining equilibrium equation, the foreign counterpart of (10), and solving for the foreign manufacturing wage. A detailed description of the derivation of the foreign manufacturing wage expression is provided in section 8.1.1.

is the foreign and domestic manufacturing expenditure share, respectively. $t_M^{*\sigma-1}$ and $t_M^{1-\sigma}$ captures the trade cost induced expenditure gap on a foreign manufacturing variety sold in the foreign country and in the home country, respectively. The expression within brackets shows that the expenditure placed on a potential foreign variety is positively affected by the foreign trade cost level and negatively influenced by the domestic trade cost level.

Expression (17) shows that the foreign manufacturing wage is decreasing in the domestic trade cost level, which suggests that domestic protection can give rise to a domestic agglomerated equilibrium. The economic interpretation of this effect is that a higher domestic trade cost level reduces the wage that a potential foreign firm can pay its employed labour since the raised domestic manufacturing import price shifts the domestic demand curve for a foreign manufacturing variety downwards. Calculations of expression (17) for different parameter sets however reveal that the domestic trade cost level influences the existence of a domestic agglomerated equilibrium only when the foreign trade cost level takes values within a very small interval.[6] The use of domestic protection can therefore result in a domestic agglomerated equilibrium only in exceptional cases.

As displayed in expression (17), the foreign trade cost level imposes two counteracting forces on the foreign manufacturing wage. As previously described, a higher foreign trade cost level raises the foreign manufacturing production costs by increasing the import price on intermediate inputs, thereby placing a downward pressure on the wage that a potential foreign firm can pay its employed labour. On the other hand, the raised foreign trade cost level shifts the foreign demand curve for a foreign manufacturing variety upwards by reducing the relative price of home-produced compared to imported manufacturing goods. The net effect is positive if the parameter combination $\sigma(1-\alpha)$ is above a particular threshold that is larger than one in value.[7] However, even if the agglomeration forces are strong enough for the net effect of foreign protection to be negative, the domestic agglomerated equilibrium cannot be dissolved by use of a foreign unilateral trade-liberalising policy since the agglomeration forces are sufficiently strong for the domestic agglomerated equilibrium to be stable at all manufacturing trade cost combinations. (See section 8.5.1.). Examples of the effect of foreign protection

[6] For example, this treshold is at $t_M^* \approx 2$ for the parameter values $\alpha = 0.5$ and $\sigma = 6$.
[7] See section 8.5.1.

on the existence of the domestic agglomerated equilibrium is shown for low, intermediate and high domestic trade cost levels in figure 1.[8]

It can be shown analytically that the foreign country can always dissolve the domestic agglomerated equilibrium by use of a sufficiently high level of protection. Letting the domestic trade cost level approach infinity in expression (16) yields:

$$w_M^* \rightarrow ((1-\alpha)/2)^{1/(\sigma(1-\alpha))} t_M^{*1-1/(\sigma(1-\alpha))}. \tag{18}$$

Since the no-black-hole condition is valid, this expression is increasing in the foreign manufacturing trade cost level. Though the use of infinitely high domestic trade costs places a downward pressure on the foreign manufacturing wage, this effect is not sufficiently strong to ensure the existence of a stable domestic agglomerated equilibrium unless the foreign trade cost level is equal to $t_M^* \approx ((1-\alpha)/2)^{1/(1-\sigma(1-\alpha))}$. The outcome that the agricultural-exporting country can use manufacturing protection to replace the agglomerated equilibrium with an equilibrium characterised by manufacturing production in both countries mirrors the result obtained by Puga & Venables (1999) in their examination of the role of trade policy in promoting industrialisation. In contrast, as described above, their result that the agricultural-exporting country can sometimes become industrialised by use of a unilateral trade liberalising strategy is not obtained. Their result however hinges on the fact that country size differences enhances the manufacturing expenditure gap between markets. Since country sizes are the same in our model, the result that foreign protection cannot trigger a domestic agglomerated equilibrium to develop is not surprising. However, as is shown in the next section, this effect can be altered in the presence of agricultural trade costs.

3.1.2 With agricultural trade costs

If the small-manufacturing-sector condition is valid and a domestic agglomerated equilibrium prevails, the foreign manufacturing wage equals:[9]

[8] We follow Fujita, Krugman & Venables (1999) in using $t_M = 1.5, 2.15$, and 3 as a typical low, intermediate and high trade cost level.

[9] This expression is obtained with the same technique as (17). The main difference in this case is that the domestic equilibrium wage now equals $t_A > 1$ instead of $t_A = 1$,

$$w_M^* = t_A t_M^{*-\alpha/(1-\alpha)} \left[\frac{(1-\alpha)}{(1+t_A)} t_M^{*\sigma-1} + \frac{(t_A+\alpha)}{(1+t_A)} t_M^{1-\sigma} \right]^{1/(\sigma(1-\alpha))}. \quad (19)$$

Expression (19) displays that domestic agricultural trade costs imposes counteracting forces on the foreign manufacturing wage. The first factor, $t_A t_M^{*-\alpha/(1-\alpha)}$, captures the positive effect caused by the fact that the agricultural trade cost level places an upward pressure on the domestic equilibrium wage.[10] The raised domestic equilibrium wage implies higher domestic manufacturing production costs, thereby reducing a manufacturing firm's profitability of remaining located together with other manufacturing producers in the home country. In turn, the wage that a potential foreign firm can pay its employed labour while continuing to break even is therefore higher, the higher the domestic agricultural trade cost level. In (19), $(1-\alpha)/(1+t_A)$ and $(t_A+\alpha)/(1+t_A)$ are the foreign and domestic manufacturing expenditure shares from a manufacturing firm being established in the foreign country. The domestic manufacturing expenditure share is increasing in the domestic level of agricultural trade costs because the raised equilibrium wage places an upward pressure on the domestic income level and thereby on the domestic manufacturing expenditure. In turn, this indicates that the within bracket expression captures the negative domestic agricultural trade cost effect on the foreign relative manufacturing expenditure.[11] Though this implies that the second factor depends negatively on the domestic agricultural trade cost level, the net effect of domestic agricultural trade costs on the foreign manufacturing wage is always positive.[12] In turn, this suggests that the home

implying new equilibrium values of Y,Y^*,E,E^*,G,G^* and λ_M. See section 8.1.2 for a detailed description of the derivation of the foreign manufacturing expression.

[10]Domestic agricultural trade costs implies higher domestic agricultural goods prices, which is accrued as salaries by agricultural workers. In turn, the raised agricultural wage triggers a labour movement into the agricultural sector unless the manufacturing wage is raised to the same level.

[11]Specifically, the derivative of the within brackets expression with respect to the agricultural trade cost level equals $-(1-\alpha)(t_M^{*\sigma-1} - t_M^{1-\sigma})(1+t_A)^{-2}$.

[12]The derivative of the foreign manufacturing wage with respect to the domestic agricultural trade cost level equals:

$\partial w_M^*/\partial t_A = ((\sigma(1-\alpha)(1+t_A^{-1}) - 1)(1-\alpha)t_A^{\sigma(1-\alpha)} t_M^{*\sigma(1-\alpha)-1} + (\sigma + \alpha\sigma + 1 + \sigma t_A + \alpha\sigma t_A^{-1})(1-\alpha)t_A^{\sigma(1-\alpha)} t_M^{1-\sigma} t_M^{*-\alpha\sigma})/(1+t_A)^2$

This expression is positive if $\sigma(1-\alpha)(1+t_A^{-1}) - 1 > 0$ since this yields a positive first term (the second term is always positive). If the no-black-hole condition is valid, country's use of agricultural protection can lead a less specialised equilibrium to replace the domestic agglomerated equilibrium.

The effect of domestic agricultural trade costs on the existence of a domestic agglomerated equilibrium is displayed for symmetric manufacturing trade costs in figure 2. In accordance with the positive effect of the domestic agricultural trade cost level on the foreign manufacturing wage, the figure displays that a higher domestic agricultural trade cost level shifts the foreign manufacturing wage curve upwards. This implies that the agglomerated equilibrium structure can exist only for agricultural trade costs below a threshold level. If the agricultural trade cost level is low enough for an agglomerated equilibrium structure to exist, the presence of agricultural trade costs introduces a lower and upper manufacturing threshold level at which the agglomerated equilibrium becomes stable. These manufacturing threshold levels will henceforth be referred to as *sustain points*. In contrast, only one sustain point exists in the absence of agricultural trade costs. The agricultural trade cost effects on the stability of an agglomerated equilibrium replicates those obtained by Fujita, Krugman & Venables (1999) in the regional new economic geography trade setting.[13]

As previously described, the domestic agricultural trade cost level increases the foreign manufacturing wage at any manufacturing trade cost combination. (Examples of this effect is shown in figure 3 and figure 4.).[14] The fact that agricultural trade costs work counter to agglomeration implies that the domestic agglomerated equilibrium can sometimes be dissolved by a foreign unilateral trade liberalising policy . That is, even if the agglomeration forces are strong enough for the foreign manufacturing trade cost level to affect the foreign manufacturing wage negatively, they may not be strong enough to ensure the existence of an agglomerated equilibrium structure.[15] This result implies that, for certain parameter combinations, the

$\sigma(1-\alpha)(1+t_A^{-1}) > (1+t_A^{-1})$, which implies that $\sigma(1-\alpha)(1+t_A^{-1})-1$ exceeds t_A^{-1}.

[13]In contrast to Davis (1998), calculations of (19) reveal that the $t_A = t_M$ requirement is not sufficient to rule out the existence of asymmetric equilibria in the modified Krugman & Venables (1995) model.

[14]As in the case without agricultural trade costs, calculations of (19) show that the home country can use manufacturing protection to establish the domestic agglomerated equilibrium only in exceptional cases (see figure 3).

[15]See section 8.5.2.

foreign country can replace the domestic agglomerated equilibrium with another equilibrium by reducing its manufacturing protection level (an example of this case is shown in figure 5).[16] When agricultural trade costs exist, the agricultural-exporting country can therefore sometimes use a unilateral trade-liberalising strategy in manufacturing trade to promote industrialisation. This result is in line with that obtained by Puga and Venables (1999), though the effect is caused by agricultural trade costs instead of country size differences in the modified Krugman & Venables (1995) model. However, since the no-black-hole condition is assumed to be valid, the agricultural-exporting country can always dissolve the domestic agglomerated equilibrium by use of a high enough manufacturing protection level. This outcome can be shown analytically by letting the domestic manufacturing trade cost level approach infinity in (19):

$$w_M^* \to t_A((1-\alpha)/(1+t_A))^{1/(\sigma(1-\alpha))} t_M^{*1-1/(\sigma(1-\alpha))}. \tag{20}$$

As previously described, the value approached by the foreign manufacturing wage is increasing in the agricultural trade cost level. Since the no-black-hole condition is valid, (20) is increasing in the foreign manufacturing trade cost level. The foreign manufacturing trade cost level at which the domestic agglomerated equilibrium becomes at infinitely high domestic trade costs is approximately equal to $t_M^* \approx (t_A^{\sigma(1-\alpha)}(1-\alpha)/(1+t_A))^{1/(1-\sigma(1-\alpha))}$.

3.2 The stability of dispersed equilibria

In this section, the effects of protection on the stability of dispersed equilibria are examined. This is done analytically when focusing on the stability of a symmetric equilibrium with respect to the symmetric manufacturing trade cost level. To determine unilateral protection effects on the stability of a dispersed equilibrium, we use a simulation method (developed by Fujita, Krugman & Venables (1999)) that also provides the resulting equilibrium structure.

[16] For foreign manufacturing protection to impose a negative effect on the foreign manufacturing wage, the t_M^* parameter must be sufficiently low and the α, t_M, and t_A parameters high enough. The exogenous and trade cost variable combination characterising a positive and negative trade cost effect, respectively, is provided in section 8.5.2.

The analytical tool used in this subsection is developed by Krugman & Venables (1995).[17] It is based on the fact that the symmetric equilibrium is stable when a marginal labour movement between sectors does not raise the relative wage in the receiving sector. A $dv/d\lambda_M$ expression is therefore calculated in terms of exogenous and trade cost variables by totally differentiating the eight equilibrium equations with respect to $Y, Y^*, E, E^*, G, G^*, w_M$, and w_M^*, using a symmetric perturbation of the equilibrium, and exchanging these endogenous variable values for their exogenous and trade cost variable expressions.

The simulation results in this section are based on frequent simulations in the $1.01 \leq t_M^*, t_M^* \leq 10$ manufacturing trade cost interval, the $0.1 \leq \mu \leq 0.5$ manufacturing expenditure share interval, the $0.1 \leq \alpha \leq 0.9$ intermediate input share interval and the $2 \leq \sigma \leq 7$ elasticity of substitution interval. In addition, the agricultural trade cost interval used in section 3.2.2. is $1.01 \leq t_A \leq 5$.

