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# Home Market Effect, Regulation Costs and Heterogeneous Firms[1]

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## ABSTRACT

This paper studies how market-specific entry sunk costs (regulation costs) affect the Home Market Effect (HME) with firm heterogeneity in marginal costs. Our model is based on the Dixit-Stiglitz monopolistic competition model with firm heterogeneity plus regulation costs difference. We find that a regulation costs gap works as dispersion force by inducing a market potential gap, which reduces the HME and could cause the reverse HME or the anti-HME. The HME first rises and then fall in terms of trade openness, whereas the HME rises in terms of regulation costs gap coordination by technical barriers to trade (TBT) agreements. Firm heterogeneity dampens the dispersion force by the regulation costs difference and thus works as an agglomeration force. Firm heterogeneity causes a perfect spatial sorting, in which a large country attracts only high productivity firms, and vice versa.

**JEL: F12, F15, R12, R38**
**Keywords**: home market effect, firm heterogeneity, regulation costs, technical barriers to trade

Ce papier étudie comment des coûts d'entrée (coûts de régulation), spécifiques à chaque marché, amendent le «Home Market Effect» (HME) en présence de firmes hétérogènes en terme de coûts marginaux. Nous trouvons que l'hétérogénéité des firmes crée une nouvelle force d'agglomération. Cette hétérogénéité implique un classement spatial des firmes en fonction de leur productivité, le grand pays attirant les firmes les plus productives. D'autre part, la différence de coûts de régulation entre pays induit une force de dispersion des activités, ce qui réduit l'effet HME. Nous trouvons alors qu'une libéralisation du commerce renforce puis réduit le HME. De plus, une réduction des barrières non tarifaires augmente le HME, renforçant donc les inégalités entre pays.

**JEL: F12, F15, R12, R38**
**Mots clés**: Effet du marché domestique, hétérogénéité des firmes, coûts de régulation, barrières non tarifaires

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# 1. Introduction

The Home Market Effect (HME) is one of the most striking features in the so-called New Trade Theory, initiated by Krugman (1980) and Helpman and Krugman (1985): a large country could attract a more than proportional share of firms in industries characterised by imperfect competition, increasing returns to scale (IRS) and trade costs. Our paper aims at examining the effect of country-specific entry costs differences on the HME with firm heterogeneity.

Various empirical evidences on the HME have been provided (Davis and Weinstein, 1996, 1999, and 2003; Redding and Venables, 2004; Trionfetti, 2001).[4] To predict these various empirical evidences, theory related to the HME has been developed by modifying and relaxing some assumptions of the Krugman (1980) and Helpman and Krugman (1985) models. For example, Head and Ries (2001) introduced national product differentiation into the perfect competition and constant returns to scale (CRS) sector in the Armington approach. Davis (1998), which modelled the CRS sector with trade costs, found a kinked firm share expenditure share diagram. More recent studies on the HME have sought to explain evidences in the multi-country framework (Behrens et al., 2004).[5]

These laborious efforts for theoretical modification have stemmed from mixed empirical evidence. A perfect example is the reverse HME (the production or firm share in the IRS sector is less than proportional to the expenditure share in the world, but they still have a positive correlation) or anti-HME (the production share is negatively correlated with the expenditure share). The reverse HME and anti-HME could be observed in many empirical evidences. In response, Head and Mayer (2001) concluded that the cause of the reverse HME lies in imperfectly elastic labour. Furthermore, the reverse HME was shown in a non-linear HME diagram by Crozet and Trionfetti (2005), introducing trade costs into both IRS and CRS sectors. One of the purposes of our paper is to investigate another possibility to explain the reverse HME and the anti-HME. We keep Helpman and Krugman's framework as much as possible intact: without modifying the CRS sector and without assuming an inelastic labour supply. Our paper modifies the IRS sector by introducing market-specific sunk costs, called regulation costs, together with firm marginal costs heterogeneity.

## The Current Literature and Our Paper

Before starting a detailed discussion, we review some current studies to put our paper in perspective. Since the abolishment of internal tariffs in the middle 1970s, Western Europe has been concerned with technical barriers to trade (TBT), such as country-specific regulation and standards. In other words, as Baldwin (2000) pointed out, the reduction of tariff barriers has led to relatively increase trade distortion of regulatory differences with respect to the location of production. In the late 1990s the WTO has sought to reach agreements on the harmonisation of these country-specific regulations and standards. This ongoing

[4] Trionfetti (2001) has shown that if consumers' expenditure is home-biased, the HME could be mitigated. See also Trionfetti and Brulhart (2005).

