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2007

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*Citation for published version (APA):*

Thede, S. (2007). *Trade and Agglomeration: the Strategic use of Protection Revisited*. (Working Papers, Department of Economics, Lund University; No. 7). Department of Economics, Lund University.  
[http://swopec.hhs.se/lunewp/abs/lunewp2007\\_007.htm](http://swopec.hhs.se/lunewp/abs/lunewp2007_007.htm)

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# Trade and Agglomeration: the Strategic use of Protection Revisited\*

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April 4, 2007

JEL Codes: F12, F13, R12, R13

Keywords: New economic geography, input-output linkages, strategic trade policy, Nash policy game.

## Abstract

The purpose of this paper is to examine whether the strategic motive for protection present in trade and agglomeration models, in the so-called new economic geography framework, is sensitive to the standard assumption that there is a sole agglomeration industry. We first investigate unilateral trade policy effects on the international production and trade pattern and the resulting national welfare levels in a new economic geography model including several agglomeration industries. The strategic use of trade policy is then examined by identifying optimal policy positions as well as equilibrium policy strategies in a Nash policy game between the trade partners. Our results show that the strategic use of protection and the resulting "tariff war" outcome prevalent in standard trade and agglomeration models is sensitive to the inclusion of several agglomeration industries. Specifically, trade liberalising policies are optimal and free trade equilibria result from the Nash game unless there is a too wide industry gap in agglomeration economies. Our results show that the case for free trade can be directly attributed to either a relatively strong direct policy impact on national real income (working through raised import prices and reduced import volumes) or similar agglomeration economies in the two industries. The results of this paper jointly suggest that the stark argument for the strategic use of protection present in standard new economic geography models can be attributed to overemphasised gains from agglomeration and/or the lack of industries with similar agglomeration economies.

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\*This paper is an offspring of my previous work. I gratefully acknowledge the comments made by Fredrik Andersson, Richard Baldwin, Rikard Forslid, Ben Ferret, Peter Neary, Hanna Norberg, Pascal Raimondos-Moller and Thierry Verdier. Material included in the paper has also benefited from suggestions made by seminar group participants at the Department of Economics, Lund University, DELTA, Paris, the School of Economics, University College Dublin and the School of Economics, Nottingham University as well as participants at the ZEW Economic Geography workshop in Mannheim 2003 and the Irish Economic Association in Belfast 2004.

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# 1 Introduction

The normative trade policy literature provides two main arguments for the use of protection. The terms-of-trade argument for protection states that, when production is characterised by perfect competition and constant returns to scale, a country with a non-negligible market size gains from using protection as the raised terms-of-trade effect is large enough to exceed the encountered deadweight loss. This outcome, which was introduced by Johnson (1953-1954), has had a profound effect on the understanding of the optimal use of protection. It has, for instance, been used to explain the unilateral pattern of protection (see Broda, Limão and Weinsten (2006)) and the economic foundation of the multilateral trade negotiation system (see Bagwell and Staiger (1999)). The other main economic argument for protection, which was initially proposed by Graham (1923), relies on the observation that a country can benefit from protecting an increasing-returns-to-scale industry in order to get a cost advantage over competitors in international markets. While both arguments have gained much attention in the trade policy field, the strand of research focused on the strategic use of protection in increasing-returns-to-scale industries has been generally criticised for its lack of generality.<sup>1</sup>

In a general equilibrium context, the argument for protecting increasing-returns-to-scale industries carries over to neoclassical trade models. As shown by Flam and Helpman (1987) and Venables (1987), a country always gains from restricting its trade in an industry characterised by monopolistic competition of the Dixit-Stiglitz (1977) form (which is the standard form used to incorporate monopolistic competition in general equilibrium settings). This result relies on the fact that, due to free market entry in the home market or international firm mobility, the demand shift caused by unilateral protection leads to an increase in the domestic number of firms and a conceptual welfare gain. The trade models that incorporate agglomeration economies, in the so-called new economic geography framework, are based on the Dixit-Stiglitz (1977) form of monopolistic competition and include additional welfare gains from protection stemming from trade cost effects on the concentration of economic activity in the presence of agglomeration economies. Several researchers have identified and discussed the economic motive for unilateral protection in standard new economic geography models (see e.g. Krugman and Venables (1995), Neary (2001), and Baldwin et. al. (2003)). These researchers have argued that the stark motive for protection seemingly prevalent in these models cannot be readily interpreted as a policy recommendation due to the specificity of the underlying theoretical framework. In particular, as pointed out by Neary (2001), a reason to take caution in interpreting trade policy effects in the new economic geography framework is that the direct link between national welfare and the protectionist support of an agglomeration industry could be sensitive to the existence of more than one agglomeration industry. In this paper, we identify the strategic use of trade policy in a new economic geography model incorporating several agglomeration industries.

The purpose of this paper is to examine whether the strategic motive for protection present in trade and agglomeration models is sensitive to the standard assumption that there is a sole agglomeration industry. Specifically, we investigate optimal trade policy outcomes and equilibrium policies of a strategic trade policy game played by the trade partners in a new economic geography model incorporating two agglomeration industries. Since agglomeration economies rely on input-output linkages between firms in our international new economic geography setting, a natural consequence of allowing for several agglomeration industries is that the strategic trade policy determination can be related to the use of

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<sup>1</sup>See, amongst others, Brander (1995) and Leahy and Neary (2000).

intermediate inputs between as well as within industries. Empirical observation shows that the use of inter-industry inputs is large at the narrowly defined level of industry aggregation suitable to examine firm agglomerations.<sup>2</sup> For example, on the basis of 4-digit level 1997 input-output data for the USA, 75 percent of manufactured inputs used in manufacturing production were produced outside the own industry.<sup>3</sup> In the same data, typical agglomeration industries such as semiconductor, electronic component, pharmaceutical and medicine manufacturing share an average input use of 53 percent from other manufacturing industries.

We use a Krugman and Venables (1996) model modified to allow for asymmetric industry conditions and trade cost asymmetries. In identifying the strategic use of trade policy while elaborating on the specific role played by input-output linkages for the formation of industry agglomerations, this paper is closely related to the work by Krugman and Venables (1995) and Puga and Venables (1999).<sup>4</sup> In their 1995 contribution, Krugman and Venables depicted the positive protection effects on the localisation of industrial production and national welfare. In turn, Puga and Venables (1999) showed that this effect continues to prevail when the Krugman and Venables (1995) model is modified into a developing country context. The main policy conclusions in Puga and Venables' (1999) model were that unilateral protection can be used to create an economic foundation for industrialisation and that a trade-liberalising policy may constitute an alternative and optimal instrument for industrialisation. As will be further described below, this trade liberalising result is not found in standard new economic geography models characterising the trade and production pattern between rich, industrialised countries.

Since previous researchers have described that strategic policy interactions between countries would lead to a "tariff war" in standard new economic geography models with one agglomeration industry (see Baldwin et al. (2003) and Neary (2001)), we examine both policy optimality per se and the policy outcomes resulting in a strategic trade policy game between the trade partners. Our aim is to identify policy outcomes consistent with international distributions of economic activity that are independently targeted as nationally welfare-maximising by the trade partners. The policy game therefore takes the form of a non-cooperative Nash game in which trade partners simultaneously choose the policy strategies maximising their national welfare levels. Equilibrium policies of the game thereby reflect the mutually consistent strategies of the trade partners.

The rest of the paper is structured as follows. The modified Krugman and Venables (1996) model is presented in the next section together with a detailed description of its equilibrium outcomes. In section 3, the national welfare effects of unilateral protection are depicted and the welfare-maximising trade policies are identified. Section 4 contains a description of the Nash policy game and its equilibrium policy strategies. In the last section, a summary of the paper's main approach and conclusions is provided together with some concluding remarks.

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<sup>2</sup>See Davis and Weinstein (2003).

<sup>3</sup>This input-output table, which is based on the NAICS industry classification, can be downloaded from the US Bureau of Economic Analysis website [www.bea.gov](http://www.bea.gov).

<sup>4</sup>Welfare effects of unilateral protection in the new economic geography framework has also been identified by Baldwin and Robert-Nicoud (2000) and Baldwin et. al. (2003).

## 2 The model

We use a modified Krugman and Venables (1996) model, which is a two-country model that intuitively can be interpreted as describing a country's trade vis-à-vis the rest of the world. There are two countries that share the same endowments, preferences and technologies and there are two industries characterised by monopolistic competition of the Dixit-Stiglitz (1977) form. A final differentiated good is produced in each industry using labour and intermediate inputs from both industries. Labour is the only primary production factor and the labour force in each country is normalised to one for simplicity. The same basic conditions govern producer behaviour in the two industries and the countries share the same inherent economic conditions. We therefore restrict the model description to include conditions facing producers in one sole industry, referred to as industry  $i$ , and economic conditions for the home country only. Foreign country variables are denoted  $*$ .