The protection effect on the equilibrium structure is obtained by simulating the (λ_M, λ_M^*) combination resulting for domestic and foreign equilibria, respectively, at a given exogenous and trade cost parameter set. Specifically, domestic equilibrium values are obtained by solving the equation system when allowing the foreign manufacturing wage to deviate from its equilibrium value. In turn, a domestic equilibrium curve is simulated by iterating this procedure when gradually altering the domestic (or foreign) manufacturing employment share. A dispersed equilibrium is obtained at the intersection of the two curves, a domestic agglomerated equilibrium can occur at the point where the domestic equilibrium curve intersects the λ_M^* - axis and a foreign agglomerated equilibrium can prevail at the intersection point of the foreign equilibrium curve and the λ_M - axis. As previously described, wage differentials within countries leads labour to move into the sector providing the highest wage and thereby determines the direction of the (λ_M, λ_M^*) movement. Above a country's equilibrium curve, the agricultural wage exceeds the manufacturing wage. This wage gap places a downward pressure on the manufacturing labour share as labour moves into the agricultural sector. Below a country's equilibrium curve, the manufacturing wage instead exceeds

[17] See section 8.2.1 and section 8.2.2. for a detailed description of how the stability conditions for the symmetric equilibrium is obtained in the absence and presence of agricultural trade costs, respectively.

the agricultural wage. This wage differential triggers a labour movement into the manufacturing sector, thereby raising the country's manufacturing labour share. In accordance, a domestic agglomerated equilibrium exists only if the domestic equilibrium curve's intersection with the λ_M-axis exceeds its intersection with the foreign equilibrium curve while a foreign agglomerated equilibrium prevails only if the foreign equilibrium curve. An equilibrium is stable if the domestic and foreign manufacturing labour shares converges to the equilibrium point when placed in its neighbourhood.

3.2.1 Without agricultural trade costs

The symmetric equilibrium is stable for symmetric manufacturing trade cost levels up to a threshold level when the no-black-hole condition is valid.[18] This threshold level, which is called the *break point* in the literature, is equal to:

$$t_{M,BP} = \left[\frac{(1+\alpha)(\sigma(1+\alpha)-1)}{(1-\alpha)(\sigma(1-\alpha)-1)}\right]^{1/(\sigma-1)}, \ t_M = t_M^*, \tag{21}$$

where $t_{M,BP}$ denotes the break point. Expression (21) is increasing in α and decreasing in σ, thereby implying that stronger agglomeration forces increases the threshold trade cost level at which the symmetric equilibrium is stabilised.[19]

Simulation results show that a country's use of protection leads to an outward shift of the country's equilibrium curve if the common level of domestic and foreign manufacturing trade costs are beneath a very high threshold level. This threshold level will henceforth be referred to as the *non-affected point.*[20] If the common part of the domestic and foreign trade cost level

[18] See section 8.2.1.

[19] As shown in the previous section, the agglomerated equilibrium is stable at symmetric trade cost levels beneath the sustain point. In combination with the symmetric equilibrium stability outcome reported above, this implies that the equilibrium structure prevailing at symmetric trade cost levels are characterised by stable agglomerated equilibria up to the sustain point and stable symmetric equilibria above the break point. In addition, simulation results reveal that the sustain point always exceeds the break point.

[20] For example, if $t_{M,C}$ denotes the common manufacturing trade cost level, the non-affected point is at $t_{M,C} \approx 10$ for the parameter values $\alpha = 0.5, \mu = 0.4$ and $\sigma = 5$.

exceeds the non-affected point, a domestic unilateral protectionist strategy does not affect the domestic equilibrium curve and therefore does not influence the (existence or) stability of the symmetric equilibrium. That is, in this case the symmetric equilibrium remains stable even when the domestic and foreign protection levels differ. The economic intuition behind this result is that the additional demand gain incurred for domestic manufacturing producers from using a higher protection level than the foreign country becomes negligible at a high enough common trade cost level. If the common trade cost level is beneath the non-affected point, a higher domestic than foreign protection level leads the symmetric equilibrium to be replaced by an asymmetric equilibrium characterised by the domestic specialisation in manufacturing production.

The simulation results also reveal that there is a threshold level of common manufacturing trade costs (between the break and sustain point) at which the home country no longer can prevent all equilibria except the domestic agglomerated equilibrium from being established by use of a high enough protection level (at a given trade policy position of the trade partner).[21] This threshold level will henceforth be referred to as the *non-triggered agglomeration point*. At common trade cost levels in the interval between the non-triggered agglomeration point and the sustain point, the simulation results reveal that the equilibrium structure resulting from a domestic relatively protectionist strategy contains at least two stable equilibria. That is, if the domestic strategy involves a high enough protection level to dissolve the foreign agglomerated equilibrium as well as the symmetric equilibrium, the stable equilibrium structure incorporates a domestic agglomerated equilibrium and a dispersed asymmetric equilibrium. For common manufacturing trade cost levels in the sustain and non-affected point interval, the unilateral use of protection implies that the dispersed asymmetric equilibrium becomes the only stable equilibrium (a case shown in figure 7).

3.2.2 With agricultural trade costs

The presence of agricultural trade costs stabilises the symmetric equilibrium at all symmetric manufacturing trade cost levels.[22] That is, the excess man-

[21] For example, this treshold is at $t_{M,C} \approx 2.1$ at parameter values $\alpha = 0.5, \mu = 0.4$ and $\sigma = 5$.

[22] This effect can be seen by comparing figure 9 and figure 10, in which the equilibrium structure at low symmetric manufacturing trade costs is displayed when low agricultural

ufacturing wage is decreasing in the manufacturing labour share in a country at all symmetric manufacturing trade cost levels.[23] This result replicates that obtained by Fujita, Krugman & Venables (1999) in a regional new economic geography setting. In the Krugman & Venables (1995) setting, the economic intuition behind this result is that the relocation of one firm triggers an agricultural wage increase in the receiver country, thereby placing an upward pressure on the manufacturing wage and the manufacturing input unit cost in the country. In detail, the additional manufacturing production results in a declining agricultural sector in the receiver country. This triggers agricultural imports which, due to agricultural trade costs and the perfect substitutability between domestic and foreign agricultural goods, increases the agricultural goods price in the country. In turn, this price increase is accrued as salaries by labour employed in the agricultural sector. The relocation of a single firm also introduces a downward pressure on the price index in its new location (as displayed by the larger weight placed on domestic varieties in (3) for $t_M > 1$). However, due to our Dixit-Stiglitz assumption of a large mass of firms, this effect is negligible.

The introduction of agricultural trade costs alters the effect of unilateral manufacturing protection on the stability of the symmetric equilibrium. First, the simulation results show that an asymmetric equilibrium is triggered by the unilateral use of manufacturing protection at all common manufacturing trade costs levels. The economic intuition behind this result is that an additional demand gain is triggered if agricultural trade costs exist in addition to the negligible effect triggered by the manufacturing trade cost differential at high enough common manufacturing trade costs. In turn, this demand gain is caused by the fact that agricultural trade costs raise the manufacturing expenditure in the agricultural-importing country.[24] Due to manufacturing trade costs, this leads to a larger upward shift in the demand curves for home-produced compared to imported manufacturing varieties.

trade costs does and does not exist, respectively.

[23] This outcome is shown in section 8.2.2.

[24] Specifically, agricultural trade costs raise the agricultural goods price in the country, thereby increasing the country's agricultural wage. In turn, this implies that the manufacturing wage must be raised to the equivalence of the agricultural wage if the new asymmetric equilibrium is to be a stable equilibrium. The raised equilibrium wage leads to an increase in the country's income and thereby in the country's manufacturing expenditure.

The simulation results reveal that the level of agricultural trade costs places a restriction on the degree of specialisation that can be obtained by the use of a unilateral protectionist strategy in manufacturing trade. Expressed differently, the use of agricultural protection has a destabilising effect on equilibria characterised by a sufficiently high own manufacturing production share. In fact, at a high enough domestic agricultural trade cost level, an equilibrium characterised by the home country specialisation in manufacturing production can exist only if located in the neighbourhood of the symmetric equilibrium.[25] In addition, the simulation results show that the non-triggered agglomeration point is decreasing in the symmetric agricultural trade cost level up to a threshold point at which it vanishes.[26] This result can be explained by the fact that the agricultural trade cost level decreases the incentive for manufacturing firms to cluster together in the same location (as explained in detail in section 3.1.2.).

4 Endogenous protection levels

In this section, the trade-policy positions of the governments are assumed to be used as strategies in a game between welfare-maximising governments. The Nash-equilibria are identified from utility level expressions specified as functions of exogenous and trade cost parameters obtained for symmetric and agglomerated equilibria and from simulated estimates obtained for dispersed asymmetric equilibria. The simulation results are based on the sample used in the previous section. The national welfare level is defined as the utility level of a domestic representative individual, which equals:[27]

$$u = w_A^{\mu} G_M^{-\mu}, w_A = w_M \tag{22}$$

[25]For example, at the parameter set $\alpha = 0.5, \sigma = 3, t_M = 4, t_M^* = 2$, the only stable equilibrium is characterised by $(\lambda_M, \lambda_M^*) = (0.402, 0.399)$ at agricultural trade cost levels above $t_A = t_A^* = 2$.

[26]For example, when the symmetric agricultural trade cost level is increased from $t_A = 1.2$ to $t_A = 1.6$ at the parameter values $\alpha = 0.5$, $\mu = 0.4$ and $\sigma = 5$, the non-triggered agglomeration point is reduced from $t_{M,C} \approx 1.7$ to $t_{M,C} \approx 1.2$. In addition, at the symmetric agricultural trade cost level $t_A \approx 1.8$, the non-triggered agglomeration point vanishes.

[27]In addition, this utility level equals the real income level of a domestic representative individual. And, since the domestic labour force is normalised to one, it equals the country's real income level.

The domestic utility level is directly and indirectly influenced by the domestic and foreign trade-policy positions. That is, trade protection imposes a direct effect on the domestic wage and manufacturing price index obtained in each equilibrium but also affects these values indirectly by influencing the set of stable equilibria.

4.1 Without agricultural trade costs

The utility of a representative individual in the home country, u, equals:[28]

$$u_{AE} = (2\mu)^{-\mu/(1-\sigma+\alpha\sigma)} \tag{23}$$

$$u_{SE} = (\mu(1 + t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} \tag{24}$$

$$u_{AE^*} = t_M^{-\mu}(2\mu)^{-\mu/(1-\sigma+\alpha\sigma)} \tag{25}$$

where u_{AE}, u_{SE} and u_{AE^*} is the domestic utility level obtained in the domestic agglomerated equilibrium, in the symmetric equilibrium, and in the foreign agglomerated equilibrium, respectively. Other things equal, u_{AE} is at least as large as u_{SE} and u_{AE^*} since the no-black-hole condition is assumed to be valid and $t_M^{-\mu}, t_M^{1-\sigma} \leq 1$ (with a strictly positive utility difference in the presence of manufacturing trade costs). In addition, by combining the (24) and (25) expressions, it can be shown that the domestic utility level is at least as high in the symmetric equilibrium as in the foreign agglomerated equilibrium when the parameter condition $t_M^{1-\sigma}(2t_M^{\alpha\sigma} - 1) \leq 1$ holds.[29]

Proposition 1 *The trade-policy equilibrium cannot generate an agglomerated equilibrium.*

[28] The utility expressions are derived in section 8.4.1.

[29] $u_{SE} > u_{AE^*}$ is equivalent to $(\mu(1 + t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} > t_M^{-\mu}(2\mu)^{-\mu/(1-\sigma+\alpha\sigma)}$. This expression can be rewritten as $t_M^{1-\sigma}(2^{\alpha\sigma} - 1) < 1$ in the following steps. $(1 + t_M^{1-\sigma})^{-\mu/(1-\sigma+\alpha\sigma)} > t_M^{-\mu}2^{-\mu/(1-\sigma+\alpha\sigma)}$; $1 + t_M^{1-\sigma} > 2t_M^{1-\sigma+\alpha\sigma}$; $1 > 2t_M^{1-\sigma+\alpha\sigma} - t_M^{1-\sigma}$; and $t_M^{1-\sigma}(2t_M^{\alpha\sigma} - 1) < 1$.