[5] Behrens *et al.* (2004) put stress on the impact of the third country effect, in which a small country with good access to the other market may well receive a large number of firms: market accessibility crucially affects the production share.

harmonisation of country-specific regulations has a significant effect on international trade (Swann, et al.,1996; Vancauteren, 2002; Vancauteren and Weiserbs, 2003).[6]

**Behrens and Thisse (2005)**
Turning to the HME discussion, a current provisional study draws attention to the above-mentioned country-specific sunk costs differences: Behrens and Thisse (2005) suggested that the basic impact of the asymmetry in country-specific fixed entry costs dampens the HME. In other words, different country-specific market-entry costs work as dispersion force. They concluded that the marginal difference of the market entry sunk costs in favour of the small country (higher costs in the larger country) reduces the HME. Similarly, our paper also provides a model with the market-specific sunk costs, which is positively correlated with market size.

**HME and Firm Heterogeneity**
The HME has been mentioned in a new research avenue, i.e. the heterogeneous-firms trade models, although their focus is not solely on the HME. Indeed, this current research avenue has put forward the important consequences of firm's productivity heterogeneity on international trade (See Bernard and Jensen, 1995, 1999a,b, 2001; Tybout, 2003; Eaton *et al.* ,2004; Bernard et al. 2003). In response, Melitz (2003) showed the reallocation effect via trade liberalisation. Concerning firm heterogeneity and the HME in a theoretical framework, there are two streams: one is Melitz (2003), Falvey et al.(2004), Helpman et al. (2003), Baldwin and Robert-Nicoud (2004), Bernard et al. (2004) and Baldwin and Forslid (2004), all of which use models with free-entry without delocation, and the other is Baldwin and Okubo (2004), which builds on a delocation model without free entry.[7] Both streams are common in marginal costs differences across firms in the Dixit-Stiglitz monopolistic competition model.[8] These streams have shown that some selection effects are at work and affect the average productivity. Even more importantly related to our paper, all models found the usual HME, just as in the homogeneous firm trade model (Helpman and Krugman (1985)). Next, we provide an overview of two seminal papers in more detail.

**Melitz (2003)**
This is a seminal paper in international trade in studying firm heterogeneity in the monopolistic competition model. Based on Krugman (1980), marginal cost differences (firm heterogeneity) and beachhead costs (fixed market-entry sunk costs) are introduced. The model never considers firm relocation between countries, but consider free entry. As a consequence, Melitz found that: 1) high productivity firms can export, 2) trade liberalisation raises the average productivity via a production reallocation effect and via a selection effect, 3) high productivity local producers can enter the export market, while low productivity local producers exit from the market, and 4) the HME can be always observed.

**Baldwin and Okubo (2004)**
This is a pioneering paper in the NEG in investigating the effect of firm heterogeneity on firm location, where firm relocation between countries is allowed and instead free market entry is prohibited. Their model has no fixed entry costs, unlike the Melitz type model, and resembles

[6] Swann, et al. (1996) found a positive effect on the UK trade. Vancauteren (2002) and Vancauteren and Weiserbs (2003) studied the effect of harmonisation on trade in the Gravity Model.
[7] Baldwin and Okubo (2005) sought to combine Melitz (2003) and Baldwin and Okubo (2004). Okubo (2005) studies the spatial sorting by taxation in the vertical linkage model.
[8] Melitz and Ottaviano (2005) is an exception: the Ottaviano Tabuchi and Thisse (2002) trade model with heterogeneous firms. The basic framework is a Melitz mechanism: non-relocation and free entry model.

the footloose capital (FC) model of Martin and Rogers (1995) with marginal cost differences, i.e. firm heterogeneity. They found that 1) high productivity firms in a small market relocate first to a big market (spatial selection effect) as trade gets freer, although low productivity firms do not change their locations (one-way spatial sorting), 2) firm heterogeneity dampens agglomeration process in terms of the number of firms (firm share), 3) the HME is likely to be underestimated in terms of firm share due to firm heterogeneity, regardless of observing the HME. However, firm heterogeneity never affects the HME in terms of production share, which means the HME in the heterogeneous firm trade model is just equal to the one in the homogeneous-firm trade model (i.e. the results in Helpman and Krugman, 1985 and the standard FC model) with respect to production share.