We follow previous trade-policy researchers of new economic geography settings in keeping the standard model assumption that trade costs are of the Samuelson iceberg form. This implies that a share of exports “melts away” in transit and that the domestic protection level in sector  $i$ ,  $\tau_i \gtrsim 1$ , equals the number of good- $i$  units that has to be exported from the foreign country for one unit of good  $i$  to reach domestic consumers. In order to simplify the identification of trade policy effects, it is assumed that there are infinitesimal natural restrictions to trade (that cannot be influenced by policy). Without a limiting effect of borders, the policy outcomes would be more complicated to identify while no additional information would be gained of the strategic use of trade policy in practice. In addition to this small alteration of the original model assumptions, three main model modifications are made to enable the investigation of unilateral trade policy effects. Two main of the modifications affect the trade cost specification in allowing for trade cost asymmetries on one hand and in formalising that trade barrier revenues are generated on the other hand. We follow Baldwin and Robert-Nicoud (2000) in modelling trade barrier revenues consistent with the iceberg trade cost specification by letting the government collect goods lost due to domestic protection. In turn, these goods are transformed into a public good  $Z$  that is costlessly provided to the population.

Consumers share an additive utility function  $u$  consisting of a Cobb-Douglas part depicting the marketed goods' consumption and an additive term depicting the public good's consumption:<sup>5</sup>

$$u = M_i^{0.5} M_j^{0.5} + \theta Z, \quad 0 < \theta \leq 0.5, \quad (1)$$

where  $M_i$  and  $M_j$  are consumption indices of good- $i$  and good- $j$  varieties and  $\theta$  is a parameter capturing the relative preference for public good consumption. As previously noted by Baldwin and Robert-Nicoud (2000), the welfare impact of trade barrier revenues is negligible in industrialised (OECD) countries. This suggests that  $\theta$  should have a value close to zero in our industrialised country setting. To provide general evidence of the revenue incentive for protection, we nevertheless choose an upper boundary of  $\theta$  equal to 0.5. For example, this could capture the relatively stronger dependency on trade barrier revenues in newly industrialised countries.

The consumption index for each differentiated good takes the form of a constant-elasticity-of-substitution (CES) function across a large number of produced varieties. The good- $i$  consumption index,  $M_i$ , equals:

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<sup>5</sup>Baldwin and Robert-Nicoud (2000) uses a Cobb-Douglas utility function to describe the consumption of all goods. In this paper, public good consumption enters welfare through an additive term as, in identifying optimal protection levels, the analytical result that no utility at all is obtained at free trade would be misleading.

$$M_i = \left[ \int_0^{N_i} m(k_i)^{\rho_i} dk_i \right]^{1/\rho_i}, \quad \rho_i = \frac{\sigma_i - 1}{\sigma_i}, \quad \sigma_i > 1, \quad k_i = 0, \dots, n_i, \dots, N_i, \quad (2)$$

where  $m(k_i)$  is the consumption of the  $k$ th good- $i$  variety,  $n_i$  is the number (mass) of domestically produced good- $i$  varieties,  $N_i$  is the total number (mass) of good- $i$  varieties,  $\rho_i$  is a parameter capturing the intensity of preference for variety of good  $i$  and  $\sigma_i$  is the elasticity of substitution between any pair of industry- $i$  varieties. To simplify the following exposition, good- $i$  varieties are ordered with the  $n_i$  domestic ones before the  $n_i^*$  imported varieties.

As previously described, the total amount of goods incurred from domestic protection is transformed into a public good  $Z$ :

$$Z = (\tau_i - 1) \int_{n_i}^{N_i} m(k_i) dk_i + (\tau_j - 1) \int_{n_j}^{N_j} m(k_j) dk_j, \quad k_j = 0, \dots, n_j, \dots, N_j, \quad (3)$$

where  $\tau_j$  is the domestic industry- $j$  protection level,  $m(k_j)$  is the consumption of the  $k$ th good- $j$  variety,  $n_j$  is the number (mass) of domestically produced industry- $j$  varieties and  $N_j$  is the total number (mass) of good- $j$  varieties. Good- $j$  varieties are ordered with the  $n_j$  domestic varieties before the  $n_j^*$  imported ones.

Each firm produces its own variety and is nonstrategic in the sense that it perceives the elasticity of substitution between varieties as its elasticity of demand.<sup>6</sup> Firms in the same industry and location are symmetric since they face identical producer conditions and each variety of a good enters symmetrically into demand. The focus is therefore placed on representative varieties/firms in the rest of the paper.

Each good is produced from a Cobb-Douglas composite of labour and intermediate inputs. To simplify, each produced variety is assumed to be used as an intermediate input in the production of final goods.<sup>7</sup> The intermediate input use in production is assumed to replicate that of final goods in consumption, so that the demand structure for intermediate inputs produced in industry  $i$  is specified by variety index (2). The input unit cost in industry- $i$  production,  $C_i$ , equals:

$$C_i = w_i^{1-\mu_i-v_i} Q_i^{\mu_i} Q_j^{v_i}, \quad \mu_i > v_i, \quad (4)$$

where  $w_i$  is the industry- $i$  wage,  $Q_i$  is the price index of  $M_i$ ,  $Q_j$  is the price index of  $M_j$ ,  $\mu_i$  is the industry- $i$  cost share placed on intermediate inputs from the same industry and  $v_i$  is the industry- $i$  cost share placed on other intermediate inputs. Since the input composite requirement includes  $M_i$  and  $M_j$ , all produced varieties are required as inputs in the production of each final good. The third main modification of the original model is to allow for industry variation in the preferences for variety, the elasticity of substitution between varieties and in the input cost shares. We follow Krugman and Venables (1996) in assuming that the cost share placed on inputs from the same industry always exceeds that placed on goods from the other industry.

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<sup>6</sup>This assumption can be considered reasonable given the large number of firms. See Helpman and Krugman (1985) for a thorough exposition of this assumption and other features of the Dixit-Stiglitz (1977) setup.

<sup>7</sup>See Venables (1996) for a formal exposition of the division of intermediate and final good producers in a new economic geography setting.

In equilibrium, the domestic industry- $i$  price index equals:

$$Q_i = [n_i p_i^{1-\sigma_i} + n_i^* (p_i^* \tau_i)^{1-\sigma_i}]^{1/(1-\sigma_i)} \quad (5)$$

where  $p_i$  and  $p_i^*$  is the domestic and foreign industry- $i$  variety price. The trade cost weight in (5) reflects the fact that there is "mill pricing" so that the domestic market price on imported good- $i$  varieties are  $\tau_i$  times larger than their foreign producer price. The protection effect on import prices implies that domestic final good producers have a cost advantage for domestically produced intermediate inputs. In general, this implies that cost linkages are stronger between firms in the same location.

The total cost of an industry- $i$  firm,  $TC_i$ , equals:

$$TC_i(x_i) = C_i (\alpha_i + \beta_i x_i) \quad (6)$$

where  $\alpha_i$  and  $\beta_i$  is the fixed and marginal input requirement in industry- $i$  production and  $x_i$  is the output level of a representative industry- $i$  producer. The average cost is decreasing in the output level due to the fixed input requirement, implying that there are increasing returns to scale in production. To simplify without loss of generality, units are chosen in such a way that  $\alpha_i = 1/\sigma_i$  and  $\beta_i = (\sigma_i - 1)/\sigma_i$ .

Since goods markets are characterised by monopolistic competition, a representative producer's marginal revenue equals its marginal cost in equilibrium. Using this fact together with the  $\beta_i$  normalisation and the input unit cost equivalence in (4) implies that the profit-maximising good- $i$  variety price can be expressed as:

$$p_i = w_i^{1-\mu_i-v_i} Q_i^{\mu_i} Q_j^{v_i}. \quad (7)$$

The market clearing condition for an industry- $i$  variety equals:

$$x_i = p_i^{-\sigma_i} [E_i Q_i^{\sigma_i-1} + E_i^* Q_i^{*\sigma_i-1} \tau_i^{*1-\sigma_i}] \quad (8)$$

where  $E_i$  and  $E_i^*$  is the domestic and foreign good- $i$  expenditure,  $Q_i^*$  is the price index of the foreign good- $i$  consumption index and  $\tau_i^*$  is the foreign industry- $i$  protection level. As can be seen from (8), the foreign demand for a domestic industry- $i$  variety is decreasing in the foreign good- $i$  protection level and the impact of this protection effect (i.e. the incurred import loss) is increasing in the substitution elasticity between good- $i$  varieties. Because the domestic demand for foreign varieties is reduced by foreign protection, domestic (consumers and) firms have a demand advantage for domestically produced goods. In general, this implies that demand linkages are stronger between producers in the same location.

There is free market entry and exit, implying that equilibrium profits are zero. Using this fact together with (6), (7) and the  $\alpha_i$  and  $\beta_i$  normalisations, it can be shown that the output level equals one in equilibrium. Inserting (7) into (8), using that there is an equilibrium unit output level and rearranging the terms yields:

$$w_i^{\sigma_i(1-\mu_i-v_i)} Q_i^{\sigma_i \mu_i} Q_j^{\sigma_i v_i} = E_i Q_i^{\sigma_i-1} + E_i^* Q_i^{*\sigma_i-1} \tau_i^{*1-\sigma_i}. \quad (9)$$

A domestic equilibrium is characterised by seven equilibrium equations. Expression (9) and its industry- $j$  counterpart are two of these equations.