The home country gains from dissolving the foreign agglomerated equilibrium and can do so by implementing a high enough protection level (given the foreign level of protection). This outcome is obtained regardless of whether the strategy is resulting in a dispersed asymmetric equilibrium or in a domestic agglomerated equilibrium. As described above, the domestic utility level in the domestic agglomerated equilibrium exceeds that obtained in the foreign agglomerated equilibrium. In addition, simulation results show that the domestic utility level is raised if the dispersed asymmetric equilibrium is established.[30] Due to the symmetry of the model, the result that the home country always gains from dissolving the foreign agglomerated equilibrium implies that the corresponding result is obtained for the foreign country in the domestic agglomerated equilibrium. This implies that the outcome of the trade-policy game never can incorporate an agglomerated equilibrium structure. The proposition is thereby validated.

Proposition 2 *The trade -policy equilibrium can generate a symmetric equilibrium.*

Simulation results reveal that the domestic utility level is unaffected by the unilateral use of protection above the non-affected point, thereby implying that symmetric equilibria above the non-affected point can result from the trade policy game.[31] That is, the proposition is validated.

As described in the previous section, if the home country uses a sufficiently high level of protection for the foreign agglomerated equilibrium as well as the symmetric equilibrium to be dissolved, a stable domestic agglomerated equilibrium or a stable dispersed asymmetric equilibrium is established. As shown above, the domestic utility level obtained in the domestic agglomerated equilibrium exceeds that obtained in the symmetric equilibrium. In

[30]Examples of this result is provided in the table below (where u_{DE} is the domestic utility level in the dispersed asymmetric equilibrium and the subscripts denote utility values yielded in the initial equilibrium (0) and in the two stable equilibria introduced by the destabilising domestic strategy (1)).

μ	α	σ	t_M^*	$t_{M,0}$	$t_{M,1}$	$u_{AE^*,0}$	$u_{DE,1}$	$u_{AE,1}$
0.4	0.5	5	2.1	2.1	2.2	0.700	0.825	0.942
0.4	0.5	4	3	3	4	0.589	0.714	0.915

[31]Specifically, this implies that a zero utility difference is verified at the 4-digit level. In principle, there may therefore be a strict utility difference above this point. However, even if the utility difference asymptotically is approaching zero, the symmetric equilibrium is a trade-policy outcome in the presence of infinitely small costs of using protection.

addition, simulation results show that the domestic utility level is raised if the dispersed asymmetric equilibrium is established. Moreover, this result is obtained regardless of whether the parameter restriction $t_M^{1-\sigma}(2t_M^{\alpha\sigma}-1)\leq 1$ is valid or not.[32] This implies that the home country always gains from dissolving the symmetric equilibrium. However, as previously described, it can do so only for common domestic and foreign trade cost levels beneath the non-affected point. This implies that only symmetric equilibria above the non-affected point can result from the trade-policy game. If denoting the non-affected point $t_{M,NA}$, the Nash-equilibrium strategy combination is $(\pi_M,\pi_M^*)=(t_{M,NA}-\tau_M,t_{M,NA}^*-\tau_M^*)$ and the Nash-equilibrium outcome is $(u,u^*)=((\mu(1+t_{M,NA}^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)},(\mu(1+t_{M,NA}^{*1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)})$ for natural trade costs levels below the non-affected point. For natural trade cost levels above the non-affected point, the Nash-equilibrium strategies are instead free-trade policy positions with the corresponding Nash-equilibrium outcome $(u,u^*)=((\mu(1+\tau_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)},(\mu(1+\tau_M^{*1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)})$.

4.2 With agricultural trade costs

The results obtained in this section relies on the assumption that the natural agricultural trade cost level is sufficiently low not to inhibit the existence of an agglomerated equilibrium structure.[33] Specifically, this implies that the parameter condition $t_A < t_M^{\sigma-1}$must be valid when trade costs are symmetric.[34] The utility level of a domestic representative individual is equal to:[35]

[32] Examples of this result is shown in the table below (where u_{DE} is the domestic utility level in the dispersed asymmetric equilibrium and the subscripts denote utility values obtained in the initial equilibrium (0) and in the equilibria obtained after using the domestic destabilising strategy (1)).

μ	α	σ	t_M^*	$t_{M,1}$	$t_{M,1}$	$u_{SE,0}$	$u_{DE,1}$	$u_{AE,1}$
0.4	0.5	5	2.1	2.1	2.2	0.794	0.825	0.942
0.4	0.5	4	3	3	4	0.703	0.714	0.915

[33] Otherwise, the level of agricultural trade costs places a boundary on the degree of specialisation that can be obtained from the unilateral use of manufacturing protection. In fact, at sufficiently high agricultural trade cost levels, only the symmetric equilibrium and equilibrium in its neighbourhood are stable (see section 3.2.1).

[34] That the agglomerated equilibrium cannot exist at agricultural trade costs $t_A \geq t_M^{\sigma-1}$ is shown in section 8.6.

[35] The utility expressions are derived in section 8.4.2.

$$u_{AE}=\left(\frac{\mu\left(1+t_A\right)}{t_A}\right)^{-\mu/(1-\sigma+\alpha\sigma)} \tag{26}$$

$$u_{SE}=(\mu(1+t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} \tag{27}$$

$$u_{AE^*}=t_A^{*-\mu}t_M^{-\mu}\left(\frac{\mu\left(1+t_A^*\right)}{t_A^*}\right)^{-\mu/(1-\sigma+\alpha\sigma)} \tag{28}$$

where u_{AE}, u_{SE} and u_{AE^*} is the domestic utility level in the domestic agglomerated equilibrium, in the symmetric equilibrium and in the foreign agglomerated equilibrium, respectively. In the domestic agglomerated equilibrium, it is optimal for the home country to use an agricultural free-trade policy since the domestic utility level is decreasing in the level of domestic agricultural trade costs.[36] Due to the symmetry of the model, it is also optimal for the foreign country to use an agricultural free-trade policy in the foreign agglomerated equilibrium. The domestic agricultural trade cost level in (26) and the foreign agricultural trade cost level in (28) are therefore equal to the natural level of agricultural trade costs. In turn, this implies that the domestic utility level is at least as high in the domestic agglomerated equilibrium as in the foreign agglomerated equilibrium since the no-black-hole condition is assumed to be valid and $t_A^{*-\mu}t_M^{-\mu} \leq 1$ (with a strictly positive utility difference if agricultural and/or manufacturing trade costs exist). In addition, by combining the (27) and (28) expressions while taking into account that $t_A^* < t_M^{\sigma-1}$, it can be shown that the domestic utility level in the symmetric equilibrium is at least as high as in the foreign agglomerated equilibrium.[37] In turn, the parameter restriction $t_A < t_M^{\sigma-1}$ implies that the

[36] As described in the previous section, a reduction in the domestic agricultural trade cost level lowers the forces working counter to agglomeration.

[37] $u_{SE} > u_{AE^*}$ is equivalent to $(\mu(1+t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} > t_A^{*-\mu}t_M^{-\mu}\left(\frac{\mu(1+t_A^*)}{t_A^*}\right)^{-\mu/(1-\sigma+\alpha\sigma)}$.In turn, this expression is equal to $(\mu(1+t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} > \left((t_A^*t_M)^{(1-\sigma+\alpha\sigma)}\frac{\mu(1+t_A^*)}{t_A^*}\right)^{-\mu/(1-\sigma+\alpha\sigma)}$, which can be rewritten into $(1+t_M^{1-\sigma})t_M^{-(1-\sigma+\alpha\sigma)} > t_A^{*-\sigma+\alpha\sigma}(1+t_A^*)$. This condition is valid since the parameter condition $t_A^* < t_M$ holds and the parameter expression $(1+t_M^{1-\sigma})t_M^{-(1-\sigma+\alpha\sigma)} > t_M{}^{-\sigma(\sigma-1)(1-\alpha)}(1+t_M{}^{\sigma-1})$ is valid. Rearranging the terms in this expression yields $(t_M^{\sigma^2(1-\alpha)-1}+t_M{}^{\sigma(1-\alpha)-1})/(1+t_M^{\sigma-1}) > 1$.This expression is always valid since $\sigma^2(1-\alpha)-1 > \sigma-1$ and $\sigma(1-\alpha)-1 > 0$.

domestic utility level is at least as high in the domestic agglomerated equilibrium as in the symmetric equilibrium.[38] To sum up, the domestic utility ranking of equilibria equals $u_{AE} \geq u_{SE} \geq u_{AE^*}$.

Proposition 3 *The trade-policy equilibrium cannot generate an agglomerated equilibrium.*

The home country always gains from dissolving the foreign agglomerated equilibrium. This result prevails regardless of whether the resulting stable equilibrium is a dispersed asymmetric equilibrium or a domestic agglomerated equilibrium.[39] As described above, the domestic utility level is higher in the domestic agglomerated equilibrium than in the foreign agglomerated equilibrium in the presence of domestic manufacturing trade costs. In addition, simulation results reveal that the home country gains from using a strategy that replaces the foreign agglomerated equilibrium even if a stable dispersed asymmetric equilibrium is established instead. Due to the symmetry of the model, the same outcomes are obtained for the foreign country in the corresponding foreign situations. The proposition is therefore validated.

Proposition 4 *The trade-policy equilibrium can generate a symmetric equilibrium.*

Simulation results reveal that a country loses from dissolving the symmetric equilibrium if a stable dispersed asymmetric equilibrium is established.[40] Due to a gradual labour movement between sectors, this result implies that

[38] $u_{SE} \leq u_{AE}$ is equivalent to $(\mu(1+t_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)} \leq \left(\frac{\mu(1+t_A)}{t_A}\right)^{-\mu/(1-\sigma+\alpha\sigma)}$. In turn, this expression equals $1+t_M^{1-\sigma} \leq 1+t_A^{-1}$, which can be rearranged into the parameter condition
$t_A \leq t_M^{\sigma-1}$.

[39] For example, in the foreign agglomerated equilibrium prevailing at the parameter values $\mu = 0.4, \alpha = 0.5, \sigma = 4, t_A = t_A^* = 1.2$ and $t_M = t_M^* = 2$, the home country's use of a destabilising policy equivalent to a 1.1 increase in the domestic protection level can raise the domestic utility level from 0.622 to 0.712 if a dispersed asymmetric equilibrium is introduced and to 0.883 if a domestic agglomerated equilibrium is established.

[40] For example, if the home country destabilises the symmetric equilibrium prevailing at the parameter values $\mu = 0.4, \alpha = 0.5, \sigma = 4, t_A = t_A^* = 1.2$ and $t_M^* = 1.5$,by raising the domestic manufacturing protection level with 0.1, the domestic utility level is reduced from $u = 0.769$ to $u = 0.761$ if a stable dispersed asymmetric equilibrium is established.

no country wants to destabilise the symmetric equilibrium above the non-triggered agglomeration point even if using a high enough manufacturing protection level to ensure that the agglomerated equilibrium in the other country cant exist. That is, the proposition is validated.

Since the domestic utility level is higher in the domestic agglomerated equilibrium than in the symmetric equilibrium, the home country gains from dissolving the symmetric equilibrium if it can ensure that a domestic agglomerated equilibrium is established (given the foreign level of protection). Due to the symmetry of the model, this outcome also implies that the foreign country gains from using the same strategy in the corresponding foreign situation. Accordingly, symmetric equilibria at manufacturing trade cost levels up to the non-triggered agglomeration point cannot result from the trade-policy game. Combined with the outcome obtained for manufacturing trade cost levels above the non-triggered agglomeration point, this implies that the optimal manufacturing strategy in a symmetric equilibrium is protectionist at natural manufacturing trade cost levels below the non-triggered agglomeration point and a free-trade policy stand otherwise. In addition, a protectionist manufacturing strategy is always combined with an agricultural free-trade policy since an agricultural-importing country's utility level is decreasing in its agricultural trade cost level. If denoting the non-triggered agglomeration point $t_{M,NTA}$ and the sustain point $t_{M,SUP}$, the Nash-equilibrium strategy combination in symmetric equilibria at natural manufacturing trade costs below the sustain point are symmetric and equal to $((\pi_A, \pi_M), (\pi_A^*, \pi_M^*)) = ((0, t_{M,Z} - \tau_M), (0, t_{M,Z}^* - \tau_M^*))$, where $Z = Z^*, Z, Z^* \in [t_{M,NTA}, t_{M,SUP}]$. Specifically, the Nash-equilibrium strategies depends on the equilibrium structure incurred from using manufacturing protection in the non-triggered agglomeration point and sustain point interval. That is, no country gains from breaking a symmetric equilibrium at a common manufacturing trade cost level within this interval while the agricultural-exporting country gains from dissolving an agglomerated equilibrium in the interval. For natural manufacturing trade cost levels below the sustain point, the resulting Nash-equilibrium outcome is $(u, u^*) = ((\mu(1 + t_{M,Z}^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)}, (\mu(1 + t_{M,Z}^{*1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)})$. In equilibria at natural manufacturing trade costs exceeding the sustain point, the Nash-equilibrium strategies are $((\pi_A, \pi_M), (\pi_A^*, \pi_M^*)) = ((x, 0), (x^*, 0))$, where $x, x^* \in [0, \infty]$. In turn, this strategy combination yields a Nash-equilibrium outcome equal to $(u, u^*) = ((\mu(1 + \tau_M^{1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)}, (\mu(1 + \tau_M^{*1-\sigma}))^{-\mu/(1-\sigma+\alpha\sigma)})$.