**Our paper**

Our heterogeneous-firms trade model is in the line of Baldwin and Okubo (2004), i.e. an application of firm heterogeneity with delocation but without free-entry. However, while Baldwin and Okubo (2004) excludes market entry sunk costs, we introduce country specific sunk costs (regulation costs) proportional to market size[9]. As a result, we find some contrasting results compared with Baldwin and Okubo (2004): 1) the regulation costs gap results in a market potential difference between countries. This triggers two-way spatial sorting (perfect spatial sorting), in which high productivity firms relocate from the small to the big country whereas low productivity firms relocate from big to small country, inducing an average productivity gap, 2) firm heterogeneity could reduce the dispersion force by the regulation costs gap and in fact could promote the agglomeration force, 3) a non-linear HME diagram comes into appearance and the reverse HME and anti-HME could also appear when the dispersion force is strong, and 4) we could observe the hump-shaped home market magnification effect (HMME) in terms of freeness of trade and pro-HMME in terms of regulation of policy harmonisation.

The paper is organised as follows: Section 2 presents the FC model with regulation costs differences. Then section 3 introduces firm heterogeneity into the model presented in section 2. Section 4 shows the results and studies forces at work, and subsequently policy analysis and intuition are discussed in section 5. Finally a conclusion is provided in section 6.

# 2. The Model with Homogeneous Firms

### A. The augmented footloose capital model—the introduction of regulation costs differences

This section introduces the basic ingredients of the model with regulation costs in the homogeneous firms trade model. Our model is the standard footloose capital (FC) model of Martin and Rogers (1995), plus regulation costs (country-specific sunk costs). Suppose a two-country, i.e. north and south, two-sector, denoted as manufacturing (M) and agriculture (A), and two-factor, i.e. physical capital, K, and labour, L, economy. The two countries are identical in all ways except their market size (northern share of world expenditure: $s_E$=E/(E+E*)), which is a variable in our paper. The total endowment of physical capital and labour in the world are respectively normalised to unity (i.e. $K^W = L^W$ =1). The north is assumed to be the larger market. Both countries are endowed with identical relative factor

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[9] This assumption does not affect our qualitative results. See appendix 1 for details.

supplies. This means that the northern endowment of capital and labour is equally proportional to the world share of expenditure (i.e., $s_E=s_K=s_L$; $s_K=K/(K+K^*)$ and $s_L=L/(L+L^*)$). The two factors are inelastically supplied in each country; capital is assumed to be mobile, while labour is immobile between countries. However, capital owners are immobile between countries. Accordingly, when pressure arises to concentrate manufacturing in one country, physical capital moves but its reward is repatriated to its country of origin, allowing no expenditure shifting. Importantly, since capital can be separated from capital owners, there can be discrepancy between the northern share of capital owners ($s_K=K/(K+K^*)$) and the northern share of employed capital (the northern firm share) ($s_N=n/(n+n^*)$).

The A-sector provides a single homogeneous good that can be freely traded. It is produced under CRS and perfect competition with a unit labour requirement. The homogeneous good is used as a numeraire. Without loss of generality, its price is set equal to 1, so that both countries' wages are equal to 1. On the other hand, the M-sector produces a differentiated good under the Dixit-Stiglitz monopolistic competition, characterised by the presence of IRS with costly trade (i.e. with iceberg trade costs). The cost function of a typical manufacturing variety is characterised by a variable cost which involves labour, while one unit of capital is employed as fixed cost per firm.

On the demand side, the utility function takes the standard quasi-linear form with a CES sub-utility function for the differentiated good produced by the M-sector:

$$U = \mu \ln C_M + C_A,\ C_M = \left( \int_{\in\Theta} c_i^{1-1/\sigma} \right)^{1/(1-1/\sigma)}$$

where $C_M$ and $C_A$ are, respectively, consumption of the composite of M-sector varieties and consumption of the A-sector good, σ, is the constant elasticity of substitution between any two varieties and Θ is the set of all varieties produced. This set is predetermined by endowments since each variety requires a given (and exogenous) amount of capital and the world capital stock is fixed. The demand for any variety k is given by:

$$c_k = \frac{\mu E}{\int_{\in\Theta} p_i^{1-\sigma}} p_k^{-\sigma}$$

Now we add regulation costs to the above FC model, which are beachhead costs and implicitly thought of as sunk costs for firms' operations, sales and business promotion.[10] The regulation costs involve labour. The literature suggests that there are multiple costs associated with launching a new business (see Djankov *et al* (2002)). In particular, Behrens and Thisse (2005) mentioned that these "range from fixed production costs, specialized infrastructure (such as those needed to load and unload cargo) and land on which plants are built, on the one end of the spectrum, to legal procedures, registration fees and administrative delays, on the other. There is no doubt that all these costs considerably vary across countries."