In equilibrium, the fact that firms make zero profits implies that total industry- $i$  wages are equal to the labour cost share of total industry- $i$  revenues:

$$w_i L_i = (1 - \mu_i - v_i) n_i p_i \quad (10)$$

where  $L_i$  is the domestic industry- $i$  labour force. By solving (10) for  $n_i$  and using the resulting expression and (7) in (5), the good- $i$  price index can be written as:

$$Q_i = ((1 - \mu_i - v_i)^{-1} (L_i w_i^{1 - \sigma_i (1 - \mu_i - v_i)} Q_i^{-\sigma_i \mu_i} Q_j^{-\sigma_i v_i} + L_i^* w_i^{*1 - \sigma_i (1 - \mu_i - v_i)} Q_i^{* - \sigma_i \mu_i} Q_j^{* - \sigma_i v_i} \tau_i^{1 - \sigma_i}))^{1 / (1 - \sigma_i)} \quad (11)$$

where  $L_i^*$  is the foreign industry- $i$  labour force,  $w_i^*$  is the foreign industry- $i$  wage and  $Q_j^*$  is the price index of the foreign good- $j$  consumption index. Expression (11) and its industry- $j$  counterpart are included amongst the seven domestic equilibrium equations.

The total domestic expenditure on a good comes from consumer demand for final products and producer demand for intermediate inputs. Combined with the industry- $i$  revenue equivalence obtained from (10), this implies that the domestic good- $i$  expenditure equals:

$$E_i = 0.5Y + \frac{\mu_i}{1 - \mu_i - v_i} w_i L_i + \frac{v_i}{1 - \mu_i - v_i} w_j (1 - L_i), \quad (12)$$

where the first term is the final good- $i$  expenditure and the second and third term is the industry- $i$  and industry- $j$  expenditure placed on intermediate inputs produced in industry  $i$ . The expenditure equation (12) and its industry- $j$  counterpart are two of the domestic equilibrium equations.

The national income consists of total labour earnings:

$$Y = w_i L_i + w_j (1 - L_i). \quad (13)$$

The national income equation is the last of the equations characterising a domestic equilibrium. Labour is assumed to move into the industry offering the highest wage, implying that the whole labour force earns the same wage in a stable domestic equilibrium. The home country can therefore be active in both industries in a stable domestic equilibrium only if domestic wages are equalised. In addition, the complete domestic specialisation in one industry is consistent with domestic equilibrium stability if the domestic labour force earns a wage that is at least as large as the (theoretical) domestic wage in the other industry. Throughout the rest of the paper, all equilibria referred to are stable unless explicitly stated otherwise.

A global equilibrium is characterised by the seven domestic equilibrium equations and their foreign counterparts. To summarise, the exogenous parameters of the equilibrium system are  $\sigma_i = \sigma_i^*$ ,  $\sigma_j = \sigma_j^*$ ,  $\mu_i = \mu_i^*$ ,  $\mu_j = \mu_j^*$ ,  $v_i = v_i^*$  and  $v_j = v_j^*$  while the endogenous parameters are  $Y$ ,  $Y^*$ ,  $E_i$ ,  $E_j$ ,  $E_i^*$ ,  $E_j^*$ ,  $Q_i$ ,  $Q_j$ ,  $Q_i^*$ ,  $Q_j^*$ ,  $w_i$ ,  $w_j$ ,  $w_i^*$  and  $w_j^*$ . The domestic and foreign protection levels  $\tau_i$ ,  $\tau_j$ ,  $\tau_i^*$  and  $\tau_j^*$  are kept exogenous in solving for global equilibrium and the identified trade policy effects are based on alterations in global equilibrium outcomes. To simplify the further exposition of global equilibria, the case when each country is active in both industries is referred to as a *dispersed equilibrium*, with a *symmetric equilibrium* constituting the special case of identical domestic and foreign production and trade structures, and an *agglomerated equilibrium* refers to the case when at least one country is completely specialised in one industry. We follow previous researchers in restricting net agglomeration forces to be sufficiently weak



for dispersed equilibria to exist at some trade cost levels that are symmetric across countries. In the modified Krugman and Venables (1996) model, this so-called no-black-hole condition is industry-specific and corresponds to  $\sigma_i(1 - \mu_i + v_i) > 1$  for industry  $i$ .

## 2.1 The equilibrium structure

The various equilibrium structures of the model are presented in this subsection. To facilitate the presentation, the consequences of each modification of the original model are described separately. The equilibrium structure is found using the same basic simulation techniques as Krugman and Venables (1996).<sup>8</sup> The simulation results throughout the rest of the paper are based on numerous simulations in the following large parameter intervals:  $1 < \sigma_i, \sigma_i^*, \sigma_j, \sigma_j^* \leq 4$ ,  $0.1 \leq \mu_i, \mu_i^*, \mu_j, \mu_j^* \leq 0.6$ ,  $0.05 \leq v_i, v_i^*, v_j, v_j^* \leq 0.4$  and  $1.01 \leq \tau_i, \tau_j, \tau_i^*, \tau_j^* \leq 10$ .<sup>9</sup>

Figure 1 displays the equilibrium structure obtained when the original model is modified to allow for industry asymmetries in trade cost levels. The break point schedule depicts the lower trade cost boundary of symmetric equilibria and the sustain point schedule depicts the upper trade cost boundary of agglomerated equilibria. As discussed in detail by previous researchers, this pattern reflects that trade liberalisation eventually leads to strong enough agglomeration economies for symmetric equilibria to be replaced by agglomerated equilibria. As trade costs are reduced, it becomes less profitable for firms to be located close to final goods' consumers and more profitable to be located close to other firms (and share the demand and cost benefits of industry concentration). In the figure, the equilibrium structure of the original model is the special case of industry symmetry marked by the 45-degree line.

*FIGURE 1 ABOUT HERE*

As can be seen from figure 1, break and sustain points, which are unique in the original model, become numerous when allowing for industry asymmetries in trade cost levels. With trade cost asymmetry between industries, one-dimensional sustain and break points can be specified as thresholds in one industry's trade cost level at which the equilibrium structure is altered given the trade cost level in the other industry. As can be seen from figure 1, these one-dimensional sustain and break points may however not be unique. First, there can be two sustain points marking an agglomerated equilibrium interval. In this case, there is a lower sustain point below which no agglomerated equilibria are sustainable due to a relatively large trade cost gap between industries. Specifically, industry concentration becomes unprofitable in the low trade-cost industry due to high import costs on intermediate inputs produced in the high trade-cost industry. Second, there can be two break points depicting an interval outside which there are symmetric equilibria. This implies that there may be a lower break point below which symmetric equilibria exist, reflecting the fact that a dispersion of economic activity becomes viable when the industry gap in trade cost levels grows sufficiently large.

In figure 2 and 3, the equilibrium structure is displayed when the original model is modified further to allow for industry asymmetries in substitution elasticities and input cost shares. These figures are directly comparable to figure 1 in using the same parameter values except for a deviation in one industry

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<sup>8</sup>The interested reader is referred to their paper for details and to Fujita, Krugman and Venables (1999) for a general description of simulation approaches used to identify equilibria in new economic geography models.

<sup>9</sup>Within the range of trade cost levels underlying the simulations, between 10 and around 100 percent of shipped goods arrive at their destination. See Anderson and Wincoop (2003) for a survey of trade cost estimates.

variable. Comparing figure 1 and 2 shows that a reduced substitution elasticity in industry  $j$  leads to an outward shift of the break and sustain point schedules. These shifts reflect that the trade cost impact on production costs is enhanced by the fact that varieties are poorer substitutes, which increases the firm benefits of industry concentration. The shifts are larger along the industry- $j$  trade cost axis as a higher cost share is placed on intermediate inputs from the same industry.

*FIGURE 2 ABOUT HERE*

*FIGURE 3 ABOUT HERE*

In comparison, figure 2 and 3 shows that a reduction in the own input cost share in industry  $j$  leads to a downward shift of the break point schedule and an inward shift of the sustain point schedule. These shifts display that a reduction of the own input cost share increases the relative firm gains of locating close to consumers, thereby reducing the sustainability of agglomeration per se. In addition, the inward shift of the sustain point schedule is larger along the industry- $j$  trade cost axis as the negative impact on agglomeration economies in the own industry exceeds the negative impact (transferred through inter-industry input-output linkages) on agglomeration economies in the other industry.

Allowing for international trade cost asymmetries does not change the general outcome that economic activity becomes concentrated when trade is sufficiently liberalised. Unilateral trade policy does influence the net benefits of industry concentration, however, which implies that a country can use its trade policy stand to alter the current production structure. This general result has been shown to prevail by previous researchers in new economic geography models including one agglomeration industry.

To present the general simulation results of unilateral trade policy effects on the production pattern, we use an additional graphical representation of the equilibrium structure provided by Krugman and Venables (1996). In figure 4 to 7, the domestic and foreign industry- $i$  employment shares are measured along the two axes and domestic and foreign equilibrium curves trace out the employment combinations consistent with national wage equalisations between industries. The wage in industry  $j$  exceeds (is exceeded by) that in industry  $i$  above (below) an equilibrium curve. Since workers move into the industry offering the highest wage, a country that is active in both industries automatically moves towards its equilibrium curve. In contrast, a country that is active in only one industry may not move towards its equilibrium curve as a nation's complete specialisation is consistent with a (theoretical) industry gap in wages.

A global dispersed equilibrium is characterised by wage equalisations within countries, implying that it occurs at the intersection of the domestic and foreign equilibrium curve. In turn, a global agglomerated equilibrium can be located in between equilibrium curve intersections with an axis. If domestic and foreign wage gaps in the neighbourhood of the equilibrium create a worker movement between industries towards the equilibrium point, the global equilibrium is stable. To simplify the exposition of unilateral trade policy effects on the equilibrium structure, there is an initial trade cost symmetry between countries in the figures below. The displayed policy effects are based on general movements of the equilibrium curves shown to prevail in numerous simulations (including those based on an initial trade cost asymmetry between countries).