5 Concluding Discussion

This study examines the economic role of trade protection in a new economic geography model where countries have no inherent differences in endowments, preferences or technologies. The specific purpose of this paper is twofold. One purpose is to examine the country-specific protection effects on the equilibrium structure in an international new economic geography setting. The other is to use this setting to identify the Nash-equilibria in a trade-policy game between welfare-maximising governments. The model used is a Krugman & Venables (1995) model modified to incorporating agricultural trade costs. An additional contribution is therefore that this paper provides the equilibrium structure effects from allowing for agricultural trade costs in an international new economic geography model. In this context, it supplements the results obtained by Davis (1998) in a new trade model and Fujita, Krugman & Venables (1999, pp.111-114) in a regional new economic geography model. In fact, the outcomes obtained at symmetric trade costs replicates those obtained by Fujita, Krugman & Venables (1999). First, it is shown that the existence of agricultural trade costs stabilises the symmetric equilibrium at all manufacturing trade cost levels while reducing the manufacturing trade cost interval at which an agglomerated equilibrium structure exists. Second, this manufacturing trade cost interval is decreasing in the agricultural trade cost level and becomes at the threshold point.[41]

At any domestic and foreign manufacturing trade cost combination, the presence of agricultural trade costs is shown to be a stabilising force working against agglomeration. Furthermore, simulation results reveal that the agricultural trade cost level places a boundary on the extent of international specialisation that can prevail in equilibrium. In fact, at a sufficiently high agricultural trade cost level, the only asymmetric equilibria that can exist are located in the neighbourhood of the symmetric equilibrium. The economic intuition behind the fact that agricultural trade costs work counter to agglomeration is that the agricultural trade cost level raises the agricultural goods price in the country specialised in manufacturing production, thereby placing an upward pressure on the labour return and the manufacturing pro-

[41] An agglomerated equilibrium structure cannot exist at symmetric trade costs if $t_A \geq t_M^{\sigma-1}$, where t_A equals the agricultural trade cost level, t_M equals the manufacturing trade cost level and σ is the elasticity of substitution between manufacturing varieties.

duction costs of a representative firm in the country.[42] In turn, this implies that an agricultural-importing country can use agricultural protection to dissolve any asymmetric equilibrium outside the neighbourhood of the symmetric equilibrium. Moreover, this strategy is independent of the trade partner's agricultural trade-policy position. However, the agricultural-importing country always loses from using a protectionist position in agricultural trade. A country therefore always implements an agricultural free-trade position in equilibria characterised by the own specialisation in manufacturing production.

Providing that the common domestic and foreign manufacturing trade cost level is not too high, a unilateral protectionist position in manufacturing trade can be used to dissolve all types of equilibria except the own agglomerated equilibrium. This is the result of that the triggered trade cost differential increases the relative market size of the protectionist country, thereby yielding a demand advantage for a representative firm located in this country. This implies that a short-run excess profit is incurred by manufacturing producers in the protectionist country, which leads an international relocation of manufacturing production to take place until manufacturing producers in both countries break even.

Since the no-black-hole condition is assumed to be valid, the agricultural-exporting country can dissolve the agglomerated equilibrium by use of a high enough manufacturing protection level (at the given manufacturing trade-policy position of the trade partner). This result is in line with that obtained by Puga & Venables (1999) in their examination of whether a developing country can become industrialised by use of an appropriate choice of trade policy. In addition, the result that the same goal can sometimes be obtained by using a liberalising strategy in manufacturing trade is also obtained if allowing for agricultural trade costs in the model. This result contrasts to the international new economic geography setting used by Puga & Venables (1999), in which country size differences were a prerequisite for a unilateral trade-liberalising strategy to dissolve the foreign agglomerated

[42] In turn, the raised wage level increases the national income level and therefore the expenditure placed on (agricultural and) manufacturing goods. However, the resulting demand effect is always exceeded by the cost effect (as shown in detail for the agglomerated equilibrium in section 3 and as revealed by simulation results for dispersed asymmetric equilibria).

equilibrium. The agricultural-exporting country always gains from using a high enough protection level (given the foreign level of protection) to dissolve the agglomerated equilibrium.

The symmetric equilibrium can be dissolved by the unilateral use of manufacturing protection except in the case when the common level of domestic and foreign manufacturing trade costs is very high and no agricultural trade costs exist. The fact that the symmetric equilibrium is independent of the unilateral use of manufacturing protection above the so-called non-affected point hinges on the fact that the demand advantage triggered by the manufacturing trade cost differential becomes negligible at sufficiently high common manufacturing trade cost levels. However, if agricultural trade costs exist, a domestic firm incurs an additional demand gain caused by the fact that agricultural trade costs trigger a higher domestic manufacturing expenditure. Specifically, the raised agricultural goods price places an upward pressure on the equilibrium wage. In turn, the higher labour return leads to a higher income level and thereby to a higher manufacturing expenditure. In fact, the presence of agricultural trade costs also implies that a moving manufacturing firm incurs higher production costs due to the upward pressure on wages. Yet, the demand effect always exceeds the cost effect, thereby implying that the effect of the existence of agricultural trade costs imposes a destabilising effect on the symmetric equilibrium. Accordingly, a unilateral protectionist position in manufacturing trade always dissolves the symmetric equilibrium in the presence of agricultural trade costs. While a country always benefits from using a strategy that dissolves the symmetric equilibrium in the absence of agricultural trade costs, a country only gains from using this strategy if it can ensure that an own agglomerated equilibrium is established when agricultural trade costs exist.

In the absence of agricultural trade costs, only symmetric equilibria above the non-affected point can result from a game between welfare-maximising governments since one of the countries always gains from dissolving an agglomerated equilibrium and both countries gains from breaking the symmetric equilibrium. At natural manufacturing trade cost levels below the non-affected point, the Nash-equilibrium strategies are therefore protectionist and just high enough for the domestic and foreign trade cost levels to equal the non-affected point. At higher natural trade cost levels, the optimal strategies are instead free-trade policies.

If agricultural trade costs exist, symmetric equilibria above the non-triggered agglomeration point can result from the trade-policy game. However, the optimal manufacturing strategies can be protectionist up to the point at which the agglomerated equilibrium is dissolved (the sustain point). If the optimal manufacturing strategies are protectionist, the optimal agricultural trade-policy positions are free-trade policies since the agricultural-importing country's welfare level is decreasing in its agricultural trade cost level in equilibrium. At natural trade cost levels above the sustain point, free-trade manufacturing policies are optimal. In addition, the Nash-equilibrium agricultural trade-policy position can incorporate any protection level since a country's welfare level is independent of its agricultural protection level in the symmetric equilibrium and because the stability of the symmetric equilibrium is independent of each country's agricultural trade cost level. In comparison with the Nash-equilibrium outcome obtained in the absence of agricultural trade costs, the endogenous trade policy outcomes incorporates considerably lower manufacturing protection levels.

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7 Figures

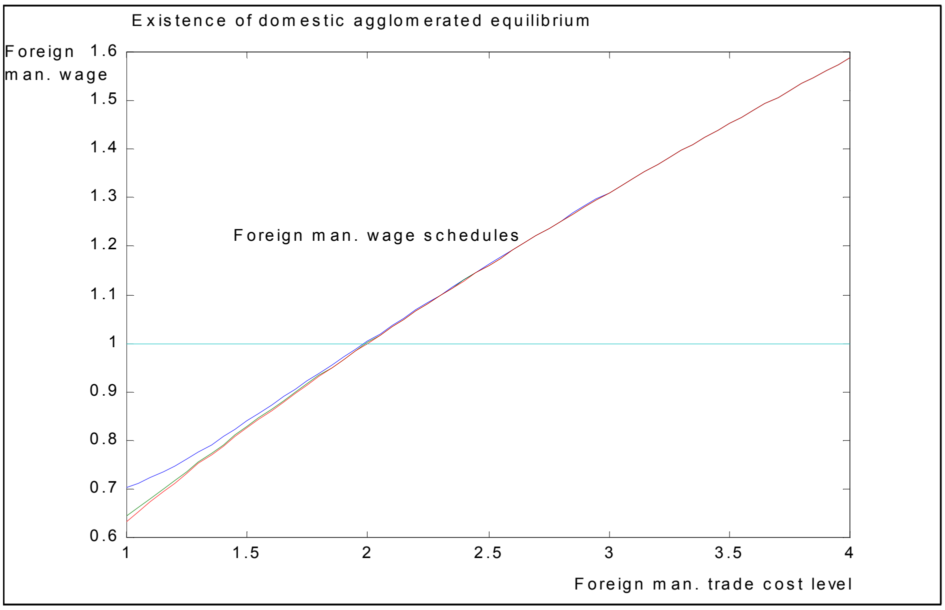

Figure 1. Parameter values: $\alpha = 0.5, \sigma = 6, t_A = t_A^* = 1, t_M = 1.5, 2.15, 3$ and $1 \leq t_M^* \leq 4$.

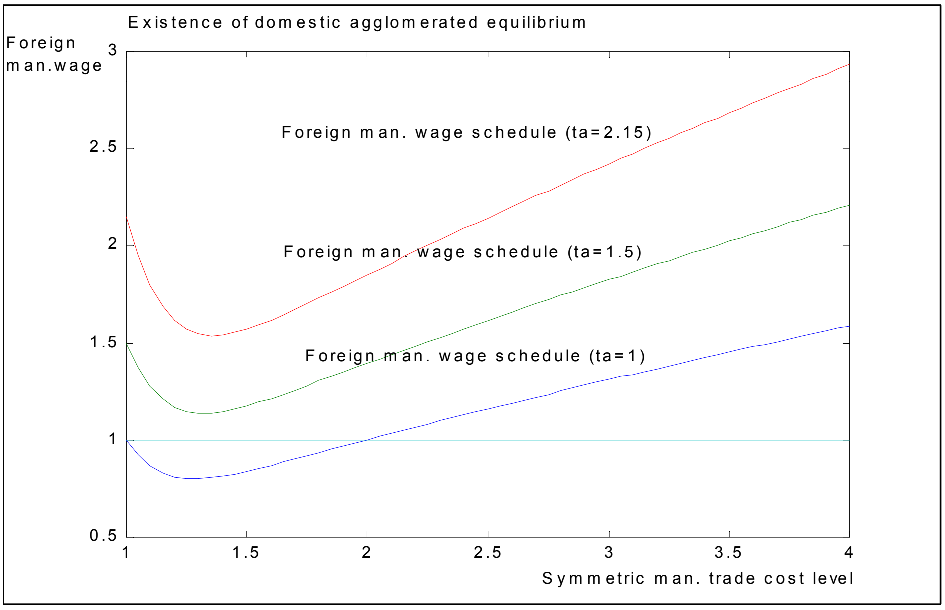

Figure 2. Parameter values: $\alpha = 0.5, \sigma = 6,\ 1 \leq t_M \leq 4$, and $t_M = t_M^*$.

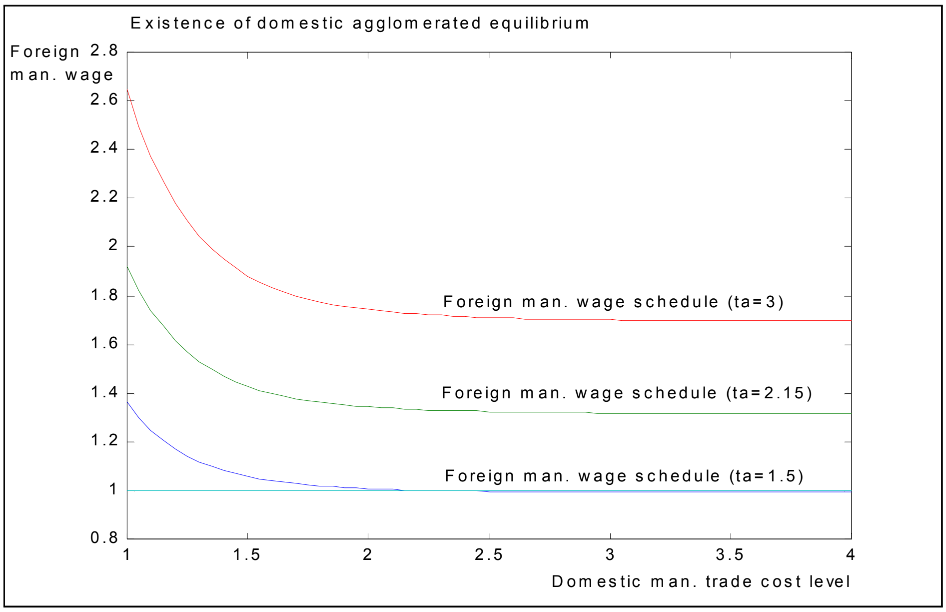

Figure 3. Parameter values: $\alpha = 0.5, \sigma = 6$, and $t_M^* = 1.2$.