*FIGURE 4 ABOUT HERE*

*FIGURE 5 ABOUT HERE*

FIGURE 6 ABOUT HERE

FIGURE 7 ABOUT HERE

The above figures display protection effects on equilibrium structures incorporating a symmetric equilibrium (in figure 4), a combination of symmetric and agglomerated equilibria (jointly shown in figure 5 and 6) and agglomerated equilibria (in figure 7).<sup>10</sup> As can be seen from these figures, a protectionist industry- $i$  policy leads to an outward shift of the domestic equilibrium curve and an inward shift of the foreign equilibrium curve. Due to the symmetry of the model, a protectionist industry- $j$  policy has the opposite effect on the equilibrium curves. These protection effects are systematic and prevalent for all underlying parameter combinations in the simulations and, as can be seen from the figures, lead to a replacement of equilibria for large enough unilateral trade cost deviations (unless the home country already is completely specialised in the targeted industry).<sup>11</sup> As can be seen from the graphs, the systematic shifts of the equilibrium curves yield the same overarching effect on the production pattern, no matter which the initial equilibrium structure is, providing that the unilateral policy deviation is sufficiently large.<sup>12</sup> Moreover, this effect is established even if the policy deviation leads to a replacement of the equilibrium structure itself. Specifically, the simulation results reveal that a country always can replace an equilibrium with one characterised by a larger domestic production in the targeted industry. The result that a country can use protection to raise its production in an industry replicates the one obtained by previous researchers in new economic geography models incorporating one agglomeration industry.<sup>13</sup>

The strategic role played by protection in the new economic geography framework can be attributed to the impact of trade cost asymmetries on firms' relative profitability of setting up production or remaining in a particular location. First, the unilateral protectionist support of an industry raises domestic firm profits in the targeted industry. Second, the raised relative profitability of domestic production in the targeted industry attracts foreign producers into the home country. Third, the domestic labour market competition is intensified in the process and domestic wages are raised, which leads to reduced firm profits in both industries. Fourth, the adverse effect on domestic firm profits lowers the relative profitability of domestic production, which triggers a firm movement out of the country in the non-targeted industry. The firm movements and labour market adjustments triggered by the protectionist policy dissolves the initial global equilibrium and continue until a global equilibrium is re-established.

The symmetry of the model implies that the results for trade-liberalising policies readily can be interpreted as opposite to those triggered by protection. This implies that a country has trade-liberalising alternatives to the protectionist policies used as instruments in targeting a preferred production pattern (unless initial trade costs are too low for free trade policies to be potent instruments for replacing equilibria). For instance, a country can become specialised in industry  $i$  by use of a domestic protectionist industry- $i$  policy and/or a trade-liberalising industry- $j$  policy. This result can be attributed to general

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<sup>10</sup>In addition to the previously described stable equilibrium structure, unstable equilibria are displayed in the figures. Since an unstable global equilibrium is unsustainable, we abstain from giving any further reference to these equilibria in the rest of the paper.

<sup>11</sup>This effect becomes negligible at very high trade cost levels.

<sup>12</sup>The policy deviation required to replace equilibria range from a marginal change in the case of replacing dispersed equilibria at relatively low trade cost levels to an excessive change needed to replace dispersed equilibria at very high trade cost levels.

<sup>13</sup>See Krugman and Venables, 1995, Puga and Venables, 1999, and Baldwin et. al, 2003.

equilibrium effects in the presence of several agglomeration industries and is novel in a new economic geography context.

The result that trade liberalisation can be used to raise the domestic production in an agglomeration industry is consistent with the result obtained by Puga and Venables (1999). As previously described, they show that a developing country can liberalise its trade in an agglomeration industry to establish an economic foundation for its production in the targeted industry. Their result hinges on the fact that the wage gap between countries becomes large enough for producers in the agglomeration industry to gain more from low labour costs than from a proximity to the agglomeration of their industry and a direct access to the larger market. The focus on similar countries in our model implies that international labour cost differences play a smaller role in determining the location of production. In fact, the strong country similarity implies that relative labour costs always impose a weaker effect on the location choice of firms compared to relative market sizes and the relative openness of markets. The strongest effect of a trade-liberalising policy on the location choice of firms in our model is therefore to raise the relative benefit of foreign production in the industry by increasing the foreign country's attractiveness as an export base.

### 3 National welfare effects of unilateral trade policy

In this section, the national welfare effects of unilateral trade policy are described and optimal policies are identified given the trade policy position of the trade partner. To elucidate the presentation, these effects are examined separately for changes in real income and public good provision.<sup>14</sup> As previous trade policy research performed in the new economic geography framework, the main focus in this paper is placed on the real income effect that captures the combined welfare effect of alterations in market prices and changes in the production and trade pattern. In addition, trade policy effects on the public good provision are identified with reference to changes in the amount of goods collected by the government. The reported welfare comparisons in this section represent general results obtained for numerous simulations in the previously depicted parameter intervals. To simplify the presentation, welfare consequences of policy alterations are described from initial observations based on trade cost symmetry between countries. The results can thereby be directly related to the previously described underlying equilibrium structures. To elucidate the result description throughout the rest of the paper, it is assumed that agglomeration economies are at least as strong in industry  $i$  as in industry  $j$ .

The simulation results reveal that the direct link between the national real income and the domestic specialisation in an industry that has been shown to prevail in new economic geography models based on one agglomeration industry continues to prevail in our setting only in the presence of a relatively large industry gap in agglomeration economies. In this case, a raised domestic specialisation in the industry with stronger agglomeration economies leads to a domestic real income gain. This result is due to the fact that an increased domestic production in the industry with stronger net agglomeration forces leads to larger consumer gains from industry concentration based on reduced domestic market prices.

As described in the previous section, agglomeration economies are stronger in an industry with a lower elasticity of substitution between product varieties, a higher input cost share placed on inputs from the own industry and a lower input cost share placed on other inputs. The inherent agglomeration

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<sup>14</sup>The domestic real income equals  $RI = wQ_i^{-0.5}Q_j^{-0.5}$ .

economies in industry  $i$  can be measured by  $iae_i = (\sigma_i(1 - \mu_i + v_i))^{-1}$ , which replicates the measure of agglomeration economies underlying the no-black-hole condition. With country symmetry in trade costs, agglomeration economies are strengthened by higher trade costs in the own industry and lower trade costs in the other industry as relatively stronger demand and cost linkages are created between firms in an industry receiving raised protectionist support. The industry- $i$  agglomeration economies are therefore increasing in the industry- $i$  trade cost gap  $\tau_i - \tau_j$ . In general, stronger net agglomeration forces enhance the impact of a given industry gap in net agglomeration forces on the allocation of production. This implies that the industry gap in net agglomeration forces required to create a direct link between national real income and the domestic production in the industry with stronger agglomeration forces is smaller, the stronger are the agglomeration economies in the other industry. Based on the described measures of agglomeration economies, a two-dimensional estimate of the industry- $i$  gap in net agglomeration forces is given by  $(gap_{iae}, gap_{i\tau}) = ((\sigma_i(1 - \mu_i + v_i))^{-1} - (\sigma_j(1 - \mu_j + v_j))^{-1}, \tau_i - \tau_j)$ .

#### TABLE 1 ABOUT HERE

In table 1, national welfare effects of unilateral trade policy are reported for observations with relatively large industry gaps in net agglomeration forces. The table contains exogenous parameter values, trade cost levels, the initial equilibrium structure, measures of inherent agglomeration economies, the two-dimensional industry gap in net agglomeration forces, equilibrium production structures as depicted by the domestic and foreign industry- $i$  employment share and the policy impacts on real income, public good provision and national welfare. As previously described, the welfare impact of public good provision depends on the preference parameter  $\theta$ . To provide general evidence of the revenue incentive for protection, the maximum welfare effect of public good provision (based on  $\theta = 0.5$ ) is reported in table 1 together with the interval of possible national welfare outcomes (with contributions of public good provision ranging from  $\theta = 0$  to  $\theta = 0.5$ ).

The real income gain of using trade policy to raise the domestic industry- $i$  production can be verified from observations in the table above. This table also provides evidence of the general simulation result that the real income gain from raising the domestic industry- $i$  production is larger if done by use of a trade-liberalising industry- $j$  policy instead of its protectionist industry- $i$  policy equivalent. This result hinges on the fact that raised trade costs increase market prices and reduce import volumes. Policy effects on welfare in undissolved agglomerated equilibria are also reported in the table. Since the initial specialisation pattern continues to prevail with non-dissolving policies, their real income effect can be entirely attributed to the direct policy effect on domestic market prices and import volumes. This implies that non-dissolving protectionist (trade-liberalising) policies have a negative (positive) effect on national real income by reducing (increasing) the domestic consumption possibilities of marketed goods.<sup>15</sup>

Simulation results show that the public good provision always is higher if a targeted specialisation pattern is established by use of a protectionist policy instead of its trade-liberalising policy equivalent. This general result, which can be seen from observations in table 1, contrasts to the ranking of policy alternatives on the grounds of real income motives as the public good provision is financed by (marketed) goods collected by the government as trade barrier revenues. The effect of non-dissolving policies on the public good provision is entirely attributed to the direct policy impact on the amount of goods collected by the government. Since this amount is increasing in the domestic protection levels for a given

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<sup>15</sup> This result is valid except in the case when all production in the targeted industry takes place in the home country.

domestic production structure, the policy effect on the public good provision is positive (negative) with a protectionist (trade-liberalising) non-dissolving policy.<sup>16</sup>

With a relatively large industry gap in net agglomeration forces, simulations show that the welfare ordering of policy alternatives ranks the real income effect above that of public good provision. This implies that a country gains from using trade liberalisation instead of protectionism to attain a preferred domestic production structure. Due to the strong gains from industry- $i$  specialisation, this result indicates that the optimal policy combination is that which maximises the domestic industry- $i$  production by use of minimal protection. The welfare-maximising unilateral policy stand is therefore a free trade industry- $j$  policy combined with the minimum industry- $i$  protection level required to maximise the domestic industry- $i$  production.<sup>17</sup>

Without a relatively large industry gap in net agglomeration forces, the national welfare is no longer directly linked to the domestic specialisation in one industry. Instead, the real income effect of industry- $i$  specialisation is reduced by the fact that the two industries have agglomeration economies of similar strength. Indeed, simulation results show that this effect can be small enough to be exceeded by the direct policy effect on real income. Simulations also show that, in exceptional cases, this policy combination may yield a total real income effect that is sufficiently small to be exceeded by the welfare effect of public good provision.

#### TABLE 2 ABOUT HERE

In table 2, welfare effects of unilateral trade policy are presented for observations without a relatively large industry gap in net agglomeration forces. For comparability, table 2 reports input values and estimates in the same parameter categories as table 1. The general result that no direct link prevails between national welfare and the domestic industry- $i$  specialisation can be seen from observations in the table. First, there can be real income gains from industry- $j$  specialisation. Second, the use of protection to establish a domestic specialisation in industry  $i$  may lead to a real income loss. Third, the effect of public good provision may (in exceptional cases) exceed the total real income effect.

Simulation results show that there may be real income gains from specialisation *per se* without a relatively large industry gap in net agglomeration forces. In table 2, this result can be seen from observations for which real income gains are made from policies replacing a completely dispersed (symmetric) equilibrium with equilibria characterised by a domestic specialisation in any industry. The largest real income benefit from specialisation is nevertheless attained with a maximised domestic specialisation in the industry with stronger agglomeration economies and, if industries are symmetric, equivalent real income gains are obtained from the maximised specialisation in any industry.

The simulations reveal that, when the real income effect mainly is attributed to the indirect specialisation effect, the previously described ordering of policy effects continues to prevail. In table 2, this result can be recognised from observations for which an increased specialisation leads to welfare gains no matter whether established with a protectionist policy or its trade-liberalising policy equivalent. Since

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<sup>16</sup>This result is valid except in the case when all production in the targeted industry takes place in the home country.

<sup>17</sup>No welfare effect is incurred from raising the industry- $i$  protection level further once all industry- $i$  production takes place in the home country, which implies that there is no upward limit to the optimal use of industry- $i$  protection. We abstain from giving further reference to this case on the grounds of realism since the mere existence of implementation costs for protection would rule out this case.

the relative impact of the different policy effects on welfare replicate those identified for a relatively large industry gap in agglomeration economies in these cases, the same optimal policy is identified unless industries are symmetric. In that case, the optimal policy position is instead a free trade position in each industry since it combines a maximised domestic specialisation with the largest consumption possibilities of marketed goods.<sup>18</sup> In other words, while agglomeration economies are strong enough for the indirect real income effect of specialisation to exceed other policy effects on welfare, there is no incentive to use protection as long as agglomeration economies are as strong in the two industries.

If the direct policy effect is the predominant real income effect, there are real income gains from trade liberalisation and real income losses from protection no matter which the established specialisation pattern is.<sup>19</sup> In table 2, this case can be seen from observations for which protection (trade liberalisation) that increases (reduces) the domestic industry- $i$  specialisation leads to a real income loss (gain). In these cases, the simulation results show that the real income effect always exceeds the welfare effect of public good provision if a trade liberalising policy is used (so that the two real income effects reinforce each other) and, so that the optimal trade policy stand is a free trade position. This ordering of welfare effects is also valid for non-dissolving policies as can be seen from the example provided in the table. On the basis of these and the previous results, the revenue motive for protection can be ruled out as a determinant of the optimal policy stand, which is a result coherent with the empirical observation that trade barrier revenues impose a negligible impact on national income in industrialised countries.

### 3.1 Strategic trade-policy interactions

This section describes the strategic trade-policy interactions between countries, which intuitively can be interpreted as the home country's unilateral policy stand vis-à-vis a policy position summarising the multilateral policies of its trade partners. In practice, the strategic trade policies could correspond to policy stands that the home country and its trade partners bring to the table in trade negotiations. Since our main objective is to identify strategic policy positions consistent with global equilibrium in the trade model, the policy game takes the form of a non-cooperative game in which the trade partners simultaneously choose policy strategies that maximise their national welfare levels. Equilibrium policies thereby constitute policy strategies that are independently targeted as nationally welfare-maximising when global equilibrium effects on the trade and production pattern are taken into account.

The policy game is assumed to be a Nash game where equilibrium outcomes are defined by the fact that none of the trade partners want to deviate from their chosen policy strategies given the policy position of the other country. The countries are assumed to be perfectly informed of the trade partner's nationally welfare-maximising objective, global economic conditions and the consequences of each domestic and foreign policy choice. A simple one-shot game is used to formalise strategic trade-policy interactions in our model in coherence with the fact that the time dimension is absent in the new economic geography framework.

Since the optimal policies in the previous section were identified given the trade partner's policy position, it is sufficient to establish that these policies are mutually consistent to identify a Nash equilibrium. As previously described, with a relatively large industry gap in net agglomeration forces, it is optimal for

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<sup>18</sup>Due to the simplifying assumption that miniscule natural trade costs exist at free trade, a maximised specialisation also occurs if the trade partner uses a free trade position.

<sup>19</sup>This result is valid except for non-dissolving policies used in an industry in which all the production is domestic.

a country to use a free-trade industry- $j$  position combined with the industry- $i$  protection level required to attain a maximised domestic industry- $i$  specialisation. This implies that one of the countries always gains from raising its industry- $i$  protection level above that of its trade partner to establish a locational equilibrium characterised by its maximised industry- $i$  production. This result indicates that no Nash equilibrium exists and reflects the "tariff war" outcome previously identified for new economic geography models with one agglomeration industry.<sup>20</sup>

Without a relatively large industry gap in agglomeration economies, the outcomes of the policy game can be categorised into two groups based on the identified policy optimality. When the optimal policy choice replicates the one attained with a relatively large industry gap, so does the outcome of the strategic policy game. This result hinges on the fact that a maximised domestic industry- $i$  specialisation can be optimal even if other policy effects on welfare are large enough to undercut the direct link between national welfare and domestic industry- $i$  production. This replication of the "tariff war" outcome can be directly attributed to a relatively large welfare impact of industry- $i$  specialisation.

The optimal policies were identified as free trade policies for all remaining underlying parameter combinations, implying that the mutually coherent equilibrium policies of the Nash game are free trade positions. This policy equilibrium is consistent with a maximised international specialisation due to the simplifying assumption that very small natural trade costs exist so that an agglomerated equilibrium structure prevails at free trade. Notably, each country's welfare is maximised with respect to its own policy position as well as that of its trade partner in this Nash equilibrium. This is the consequence of that the largest domestic consumption possibilities of marketed goods are attained at free trade in combination with the fact that the opportunity cost of marketed good consumption is too high for public good consumption to occur in equilibrium. The free trade policy equilibrium is based on industry symmetry and/or weak agglomeration economies (partially due to the inter-industry use of intermediate inputs).

## 4 Summary and Concluding Remarks

In this paper, the strategic use of protection in agglomeration and trade models (within the so-called new economic geography framework) has been revisited. Specifically, we have examined whether the welfare argument to protect agglomeration industries carries over to a new economic geography model including more than one agglomeration industry. In so doing, particular focus has been placed on the role played by input-output linkages between industries with reference to evidence that these linkages matter for production in agglomeration industries.

The paper's approach has been to examine national welfare effects of unilateral trade policy in a modified Krugman and Venables (1996) model in order to identify the policy optimality. This was done on the basis of policy effects on the relative sizes of the direct real income effect, the indirect real income effect caused by specialisation and the effect on the domestic public good provision (financed by trade barrier revenues). Our results showed that industry asymmetries in agglomeration economies play a vital role in determining the policy optimality. If the gains from agglomeration, as measured in terms of net agglomeration forces, are sufficiently larger in one industry compared to the other, the welfare-maximising policy is similar to that identified by previous researchers in that it is optimal to protect

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<sup>20</sup>See Baldwin et. al. (2003).



the industry with stronger agglomeration economies to increase the domestic equilibrium production in that industry. Specifically, the optimal policy in this case is the protection level required to attain a maximised domestic specialisation in the industry with stronger agglomeration economies combined with a free trade policy in the other industry. The downward pressure placed on the domestic use of protection is due to the direct policy effect on real income, which reduces the domestic consumption possibilities of marketed goods by raising import prices and reducing import volumes.