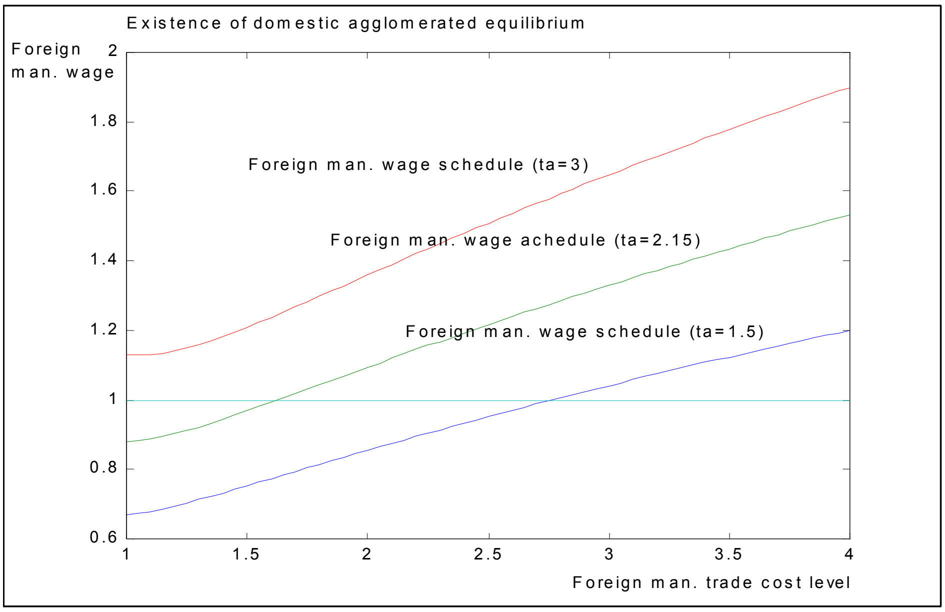

Figure 4. Parameter values: $\alpha = 0.6, \sigma = 5$, and $t_M = 2.15$.

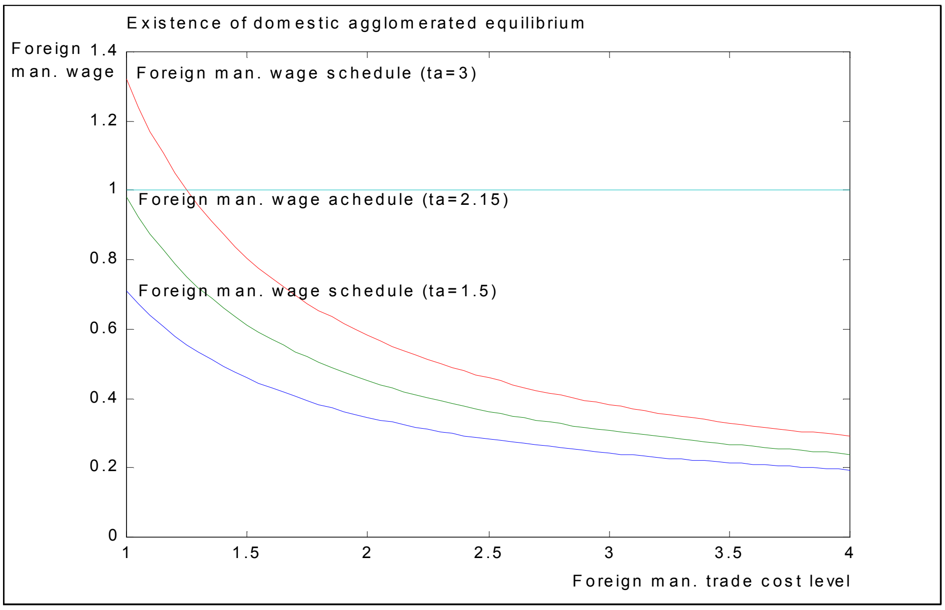

Figure 5. Parameter values: $\alpha = 0.6, \sigma = 2$, and $t_M = 2.15$.

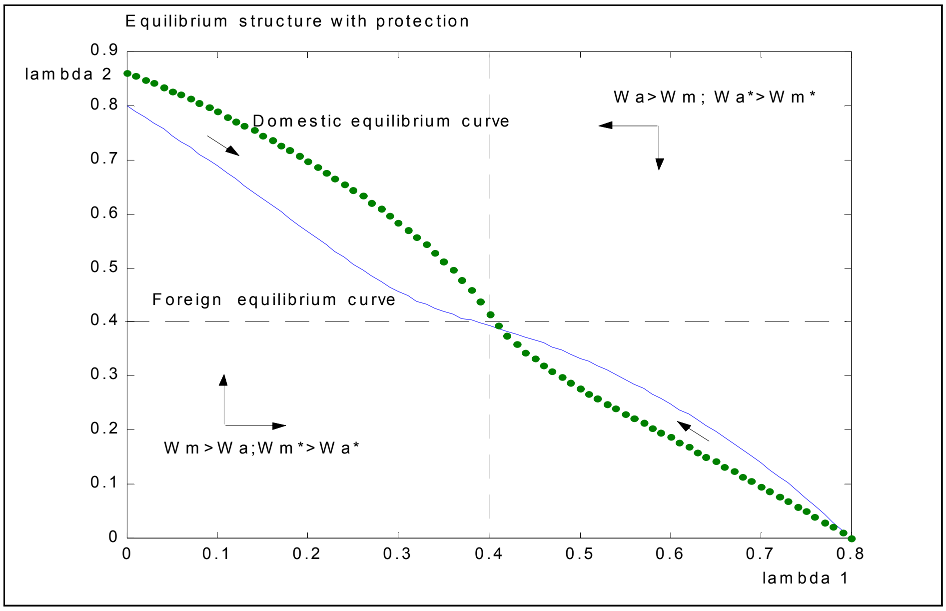

Figure 6. Parameter values: $\alpha = 0.5, \sigma = 5, \mu = 0.4, \pi_M = 0.5,$
$\pi_M^* = 0, t_A = t_A^* = 1$, and $\tau_M = \tau_M^* = 2.5$.

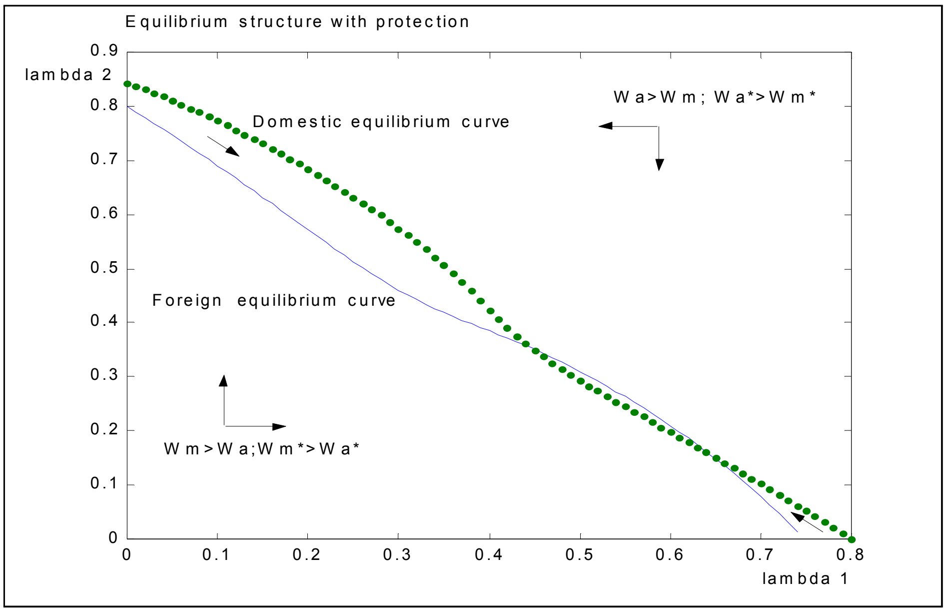

Figure 7. Parameter values: $\alpha = 0.5, \sigma = 5, \mu = 0.4, \pi_M = 0.7,$
$\pi^*_M = 0, t_A = t^*_A = 1$, and $\tau_M = \tau^*_M = 2.15$.

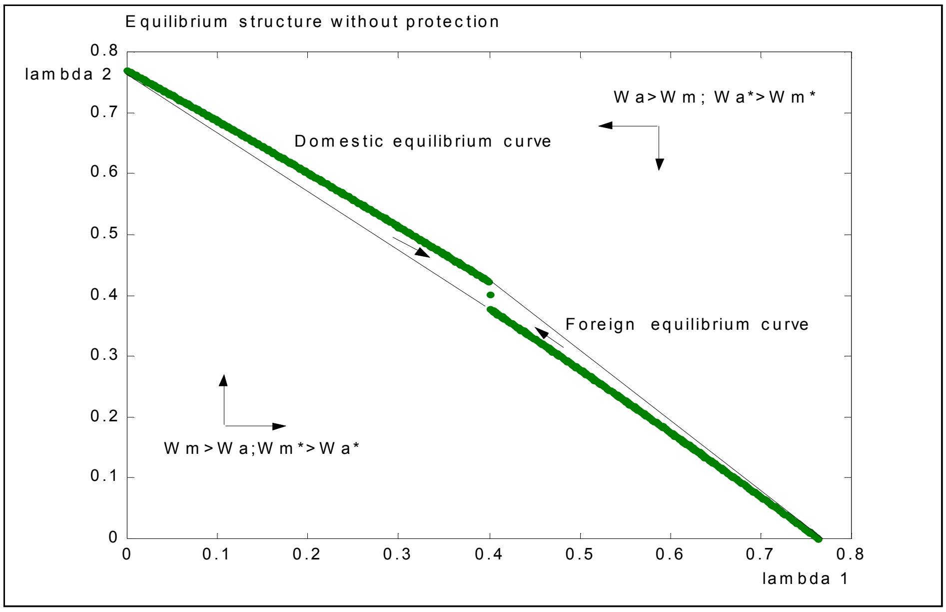

Figure 8. Parameter values: $\alpha = 0.5, \sigma = 5, \mu = 0.4, \pi_M = \pi^*_M = 0,$
$t_A = t^*_A = 1.1$, and $\tau_M = \tau^*_M = 1.05$.

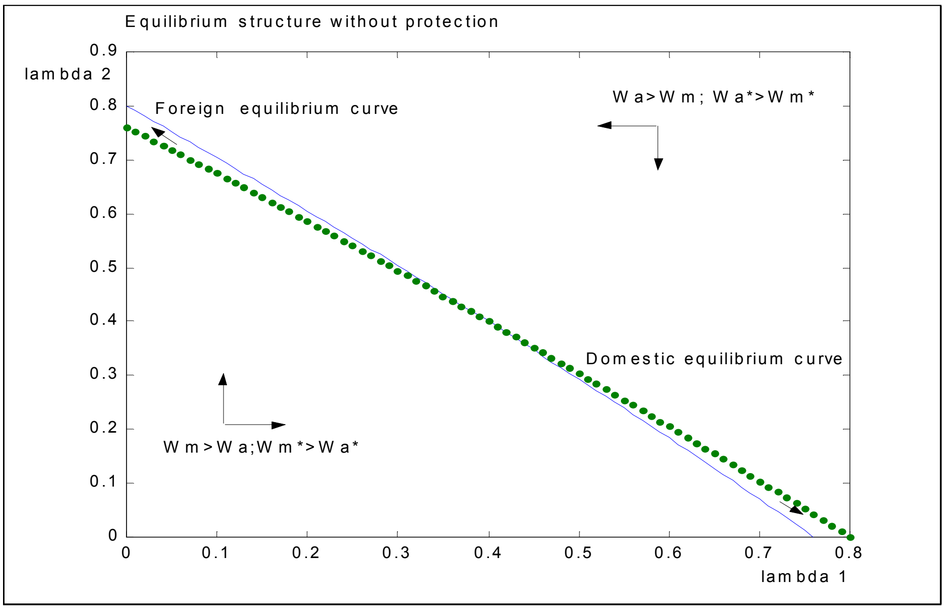

Figure 9. Parameter values: $\alpha = 0.5, \sigma = 5, \mu = 0.4, \pi_M = \pi_M^* = 0$, $t_A = t_A^* = 1$, and $\tau_M = \tau_M^* = 1.04$.