For the remaining combinations of underlying parameter values, free trade policies are optimal. This result, which stands in clear contrast to the results of previous researchers in the area, can rely on the fact that a complete trade liberalisation maximises welfare when the direct policy effect constitutes the predominant real income effect or on the prevalence of as strong agglomeration economies in the two industries. Though the revenue motive for protection can occasionally impose the main welfare influence on policy, our results show that it is always optimal for a country to completely liberalise its trade in these cases. This implies that the revenue motive for protection never determines the optimal use of policy in our model, which is a result in line with the empirical observation that trade barrier revenues take up a negligible share of government revenues in industrialised countries.

Strategic trade policy interactions were formalised using a simple non-cooperative policy game in which the trade partners simultaneously choose policy strategies maximising their national welfare levels. A Nash game was used to specify the strategic policy equilibrium, which is identical to a mutually consistent use of optimal policies on part of the trade partners. The equilibrium policies of the game were therefore based on the policy optimality obtained for various underlying parameter combinations. For the case when the gains from agglomeration were sufficiently larger in one industry compared to the other, no Nash equilibrium could be found since a country always gains from raising its protection level in the industry with stronger agglomeration economies above that of its trade partner to attain a maximised specialisation in the targeted industry. The result that so-called “tariff war” outcomes result from strategic trade-policy interactions in the new economic geography framework replicates the outcome described by previous researchers. For the remaining parameter combinations, free trade outcomes result from the policy game. This policy equilibrium is a novel discovery in the new economic geography framework and can be directly attributed to the existence of several agglomeration industries in our model. Furthermore, in working as a counterforce against agglomeration, stronger inter-industry input-output linkages enlarge the subcategory of free trade policy outcomes across combinations of the remaining input parameters of the model.

The result that it can be strategic to use a free trade position in a new economic geography framework under general model conditions is coherent with the empirical observation that protection levels are low in bilateral trade between industrialised countries.<sup>21</sup> This implies that the study of trade and agglomeration models can contribute to our understanding of trade policy implementation in practice. On one hand, our free trade results rely on cases when the indirect real income effect of specialisation does not constitute the predominant real income effect so that the impact of agglomeration economies on overall welfare is relatively weak. On the other hand, the optimality of free trade can be due to industry symmetry so that both countries can gain from specialisation and trade despite the fact that production is characterised by strong agglomeration economies.

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<sup>21</sup>This observation has generally been explained by the high share of intra-industry trade prevalent between rich, industrialised trade partners. See, amongst others, Greenaway and Hine (1991), Hufbauer and Chilas (1974) and Krugman (1982).

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## TABLES

**Table 1: National welfare effects of unilateral trade policy with a relatively large industry gap in net agglomeration forces<sup>a</sup>**

$\sigma_i, \sigma_j$	$\mu_i, \mu_j$	$v_i, v_j$	$\tau_i, \tau_j$	$eqst_{in}$	$iae_i, iae_j$	$gap_{i \leftrightarrow j}$	$\tau'_i, \tau'_j$	$L_i, L_i^*$	$L'_i, L'_i^*$	$\Delta RI$	$\Delta PG_{max}$	$\Delta u_{min}, \Delta u_{max}$
2,2	0.30,0.10	0.05,0.05	1.10,1.10	agg	0.67,0.53	0.14,0.00	1.20,1.10	1.00,0.00	1.00,0.00	-4.00*10 <sup>-4</sup>	1.00*10 <sup>-4</sup>	-4.00*10 <sup>-4</sup> , -3.00*10 <sup>-4</sup>
2,2	0.30,0.10	0.05,0.05	1.10,1.10	agg	0.67,0.53	0.14,0.00	1.10,1.00	1.00,0.00	1.00,0.00	0.10	-0.03	0.07,0.10
2,3	0.30,0.20	0.10,0.10	1.50,1.50	agg	0.65,0.37	0.26,0.00	2.20,1.50	0.00,0.97	0.97,0.00	0.32	-0.01	0.31,0.32
2,3	0.30,0.20	0.10,0.10	1.50,1.50	agg	0.65,0.37	0.26,0.00	1.50,1.00	0.00,0.97	0.97,0.00	0.93	-0.13	0.80,0.93
2,3	0.30,0.20	0.10,0.10	1.50,1.30	agg	0.65,0.37	0.26,0.20	3.20,1.30	0.00,0.98	0.98,0.00	0.50	-0.05	0.45,0.50
2,3	0.30,0.20	0.10,0.10	1.50,1.30	agg	0.65,0.37	0.26,0.20	1.60,1.30	0.00,0.98	0.00,0.98	-8.00*10 <sup>-4</sup>	1.00*10 <sup>-4</sup>	-7.00*10 <sup>-4</sup> , -8.00*10 <sup>-4</sup>
2,3	0.30,0.20	0.10,0.10	1.50,1.30	agg	0.65,0.37	0.26,0.20	1.40,1.30	0.00,0.98	0.00,0.98	1.00*10 <sup>-3</sup>	-1.00*10 <sup>-4</sup>	9.00*10 <sup>-4</sup> , 1.00*10 <sup>-3</sup>
3,3	0.30,0.30	0.20,0.20	1.50,1.20	sym	0.37,0.37	0.00,0.30	1.60,1.20	0.50,0.50	0.72,0.27	0.09	-0.02	0.07,0.09
3,3	0.30,0.30	0.20,0.20	1.50,1.20	sym	0.37,0.37	0.00,0.30	1.50,1.15	0.50,0.50	0.72,0.27	0.19	-0.03	0.16,0.19
4,4	0.30,0.30	0.10,0.10	1.50,1.20	sym,agg	0.31,0.31	0.00,0.30	1.70,1.20	0.50,0.50	1.00,0.00	0.07	-0.00	0.07,0.07
4,4	0.30,0.30	0.10,0.10	1.50,1.20	sym,agg	0.31,0.31	0.00,0.30	1.50,1.15	0.50,0.50	1.00,0.00	0.09	-0.01	0.08,0.09
4,4	0.30,0.30	0.10,0.10	1.50,1.20	sym,agg	0.31,0.31	0.00,0.30	1.50,1.10	0.50,0.50	1.00,0.00	0.12	-0.03	0.09,0.12

<sup>a</sup>Observations report a domestic trade cost deviation (denoted ') from trade cost levels that are symmetric between countries.

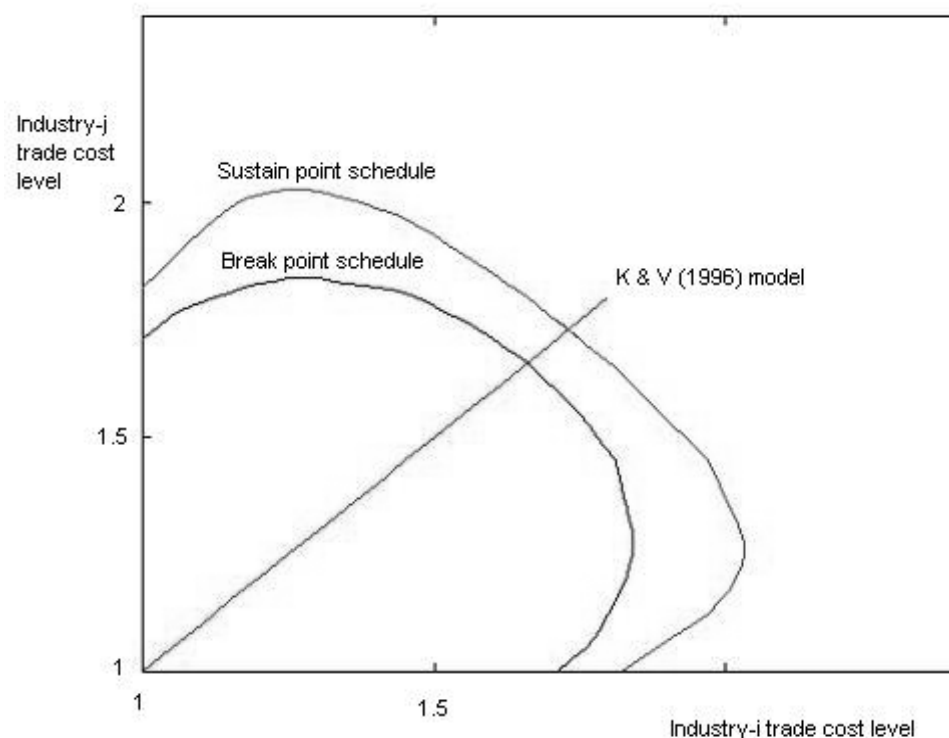
**Table 2: National welfare effects of unilateral trade policy without a relatively large industry gap in net agglomeration forces<sup>a</sup>**

$\sigma_i, \sigma_j$	$\mu_i, \mu_j$	$v_i, v_j$	$\tau_i, \tau_j$	$eqst_{in}$	$iae_i, iae_j$	$gap_{iesgap_{ir}}$	$\tau'_i, \tau'_j$	$L_i, L_i^*$	$L'_i, L_i^{*'}$	$\Delta RI$	$\Delta PG_{max}$	$\Delta u_{min}, \Delta u_{max}$
2,2	0.20,0.20	0.10,0.10	1.30,1.30	agg	0.56,0.56	0.00,0.00	1.40,1.30	1.00,0.00	1.00,0.00	-1.70*10 <sup>-3</sup>	2.5*10 <sup>-3</sup>	-1.70*10 <sup>-3</sup> , -1.45*10 <sup>-3</sup>
2,2	0.20,0.20	0.10,0.10	1.30,1.30	agg	0.56,0.56	0.00,0.00	1.00,1.30	1.00,0.00	1.00,0.00	0.10	-0.02	0.08,0.10
2,2	0.20,0.20	0.10,0.10	1.30,1.30	agg	0.56,0.56	0.00,0.00	1.70,1.30	1.00,0.00	0.00,1.00	-6.00*10 <sup>-3</sup>	7.5*10 <sup>-4</sup>	-6.00*10 <sup>-3</sup> , -5.25*10 <sup>-3</sup>
2,2	0.20,0.20	0.10,0.10	1.30,1.30	agg	0.56,0.56	0.00,0.00	1.30,1.00	1.00,0.00	0.00,1.00	0.36	-0.09	0.27,0.36
3,3	0.30,0.20	0.10,0.10	1.50,1.50	sym	0.42,0.37	0.05,0.00	2.20,1.50	0.50,0.50	1.00,0.00	0.14	0.02	0.14,0.16
3,3	0.30,0.20	0.10,0.10	1.50,1.50	sym	0.42,0.37	0.05,0.00	1.50,1.00	0.50,0.50	1.00,0.00	0.26	-0.08	0.18,0.26
3,3	0.30,0.20	0.10,0.10	1.50,1.50	sym	0.42,0.37	0.05,0.00	1.50,1.60	0.50,0.50	0.00,1.00	-0.03	0.04	0.01,0.04
3,3	0.30,0.20	0.10,0.10	1.50,1.50	sym	0.42,0.37	0.05,0.00	1.40,1.50	0.50,0.50	0.00,1.00	0.06	0.03	0.06,0.09
3,3	0.30,0.30	0.20,0.20	1.50,1.40	sym	0.37,0.37	0.00,0.10	1.70,1.40	0.50,0.50	0.72,0.27	-0.01	0.01	-0.01,0.01
3,3	0.30,0.30	0.20,0.20	1.50,1.40	sym	0.37,0.37	0.00,0.10	1.50,1.30	0.50,0.50	0.72,0.27	0.13	-0.02	0.11,0.13
3,3	0.30,0.30	0.20,0.20	1.50,1.40	sym	0.37,0.37	0.00,0.10	1.50,1.20	0.50,0.50	1.00,0.00	0.39	-0.03	0.36,0.39
4,4	0.20,0.20	0.10,0.15	1.10,1.10	sym,agg	0.28,0.26	0.02,0.00	1.20,1.10	0.50,0.50	1.00,0.00	0.01	0.01	0.00,0.01
4,4	0.20,0.20	0.10,0.15	1.10,1.10	sym,agg	0.28,0.26	0.02,0.00	1.10,1.00	0.50,0.50	1.00,0.00	0.06	-0.03	0.03,0.06

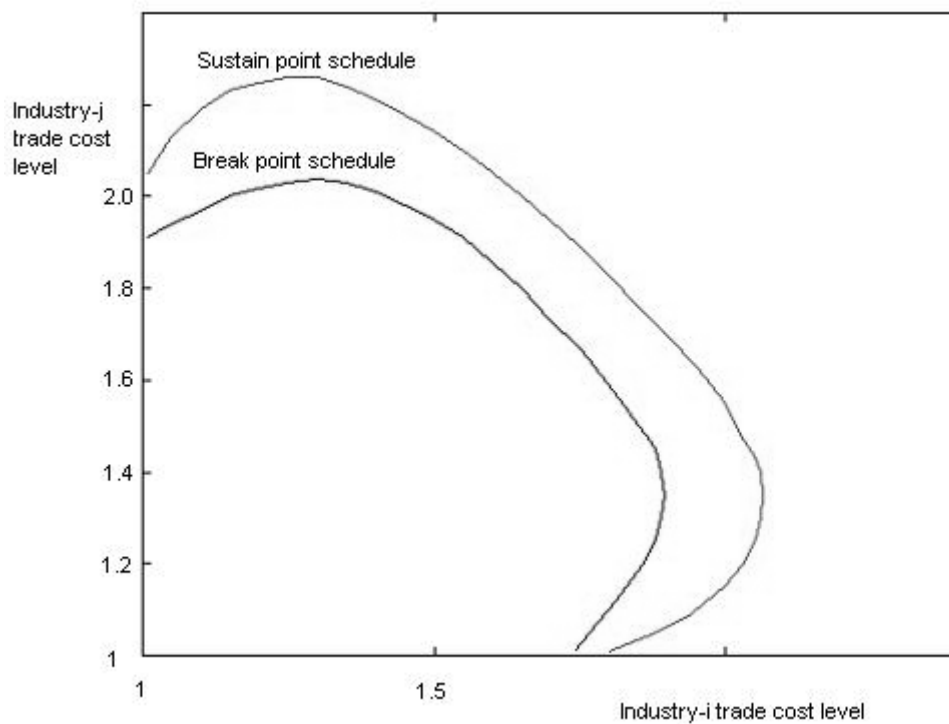
<sup>a</sup> Observations report a domestic trade cost deviation (denoted ') from trade cost levels that are symmetric between countries.

## **FIGURES**

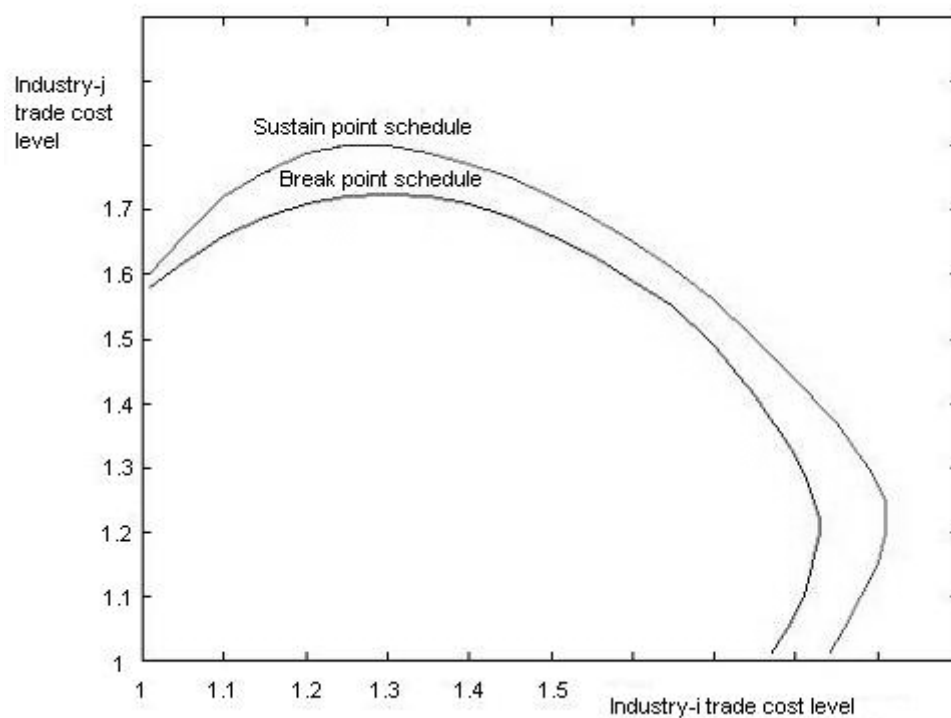
**Figure 1: Equilibrium structure with asymmetric trade cost levels between industries**



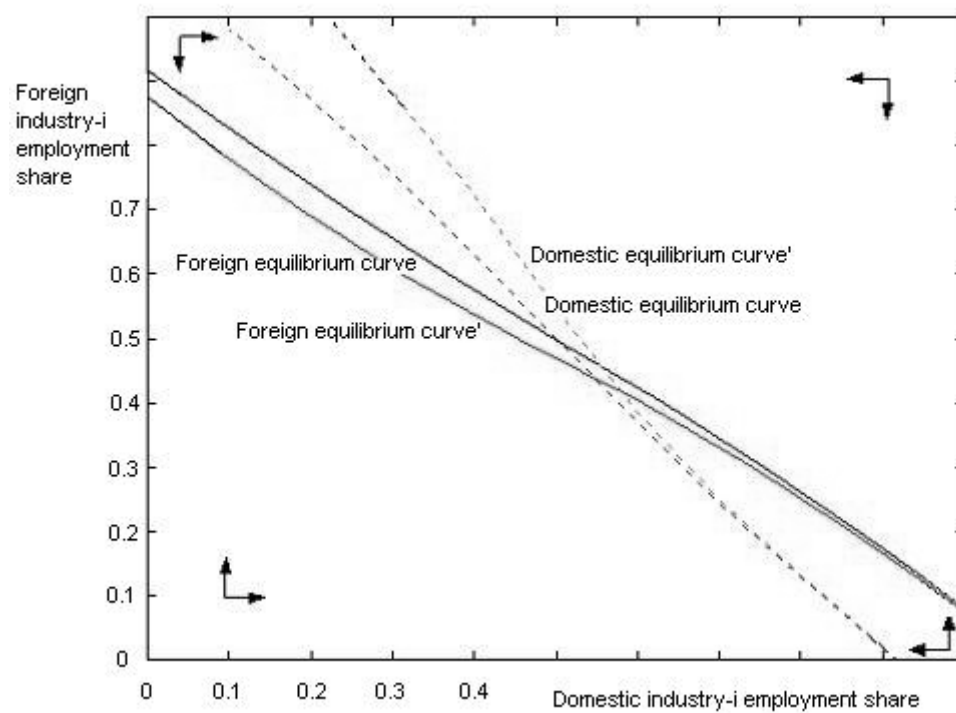
**Figure 2: Equilibrium structure with industry asymmetries in trade costs and substitution elasticities**