8 Appendix

8.1 Deriving the foreign manufacturing wage expression

8.1.1 Without agricultural trade costs

When no agricultural trade costs exist, the perfect substitutability of domestic and foreign agricultural goods implies that domestic and foreign agricultural production can occur only if agricultural goods prices are equalised. Furthermore, since the agricultural wage equals the agricultural goods price in a country and the foreign agricultural good is numeraire, this implies that the domestic and foreign agricultural wage equals one in equilibria characterised by domestic and foreign agricultural production. In addition, a domestic agglomerated equilibrium characterised by agricultural production is stable if agricultural and manufacturing workers in the home country earns the same wage. In combination, these model implications together indicate that the domestic equilibrium wage equals one in a stable domestic agglomerated equilibrium when the small manufacturing sector condition is valid. The domestic agglomerated equilibrium is therefore characterised by $w^e = 1$ as well as by $\lambda_M^* = 0$ and $w_A^* = 1$. Inserting these values into the income, expenditure and price index equilibrium equations yields $Y = 1$, $Y^* = 1$, $E = \mu + \frac{\alpha}{1-\alpha}\lambda_M$, $E^* = \mu$, $G = \lambda_M^{1/(1-\sigma+\sigma\alpha)}$, and $G^* = \lambda_M^{1/(1-\sigma+\sigma\alpha)} t_M^*$. In addition, by inserting the obtained expenditure and price index expressions into (12) and using the fact that the domestic manufacturing wage equals one, the domestic wage expression can be rewritten as:

$$\frac{1}{1-\alpha} = \lambda_M^{-1}(\mu + \frac{\alpha}{1-\alpha}\lambda_M) + \lambda_M^{-\sigma\alpha/(1-\sigma+\sigma\alpha)} \lambda_M^{\sigma-1/(1-\sigma+\sigma\alpha)} t_M^{*\sigma-1+1-\sigma} \mu$$

By solving this expression for the domestic manufacturing labour share, it can be shown that $\lambda_M = 2\mu$.[43] In turn, this implies that the expenditure and

[43] Specifically, this is done in the following steps. $\frac{1}{1-\alpha} = \lambda_M^{-1}(\mu + \frac{\alpha}{1-\alpha}\lambda_M) + \lambda_M^{-\sigma\alpha/(1-\sigma+\sigma\alpha)} \lambda_M^{\sigma-1/(1-\sigma+\sigma\alpha)} t_M^{*\sigma-1+1-\sigma} \mu$;
$\frac{1}{1-\alpha} = \lambda_M^{-1}\mu + \frac{\alpha}{1-\alpha} + \lambda_M^{-1} t_M^{*0} \mu$;
$\frac{1-\alpha}{1-\alpha} = 2\lambda_M^{-1}\mu$;
$\lambda_M = 2\mu$.

price index equations are equal to $E = \frac{\mu(1+\alpha)}{1-\alpha}$, $E^* = \mu$, $G = (2\mu)^{1/(1-\sigma+\sigma\alpha)}$, and $G^* = (2\mu)^{1/(1-\sigma+\sigma\alpha)} t_M^*$. In addition, the foreign wage expression is obtained by using these expressions in the foreign counterpart of (12). Specifically, this is done in the following steps:

$$\frac{w_M^{*\sigma(1-\alpha)} G^{*\sigma\alpha}}{1-\alpha} = G^{*\sigma-1} E^* + G^{\sigma-1} t_M^{1-\sigma} E$$

$$\frac{w_M^{*\sigma(1-\alpha)}}{1-\alpha} = G^{*\sigma-1-\sigma\alpha} E^* + G^{*-\sigma\alpha} G^{\sigma-1} t_M^{1-\sigma} E$$

$$\frac{w_M^{*\sigma(1-\alpha)}}{1-\alpha} = \frac{t_M^{*\sigma-1-\sigma\alpha}\mu}{2\mu} + \frac{(2\mu)^{-\sigma\alpha/(1-\sigma+\sigma\alpha)} t_M^{*-\sigma\alpha} (2\mu)^{(\sigma-1)/(1-\sigma+\sigma\alpha)} t_M^{1-\sigma} \mu(1+\alpha)}{(1-\alpha)}$$

$$\frac{w_M^{*\sigma(1-\alpha)}}{1-\alpha} = \frac{t_M^{*\sigma-1-\sigma\alpha}}{2} + \frac{t_M^{*-\sigma\alpha} t_M^{1-\sigma}(1+\alpha)}{2(1-\alpha)}$$

$$w_M^{*\sigma(1-\alpha)} = \frac{(1-\alpha)}{2} t_M^{*\sigma-1-\sigma\alpha} + \frac{(1+\alpha)}{2} t_M^{*-\sigma\alpha} t_M^{1-\sigma}$$

$$w_M^{*\sigma(1-\alpha)} = t_M^{*-\sigma\alpha} \left[\frac{(1-\alpha)}{2} t_M^{*\sigma-1} + \frac{(1+\alpha)}{2} t_M^{1-\sigma} \right]$$

$$w_M^* = t_M^{*-\alpha/(1-\alpha)} \left[\frac{(1-\alpha)}{2} t_M^{*\sigma-1} + \frac{(1+\alpha)}{2} t_M^{1-\sigma} \right]^{1/\sigma(1-\alpha)}$$

8.1.2 With agricultural trade costs

The fact that domestic and foreign agricultural goods are perfect substitutes implies that the consumption of home-produced and imported agricultural goods requires the agricultural import price to equal the agricultural producer price in a country. If agricultural trade costs exist, this implies that the domestic agricultural goods price equals $p_A = t_A p_A^*$ when domestic and foreign agricultural goods are consumed in the home country. In this case, the domestic agricultural wage equals the domestic agricultural trade cost level since the domestic agricultural wage equals the domestic agricultural goods price and the foreign agricultural good is numeraire. In addition, the domestic equilibrium is stable if the domestic manufacturing wage equals the domestic agricultural wage. This implies that the domestic agglomerated equilibrium is characterised by $w^e = t_A$ as well as by $\lambda_M^* = 0$ and $w_A^* = 1$. Inserting these values into the income, expenditure and price index equilibrium equations, yields $Y = t_A$, $Y^* = 1$, $E = \left(\mu + \frac{\alpha}{1-\alpha}\lambda_M\right) t_A$, $E^* = \mu$, $G = \lambda_M^{1/(1-\sigma+\sigma\alpha)} t_A$, and $G^* = \lambda_M^{1/(1-\sigma+\sigma\alpha)} t_A t_M^*$. By using the obtained expenditure and price index equations and the fact that the domestic manufacturing wage equals the domestic agricultural trade cost level in (12), it can be shown that $\lambda_M = \mu(1 + t_A^{-1})$. Specifically, this is done in the following steps.

$$\frac{1}{1-\alpha} = \lambda_M^{-1} t_A^{\sigma-1-\sigma\alpha}(\mu + \tfrac{\alpha}{1-\alpha}\lambda_M)t_A + \lambda_M^{-\sigma\alpha/(1-\sigma+\sigma\alpha)} t_A^{-\sigma\alpha} \lambda_M^{\sigma-1/(1-\sigma+\sigma\alpha)} t_A^{\sigma-1}\mu$$

$$\frac{1}{1-\alpha} = \lambda_M^{-1}\mu t_A^{\sigma-\sigma\alpha} + \frac{\alpha}{1-\alpha} t_A^{\sigma-\sigma\alpha} + \lambda_M^{-1} t_A^{\sigma-\sigma\alpha-1}\mu$$

$$1 = \lambda_M^{-1}\mu(1 + t_A)$$

$$\lambda_M = \mu(1 + t_A^{-1})$$

Using this manufacturing labour share expression in the expenditure and price index equilibrium equations, yields $E = \frac{\mu(t_A+\alpha)}{1-\alpha}$, $E^* = \mu$, $G = (\mu(1 + t_A^{-1}))^{1/(1-\sigma+\sigma\alpha)} t_A$, and $G^* = (\mu(1 + t_A^{-1}))^{1/(1-\sigma+\sigma\alpha)} t_A t_M^*$. In turn, the foreign wage expression is obtained by using these expressions in the foreign counterpart of (12). This is done in the following steps:

$$\frac{w_M^{*\sigma(1-\alpha)}}{1-\alpha} = \frac{(t_A t_M^*)^{\sigma-1-\sigma\alpha}\mu}{\mu(1+t_A^{-1})} + \frac{t_A^{-\sigma\alpha} t_M^{*-\sigma\alpha}(\mu(1+t_A^{-1}))^{(\sigma-1)/(1-\sigma+\sigma\alpha)} t_A^{\sigma-1} t_M^{1-\sigma}\mu(t_A+\alpha)}{(\mu(1+t_A^{-1}))^{-\sigma\alpha/(1-\sigma+\sigma\alpha)}(1-\alpha)}$$

$$\frac{w_M^{*\sigma(1-\alpha)}}{1-\alpha} = \frac{t_A^{\sigma-\sigma\alpha} t_M^{*\sigma-1-\sigma\alpha}}{(1+t_A)} + \frac{t_A^{\sigma-\sigma\alpha} t_M^{*-\sigma\alpha} t_M^{1-\sigma}(t_A+\alpha)}{(1+t_A)(1-\alpha)}$$

$$w_M^{*\sigma(1-\alpha)} = \frac{(1-\alpha)}{(1+t_A)} t_A^{\sigma-\sigma\alpha} t_M^{*\sigma-1-\sigma\alpha} + \frac{(t_A+\alpha)}{(1+t_A)} t_A^{\sigma-\sigma\alpha} t_M^{*-\sigma\alpha} t_M^{1-\sigma}$$

$$w_M^{*\sigma(1-\alpha)} = t_A^{\sigma(1-\alpha)} t_M^{*-\sigma\alpha} \left[\frac{(1-\alpha)}{(1+t_A)} t_M^{*\sigma-1} + \frac{(t_A+\alpha)}{(1+t_A)} t_M^{1-\sigma} \right]$$

$$w_M^* = t_A t_M^{*-\alpha/(1-\alpha)} \left[\frac{(1-\alpha)}{(1+t_A)} t_M^{*\sigma-1} + \frac{(t_A+\alpha)}{(1+t_A)} t_M^{1-\sigma} \right]^{1/\sigma(1-\alpha)}$$

8.2 Deriving the symmetric equilibrium stability conditions

8.2.1 Without agricultural trade cost

By totally differentiating the equilibrium equations, inserting the symmetric equilibrium variable values expressed in terms of exogenous and trade cost parameters, and using a symmetric perturbation of the equilibrium (i.e. that $dY = -dY^*, dE = -dE^*$ $, dG = -dG^*$, $dw_M = -dw_M^*$, and $d\lambda_M = -d\lambda_M^*$), we yield the following equation system:

$$\left[1 - \sigma + \alpha\sigma \left(\frac{1-t_M^{1-\sigma}}{1+t_M^{1-\sigma}} \right) \right] \frac{dG}{G} - \left[\frac{1-t_M^{1-\sigma}}{\mu(1+t_M^{1-\sigma})} \right] d\lambda_M - \left[\frac{(1-\sigma(1-\alpha))(1-t_M^{1-\sigma})}{1+t_M^{1-\sigma}} \right] dw_M = 0$$

$$\sigma dw_M + \left[\frac{(\alpha\sigma - \sigma + 1) + (\alpha\sigma + \sigma - 1)t_M^{1-\sigma}}{(1-\alpha)(1+t_M^{1-\sigma})} \right] \frac{dG}{G} - \left[\frac{1-t_M^{1-\sigma}}{\mu(1+t_M^{1-\sigma})} \right] dE = 0$$

$$dE - \mu dY - \left[\frac{\alpha}{1-\alpha} \right] d\lambda_M - \left[\frac{\alpha\mu}{1-\alpha} \right] dw_M = 0$$

$$dY - \mu dw_M = 0$$

The equation system is solved for $dv/d\lambda_M$ as a function of the exogenous and trade cost parameters. Since agricultural production is characterised by constant returns to scale and the unit input requirement in agricultural production equals one, $dv/d\lambda_M = dw_M/d\lambda_M$.[44]

$$\frac{dv}{d\lambda_M} = \frac{\left(t_M^{1-\sigma} - 1\right)\left(\alpha(2\sigma-1)\left(1+t_M^{1-\sigma}\right) - (\sigma\alpha^2+\sigma-1)\left(1-t_M^{1-\sigma}\right)\right)}{\mu\Delta\left(1+t_M^{1-\sigma}\right)^2} \tag{29}$$

where

$$\begin{aligned}\Delta &= \sigma(1-\sigma)(1-\alpha) + (\alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha))Z + \\ &\quad (\sigma((\sigma-1)(1-\alpha)-\alpha^2-\mu\alpha(1-\alpha))+1-\sigma)Z^2,\ Z = \left[\frac{1-t_M^{1-\sigma}}{1+t_M^{1-\sigma}}\right].\end{aligned}$$

If the no-black-hole condition is valid, it can be shown that the domestic manufacturing excess wage is decreasing in the domestic manufacturing labour share above the break point. This is the result of that the numerator is positive at (symmetric) trade cost levels above the break point, while the denominator is always negative. Since $t_M^{1-\sigma} < 1$ by definition, the numerator of (29) is positive if its second factor is negative. In turn, it can be shown in the following steps that the second factor is positive at (symmetric) trade cost levels above the break point.

$$\alpha(2\sigma-1)\left(1+t_M^{1-\sigma}\right) - \left(\sigma\alpha^2+\sigma-1\right)\left(1-t_M^{1-\sigma}\right) < 0$$

$$(2\alpha\sigma-\alpha+\sigma\alpha^2+\sigma-1)t_M^{1-\sigma} < \ \sigma\alpha^2+\sigma-1-2\alpha\sigma+\alpha$$

$$(\sigma(\alpha^2+2\alpha+1)-(1+\alpha))t_M^{1-\sigma} < \sigma(1-2\alpha+\alpha^2)-(1-\alpha)$$

$$(\sigma(1+\alpha)-1)(1+\alpha)t_M^{1-\sigma} < (\sigma(1-\alpha)-1)(1-\alpha)$$

[44] That is, $dw_A/d\lambda_M = 0$.

$$t_M^{\sigma-1} > \frac{(\sigma(1+\alpha)-1)(1+\alpha)}{(\sigma(1-\alpha)-1)(1-\alpha)}$$

$$t_M > \left[\frac{(\sigma(1+\alpha)-1)(1+\alpha)}{(\sigma(1-\alpha)-1)(1-\alpha)}\right]^{1/(\sigma-1)}$$

As for the denominator, it is negative since the determinant Δ is negative if the no-black-hole condition is valid while its other two factors are positive (by definition). That the determinant is negative can be shown by using the fact that $\Delta(Z)$ is an equation of the second degree, that the determinant Δ is negative at its minimum and maximum value and that it is increasing in Z between these values its minimum and maximum values. At the minimum value of Z, the determinant equals $\Delta(Z=0) = \sigma(1-\sigma)(1-\alpha)$ and is therefore always negative in value. At the maximum value of Z, the determinant is equal to $\Delta(Z = 1) = (1-\alpha)(1-\mu)(1-\sigma(1-\alpha))$ and is negative if the no-black-hole condition is valid.[45] The derivative of Δ s.t. Z equals $\Delta'(Z) = \alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha)+(\sigma((\sigma-1)(1-\alpha)-\alpha^2-\mu\alpha(1-\alpha))+1-\sigma)Z$. At the minimum value of Z, the derivative equals $\Delta'(0) = \alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha)$ and is therefore always positive in value. At the maximum value of Z, the derivative is equal to $\Delta'(1) = (1-\alpha)(-(\sigma-1)+\sigma(\sigma+\alpha-1)-\mu(1-\sigma(1-\alpha)))$.[46] If the no-

[45] $\Delta(Z) = \sigma(1-\sigma)(1-\alpha)+(\alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha))Z+(\sigma((\sigma-1)(1-\alpha)-\alpha^2-\mu\alpha(1-\alpha))+1-\sigma)Z^2$; $Z=1$ yields $\Delta(1) = \sigma(1-\sigma)(1-\alpha)+\alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha)+\sigma(\sigma-1)(1-\alpha)-\sigma\alpha^2-\mu\sigma\alpha(1-\alpha)+1-\sigma$. This expression can be rewritten into $\Delta(1) = (1-\alpha)(1-\mu)(1-\sigma(1-\alpha))$ by rearranging the terms in the following steps.
$\Delta(1) = \sigma(1-\sigma)(1-\alpha)+\alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha)+\sigma(\sigma-1)(1-\alpha)-\sigma\alpha^2-\mu\sigma\alpha(1-\alpha)+1-\sigma$;
$\Delta(1) = -(1-\alpha)(\alpha\sigma(\mu-1)-\sigma(1-\sigma)-(1-\sigma)+\mu(1-\sigma)-\sigma(\sigma-1))$;
$\Delta(1) = -(1-\alpha)(\alpha\sigma(\mu-1)-(1-\sigma)+\mu(1-\sigma))$;
$\Delta(1) = -(1-\alpha)(\alpha\sigma(\mu-1)+(\mu-1)(1-\sigma))$;
$\Delta(1) = -(1-\alpha)(\mu-1)(1-\sigma+\alpha\sigma)$;
$\Delta(1) = (1-\alpha)(1-\mu)(1-\sigma(1-\alpha))$.

[46] The derivative obtained at the maximum value of Z equals $\Delta'(1) = \alpha(2\sigma-1)+\mu(\sigma-1)(1-\alpha)+\sigma((\sigma-1)(1-\alpha)-\alpha^2-\mu\alpha(1-\alpha))+1-\sigma$. This expression can be rewritten into $\Delta'(1) = (1-\alpha)((1-\sigma)+\sigma(\sigma+\alpha-1)-\mu(1-\sigma(1-\alpha)))$. in the following steps.
$\Delta'(1) = -(1-\alpha)\left(-\sigma\alpha+\mu\sigma\alpha-1+\mu-\mu\sigma+2\sigma-\sigma^2\right)$;
$\Delta'(1) = -(1-\alpha)(\mu(1-\sigma+\sigma\alpha)+\sigma-1-\sigma(\sigma+\alpha-1)$;
$\Delta'(1) = (1-\alpha)(-\mu(1-\sigma(1-\alpha))-\sigma+1+\sigma(\sigma+\alpha-1)$;
$\Delta'(1) = (1-\alpha)(-(\sigma-1)+\sigma(\sigma+\alpha-1)-\mu(1-\sigma(1-\alpha)))$.

black-hole condition is valid, this derivative is positive since the second as well as the first factor is positive.[47]

8.2.2 With agricultural trade cost

As previously explained, in the presence of agricultural trade costs, no agricultural trade takes place in the symmetric equilibrium or in equilibria in its neighbourhood. To derive the symmetric equilibrium stability conditions, internal agricultural market clearing conditions are therefore included in the equilibrium equation system. Specifically, the fifth equation in the system is obtained from totally differentiating the expression $(1-\lambda_M)w_A-(1-\mu)Y=0$. In addition, the equilibrium in the neigbourhood of the symmetric equilibrium incorporates an agricultural wage different from that obtained in the symmetric equilibrium. That is, dw_A differs from zero, and is therefore included the fourth and fifth equation. In the presence of agricultural trade costs, the equation system is equal to:

$$\left[(1-\sigma)+\alpha\sigma\left(\frac{1-t_M^{1-\sigma}}{1+t_M^{1-\sigma}}\right)\right]\frac{dG}{G}-\left[\frac{1-t_M^{1-\sigma}}{\mu(1+t_M^{1-\sigma})}\right]d\lambda_M-\left[\frac{(1-\sigma(1-\alpha))(1-t_M^{1-\sigma})}{1+t_M^{1-\sigma}}\right]dw_M=0$$

$$\sigma dw_M+\left[\frac{(\alpha\sigma-\sigma+1)+(\alpha\sigma+\sigma-1)t_M^{1-\sigma}}{(1-\alpha)(1+t_M^{1-\sigma})}\right]\frac{dG}{G}-\left[\frac{1-t_M^{1-\sigma}}{\mu(1+t_M^{1-\sigma})}\right]dE=0$$

$$dE-\mu dY-\left[\frac{\alpha}{1-\alpha}\right]d\lambda_M-\frac{\alpha\mu}{(1-\alpha)}dw_M=0$$

$$dY-\mu dw_M-(1-\mu)dw_A=0$$

$$(1-\mu)dw_A-(1-\mu)dY-d\lambda_M=0$$

The equation system is solved for $dv/d\lambda_M$ as a function of the exogenous and trade cost parameters. Since agricultural production is characterised by constant returns to scale and the unit input requirement in agricultural production equals one, $dv/d\lambda_M=dw_M/d\lambda_M$.[48]

[47] The third term in the second parenthesis is positive in this case, implying that the value of the second factor is positive as the second positive term always exceeds the first negative term.

[48] That is, $dw_A/d\lambda_M=0$ since $P_A(dMPL_A/d\lambda_M)=0$.

$$\frac{dv}{d\lambda_M} = -\frac{1}{\mu}\frac{(1-\sigma(1+\alpha))\left(1-t_M^{1-\sigma}\right)}{\left(t_M^{1-\sigma}(1-\sigma(1+\alpha))+(2\sigma-1)(1-\sigma(1-\alpha))\right)} \tag{30}$$

Since the no-black-hole condition is valid, (30) is always negative. That is, the symmetric equilibrium is stable at all (symmetric) manufacturing trade cost levels.

8.3 Deriving the symmetric equilibrium variable expressions

By definition, the symmetric equilibrium is characterised by identical endogenous variable values in the two countries. That is, $w_M = w_M^*$, $\lambda_M = \lambda_M^*$, $Y = Y^*$, $E = E^*$, and $G = G^*$. The fact that domestic and foreign agricultural wages are equalised in the symmetric equilibrium combined with assumption that the foreign agricultural good is numeraire and the model implication that the agricultural goods price equals the agricultural wage in a country together imply that the international agricultural wage is equal to one. In turn, the stability condition that the agricultural and manufacturing wage must be equal indicates that the international manufacturing wage also equals one in a stable symmetric equilibrium. Using that $w_A = w_M = 1$ in the domestic income, expenditure and price index equilibrium equations yields $Y = 1, E = \mu + \frac{\alpha}{1-\alpha}\lambda_M$, and $G = (\lambda_M(1+t_M^{1-\sigma}))^{1/(1-\sigma+\sigma\alpha)}$. In addition, by using the obtained expenditure and price index expressions and their foreign counterparts in (12) and taking account of the fact that the domestic manufacturing wage equals one, it can be shown that $\lambda_M = \mu$ in the symmetric equilibrium. This is done in the following steps.

$$\frac{1}{1-\alpha} = \lambda_M^{-1}(1+t_M^{1-\sigma})^{-1}(\mu+\frac{\alpha}{1-\alpha}\lambda_M)+\lambda^{-1}(1+t_M^{1-\sigma})^{-1}t_M^{*1-\sigma}(\mu+\frac{\alpha}{1-\alpha}\lambda_M)$$

$$\frac{1}{1-\alpha} = \lambda_M^{-1}(1+t_M^{1-\sigma})^{-1}(\mu+\frac{\alpha}{1-\alpha}\lambda_M)(1+t_M^{*1-\sigma}).$$

$$t_M = t_M^* \rightarrow \frac{1}{1-\alpha} = \lambda_M^{-1}(\mu+\frac{\alpha}{1-\alpha}\lambda_M)$$

$$\frac{1}{1-\alpha} = \lambda_M^{-1}\mu+\frac{\alpha}{1-\alpha}$$

$$1 = \lambda_M^{-1}\mu$$

The fact that the manufacturing labour share equals lambda implies that the domestic manufacturing expenditure and the domestic price index equals $E = \frac{\mu(1+\alpha)}{1-\alpha}$ and $G = (\mu(1+t_M^{1-\sigma}))^{1/(1-\sigma+\sigma\alpha)}$ in the symmetric equilibrium.

8.4 Deriving the domestic utility level expressions

8.4.1 Without agricultural trade costs

If the small-manufacturing-sector condition is valid, the domestic equilibrium wage and the domestic manufacturing price index equals $w^e = 1$ and $G = (2\mu)^{1/(1-\sigma+\sigma\alpha)}$ in the domestic agglomerated equilibrium. The domestic utility level in the domestic agglomerated equilibrium is obtained by inserting these equilibrium values in (22), yielding a utility level equal to $u_{AE} = (2\mu)^{-\mu/(1-\sigma+\sigma\alpha)}$. In addition, the foreign equilibrium wage and the foreign manufacturing price index equals $w^{*e} = 1$ and $G^* = (2\mu)^{1/(1-\sigma+\sigma\alpha)}t_M^*$ in the domestic agglomerated equilibrium. By using these equilibrium values in the foreign counterpart of (22), the foreign utility level in the agglomerated equilibrium is obtained. This utility level equals

$u_{AE}^* = (2\mu)^{-\mu/(1-\sigma+\sigma\alpha)}t_M^*$. Due to the symmetry of the model, the domestic and foreign utility level in the foreign agglomerated equilibrium equals $u_{AE^*} = (2\mu)^{-\mu/(1-\sigma+\sigma\alpha)}t_M$ and $u_{AE^*}^* = (2\mu)^{-\mu/(1-\sigma+\sigma\alpha)}$.