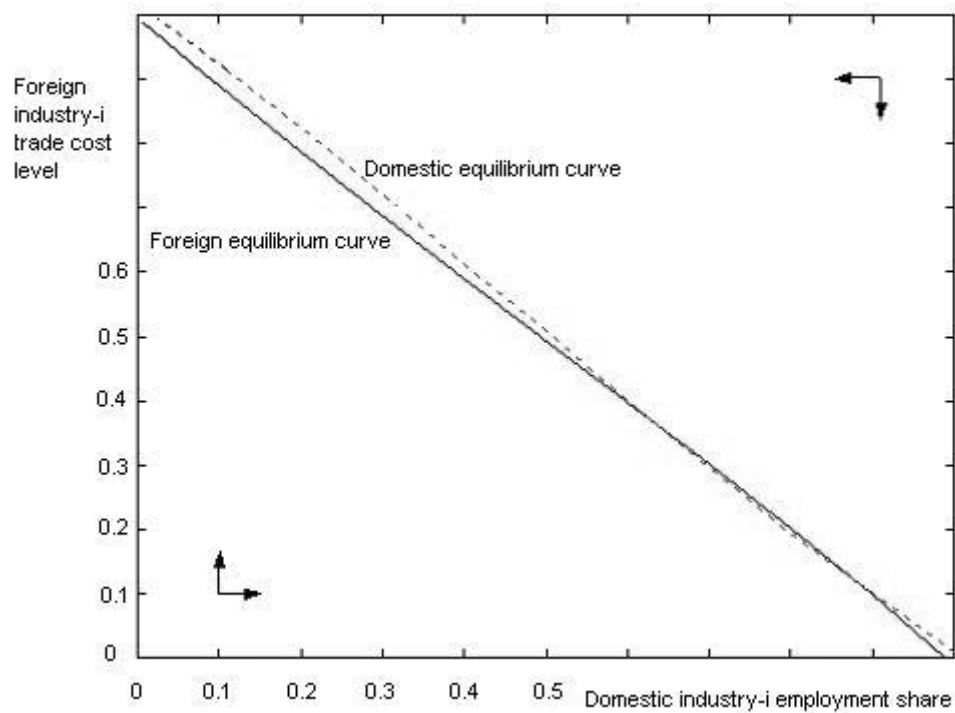
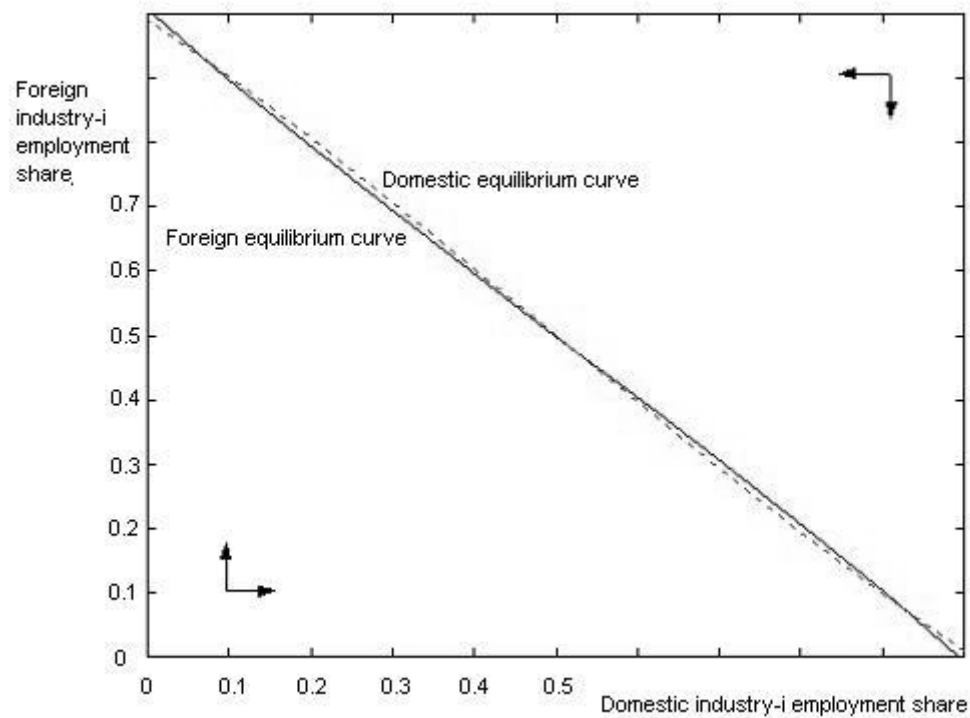
**Figure 3: Equilibrium structure with industry asymmetries in trade costs and input cost shares**



**Figure 4: Effects of raising the domestic industry-i protection level from a symmetric equilibrium structure**

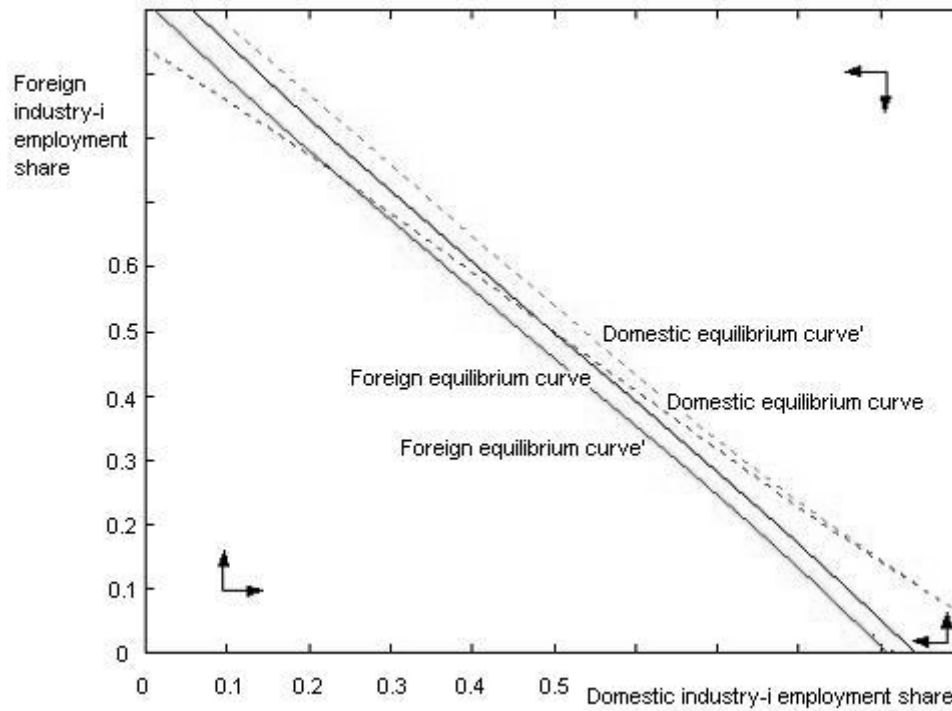


**Figure 5 and 6: Effects of raising the domestic industry-i protection level from a combined symmetric and agglomerated equilibrium structure**





**Figure7: Effects of raising the domestic industry-i protection level from an agglomerated equilibrium structure**



Input parameter values underlying the figures are as follows (reported by figure: input values). Figure 1:  $\sigma_i = \sigma_j = 4$ ,  $\mu_i = \mu_j = 0.4$ ,  $v_i = v_j = 0.1$ ; Figure 2:  $\sigma_i = 4$ ,  $\sigma_j = 3.6$ ,  $\mu_i = \mu_j = 0.4$ ,  $v_i = v_j = 0.1$ ; Figure 3:  $\sigma_i = \sigma_j = 4$ ,  $\mu_i = 0.4$ ,  $\mu_j = 0.35$ ,  $v_i = v_j = 0.1$ ; Figure 4:  $\sigma_i = \sigma_j = 4$ ,  $\mu_i = 0.4$ ,  $\mu_j = 0.35$ ,  $v_i = v_j = 0.1$ ,  $\tau_i = \tau_i^* = 2$ ,  $\tau_j = \tau_j^* = 2$  and  $\tau_i' = 3$ ; Figure 5:  $\sigma_i = \sigma_j = 4$ ,  $\mu_i = 0.4$ ,  $\mu_j = 0.35$ ,  $v_i = v_j = 0.1$ ,  $\tau_i = \tau_i^* = 1.7$ ,  $\tau_j = \tau_j^* = 1.7$ ,  $\tau_i' = 1.8$ ; Figure 6:  $\sigma_i = \sigma_j = 4$ ,  $\mu_i = 0.4$ ,  $\mu_j = 0.35$ ,  $v_i = v_j = 0.1$ ,  $\tau_i = \tau_i^* = 1.5$ ,  $\tau_j = \tau_j^* = 1.5$  and  $\tau_i' = 2.1$ .