In the symmetric equilibrium, the domestic equilibrium wage and the domestic manufacturing price index equals $w^{*e} = 1$ and

$G = (\mu(1+t_M^{1-\sigma}))^{1/(1-\sigma+\sigma\alpha)}$, thereby implying that the domestic utility level equals $u_{SE} = (\mu(1+t_M^{1-\sigma}))^{1/(1-\sigma+\sigma\alpha)}$.

8.4.2 With agricultural trade costs

If the small-manufacturing-sector condition is valid, the domestic equilibrium wage and the domestic manufacturing price index equals $w^e = t_A$ and $G = t_A(\mu(1+t_A^{-1}))^{1/(1-\sigma+\sigma\alpha)}$ in the domestic agglomerated equilibrium. Inserting these values into (22) yields the domestic utility level in the domestic agglomerated equilibrium, $u_{AE} = (\mu(1+t_A^{-1}))^{-\mu/(1-\sigma+\sigma\alpha)}$. The foreign equilibrium wage and the foreign manufacturing price index equals

$w^{*e} = 1$ and $G^* = t_A t_M^* (\mu(1+t_A^{-1}))^{1/(1-\sigma+\sigma\alpha)}$, thereby yielding a foreign utility level equal to $u_{AE}^* = t_A^{-\mu} t_M^{*-\mu} (\mu(1+t_A^{-1}))^{-\mu/(1-\sigma+\sigma\alpha)}$. Due to the symmetry of the model, the domestic and foreign utility level equals $u_{AE^*} = t_A^{*-\mu} t_M^{-\mu} (\mu(1+t_A^{*-1}))^{-\mu/(1-\sigma+\sigma\alpha)}$ and $u_{AE^*}^* = (\mu(1+t_A^{*-1}))^{-\mu/(1-\sigma+\sigma\alpha)}$ in the foreign agglomerated equilibrium.

Since no agricultural trade takes place in the symmetric equilibrium in the presence of agricultural trade costs, the domestic utility level expression is equivalent to that obtained when no agricultural trade costs exist. As shown in the previous subsection, this utility level equals
$u_{SE} = (\mu(1+t_M^{1-\sigma}))^{1/(1-\sigma+\sigma\alpha)}$.

8.5 The foreign manufacturing wage effect of foreign manufacturing trade costs in the domestic agglomerated equilibrium

8.5.1 Without agricultural trade costs

If the small manufacturing sector condition is valid and the domestic agglomerated equilibrium prevails, the foreign manufacturing wage expression is equal to:

$$w_M^{*\sigma(1-\alpha)} = \frac{(1-\alpha)}{2} t_M^{*\sigma-\sigma\alpha-1} + \frac{(1+\alpha)}{2} t_M^{*-\sigma\alpha} t_M^{1-\sigma}. \tag{31}$$

The parameter combination required for the foreign manufacturing trade cost level to impose a positive effect on the foreign manufacturing wage is:[49]

$$t_M^{1-\sigma} < \frac{(1-\alpha)(\sigma(1-\alpha)-1)}{\sigma\alpha(1+\alpha)} t_M^{*\sigma-1}. \tag{32}$$

The right-hand side of this expression is negative when $\sigma(1-\alpha) < 1$, indicating that the validity of the no-black-hole condition is a prerequisite

[49] Specifically, this expression is obtained from using the derivative of the (31) expression with respect to the foreign trade cost level. This derivative equals:
$\partial w_M^{*\sigma(1-\alpha)}/t_M^* = \frac{(1-\alpha)(\sigma(1-\alpha)-1)}{2} t_M^{*\sigma-\sigma\alpha-2} + \frac{-\sigma\alpha(1+\alpha)}{2} t_M^{*-\sigma\alpha-1} t_M^{1-\sigma}$, implying that the parameter restriction $(1-\alpha)(\sigma(1-\alpha)-1)t_M^{*\sigma-\sigma\alpha-2} > \sigma\alpha(1+\alpha)t_M^{*-\sigma\alpha-1}t_M^{1-\sigma}$ is valid if the derivative is positive. In turn, this restriction can be rewritten into (32).

for (32) to hold. However, for sufficiently high α and t_M, and low enough σ and t_M^* parameter values, the right-hand side does not exceed the left-hand side of (32) even if the no-black-hole condition is valid. In this case, $\sigma(1-\alpha)$ must exceed a treshold value larger than one for the foreign manufacturing trade cost effect to be positive. Yet, even if the foreign manufacturing trade cost effect is negative, a foreign unilateral trade-liberalising policy cannot be used to dissolve the domestic agglomerated equilibrium. Basically, this is the result of that the foreign manufacturing wage equals one in the absence of manufacturing trade costs, so that the domestic agglomerated equilibrium cannot be dissolved by the foreign trade-liberalising policy even if it would imply that the foreign manufacturing policy stand was a free-trade position.

8.5.2 With agricultural trade costs

When agricultural trade costs exist and the small manufacturing sector condition is valid, the foreign manufacturing wage expression obtained in the domestic agglomerated equilibrium equals:

$$w_M^{*\sigma(1-\alpha)} = \frac{(1-\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)} t_M^{*\sigma-1-\sigma\alpha} + \frac{(t_A+\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)} t_M^{1-\sigma} t_M^{*-\sigma\alpha} \tag{33}$$

The parameter combination required for the foreign manufacturing trade cost level to impose a positive effect on the foreign manufacturing wage is:[50]

$$t_M^{1-\sigma} < \frac{(\sigma(1-\alpha)-1)}{\sigma\alpha} \frac{(1-\alpha)}{(t_A+\alpha)} t_A^{-1} t_M^{*\sigma-1} \tag{34}$$

[50] The derivative of the foreign manufacturing wage with respect to the foreign manufacturing trade cost level equals:
$\frac{\partial w_M^{*\sigma(1-\alpha)}}{\partial t_M^*} = (\sigma(1-\alpha)-1)\frac{(1-\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)-1} t_M^{*\sigma-2-\sigma\alpha} - \sigma\alpha\frac{(t_A+\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)} t_M^{1-\sigma} t_M^{*-\sigma\alpha-1}$
A positive effect implies that $(\sigma(1-\alpha)-1)\frac{(1-\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)-1} t_M^{*\sigma-2-\sigma\alpha} > \sigma\alpha\frac{(t_A+\alpha)}{(1+t_A)} t_A^{\sigma(1-\alpha)} t_M^{1-\sigma} t_M^{*-\sigma\alpha-1}$, which equals $(\sigma(1-\alpha)-1)(1-\alpha)t_A^{-1}t_M^{*\sigma-1} > \sigma\alpha(t_A+\alpha)t_M^{1-\sigma}$.
By rearranging the terms, this parameter condition can be expressed as
$\frac{(\sigma(1-\alpha)-1)}{\sigma\alpha}\frac{(1-\alpha)}{(t_A+\alpha)} t_A^{-1} t_M^{*\sigma-1} > t_M^{1-\sigma}$.

If the no-black-hole condition is invalid, the (34) expression does not hold since the right-hand side is negative. However, the validity of the no-black-hole condition is not a sufficient condition for the foreign trade cost level to affect the foreign manufacturing wage positively. Instead, the negative foreign manufacturing wage effect can exist even if $\sigma(1-\alpha) > 1$ holds when α, t_M and $t_A$are large enough and t_M^* is sufficiently small. This negative foreign trade cost effect can affect the existence of the domestic agglomerated equilibrium in the presence of agricultural trade costs. Since the foreign manufacturing wage equals t_A in the absence of manufacturing trade costs, a foreign trade-liberalising manufacturing strategy can be used to dissolve the domestic agglomerated equilibrium if the natural manufacturing trade cost level and the domestic manufacturing protection level is low enough.

8.6 The existence of agglomerated equilibria and the agricultural trade cost level

At symmetric trade costs, agglomerated equilibria cannot exist at the agricultural trade cost level $t_A = t_M^{\sigma-1}$. This can be shown by inserting $t_M^* = t_M$ and $t_A = t_M^{\sigma-1}$ in expression (19), which becomes equal to:

$w_M^* = t_M^{\sigma-1} t_M^{-\alpha/(1-\alpha)} \left[\frac{(1-\alpha)}{(1+t_M^{\sigma-1})} t_M^{\sigma-1} + \frac{(t_M^{\sigma-1}+\alpha)}{(1+t_M^{\sigma-1})} t_M^{1-\sigma} \right]^{1/(\sigma(1-\alpha))}$. In turn, by taking into account that the foreign manufacturing wage must not exceed one in value for the domestic agglomerated equilibrium to exist, the following parameter condition is obtained:[51]

[51] Specifically, this is done in the following steps:

$t_M^{((\sigma-1)(1-\alpha)-\alpha)/(1-\alpha)} \left[\frac{(1-\alpha) t_M^{\sigma-1}}{(1+t_M^{\sigma-1})} + \frac{(1+\alpha t_M^{1-\sigma})}{(1+t_M^{\sigma-1})} \right]^{1/(\sigma(1-\alpha))} \leq 1;$

$t_M^{\sigma(1-\alpha)((\sigma-1)(1-\alpha)-\alpha)/(1-\alpha)} \left[\frac{(1-\alpha) t_M^{\sigma-1}}{(1+t_M^{\sigma-1})} + \frac{(1+\alpha t_M^{1-\sigma})}{(1+t_M^{\sigma-1})} \right] \leq 1;$

$t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} \frac{(1+t_M^{\sigma-1}+\alpha(t_M^{1-\sigma}-t_M^{\sigma-1})}{(1+t_M^{\sigma-1})} \leq 1;$

$t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)}(1 + t_M^{\sigma-1} + \alpha(t_M^{1-\sigma} - t_M^{\sigma-1})) \leq (1 + t_M^{\sigma-1});$

$(t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} - 1)(1 + t_M^{\sigma-1}) + \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)}(t_M^{1-\sigma} - t_M^{\sigma-1})) \leq 0;$

$(t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} - 1)(1 + t_M^{\sigma-1}) + \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)}(1 - t_M^{2(\sigma-1)})/t_M^{\sigma-1}) \leq 0;$

$(t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} - 1)(1 + t_M^{\sigma-1}) + \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)+1-\sigma}(1 + t_M^{\sigma-1})(1 - t_M^{\sigma-1})) \leq 0;$

$(t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} - 1) + \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)+1-\sigma}(1 - t_M^{\sigma-1}) \leq 0;$

$t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} - 1 + \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)+1-\sigma} - \alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} \leq 0;$

$(1-\alpha) t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)} + (\alpha t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)+1-\sigma} - 1) \leq 0;$

$(1+t_M^{\sigma-1})t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)}\left[(1-\alpha)+\alpha t_M^{1-\sigma}-t_M^{-\sigma((\sigma-1)(1-\alpha)-\alpha)}\right]\leq 0$, which is non-positive if $\left[(1-\alpha)+\alpha t_M^{1-\sigma}-t_M^{-\sigma((\sigma-1)(1-\alpha)-\alpha)}\right]\leq 0$.

In turn, this expression can be rewritten into
$\left[1-\alpha+t_M^{1-\sigma}(\alpha-t_M^{\sigma((1-\sigma)(1-\alpha)-\alpha)-(1-\sigma)})\right]\leq 0$,
where $\sigma((1-\sigma)(1-\alpha)-\alpha)-(1-\sigma)=(1-\sigma)(\sigma(1-\alpha)-1)-\alpha\sigma$.
This expression is positive since $(t_M^{\sigma((1-\sigma)(1-\alpha)-\alpha)-(1-\sigma)}-\alpha)<(1-\alpha)$ and $t_M^{1-\sigma}<1$.

This implies that a domestic agglomerated equilibrium cannot exist at an agricultural trade cost level of $t_A=t_M^{\sigma-1}$. In addition, the positive effect of agricultural trade costs on the foreign manufacturing wage indicates that no agglomerated equilibrium structure can exist at higher agricultural trade cost levels either.

$(1+t_M^{\sigma-1})t_M^{\sigma((\sigma-1)(1-\alpha)-\alpha)}\left[(1-\alpha)+\alpha t_M^{1-\sigma}-t_M^{-\sigma((\sigma-1)(1-\alpha)-\alpha)}\right]\leq 0.$