The country-specific sunk costs (regulation costs) as shown in Behrens and Thisse (2005) are discussed in our paper, although our set up is different from theirs on two points. First, their study focuses on how a small difference of country-specific sunk costs between two countries affects the number of firms and the HME in the framework of Ottaviano et al. (2003). On the other hand, our model attempts to study the impact of country-specific sunk (regulation) costs on the HME in the framework of Dixit-Stiglitz monopolistic competition model with firm heterogeneity. The second difference from Behrens and Thisse (2005) is the market-size-dependence of the sunk costs in our paper: proportional to market size (expenditure share and

[10] For the beachhead costs, see Baldwin (1989).

equally population share in our quasi-linear utility function model) for simplicity's sake.[11] According to Mulligan and Schleifer (2004) and Demsetz (1967), regulation levels are positively correlated with population and market size in the market.[12] Applying this idea, regulation costs are modelled in the simplest way, which is proportional to the market size (expenditure share and population) with a linear function for simplicity:[13]

$$R_N = \beta s_E$$
$$R_S = \beta(1-s_E)$$

where $s_E$ is the share of northern expenditure as well as the northern population (the number of workers and capital owners) share (because of $s_E=s_L=s_K$). This allows us to keep symmetry with respect to $s_E$: symmetric market sizes result in identical production shares between the countries due to the same regulation costs.[14] Utilising this regulation costs set-up, pure profits in each country can be expressed as[15]:

$$\pi_N = \frac{\mu E^W}{\sigma N^W} \underbrace{\left( \frac{s_E}{\Delta} + \phi \frac{1-s_E}{\Delta^*} \right)}_{Northern\,Market\,Potential} - \beta s_E$$

$$\pi_S = \frac{\mu E^W}{\sigma N^W} \underbrace{\left( \frac{1-s_E}{\Delta^*} + \phi \frac{s_E}{\Delta} \right)}_{Southern\,Market\,Potential} - \beta (1-s_E)$$

where $E^W$ (world income) and $N^W$ (total number of firms) can be normalised to unity, and $\phi$ is the 'free-ness' of trade: $0 \le \phi \equiv \tau^{1-\sigma} \le 1$ (from 0 with prohibitive iceberg trade costs to 1 with zero iceberg trade costs), and $\Delta$ ($\Delta^*$) (a mnemonic for the denominator of the standard CES demand function) reflects the degree of competition in the north (the south):

$$(1)\quad \Delta = s_N + \phi\left(1-s_N\right) \text{ and } \Delta^* = \phi s_N + \left(1-s_N\right)$$

**B. Equilibrium and the impact of regulation costs differences**

In equilibrium, profits between the two countries are equalised:

$$(2)\quad \pi_N - \pi_S = 0 \Leftrightarrow \frac{\mu}{\sigma}(1-\phi)\left(B-B^*\right) = \beta(2s_E-1)$$

where $B \equiv \frac{s_E}{\Delta}$ and $B^* \equiv \frac{1-s_E}{\Delta^*}$,which is thought of as per-firm demand in each country, i.e. total market expenditure divided by a term that stands for the overall degree of competition in its market. We call $(B+\phi B^*)$ and $(\phi B + B^*)$ the market potential in the north and the south respectively.

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[11] See Sutton (1991) for detailed discussion on endogenous sunk costs.

[12] According to Mulligan and Schleifer (2004), heavily populated states are likely to regulate more activities and regulate each activity in more detail. In order to achieve some kind of uniformity, the big states are more likely to resort to rules and regulations rather than market mechanism. This causes firms to pay higher fixed costs to satisfy more regulations. They suggested that population is an empirically crucial determinant of regulation. Demsetz (1967) suggested that the creation of institution and regulation is determined by market size.

[13] In the quasi-linear utility function model, the share of expenditure is just equal to the share of population.

[14] This is convenient and beautiful in the course of the discussion in the HME, namely the slope of the relationship between the share of expenditure and the share of production in a two-country world. Moreover, it is worth to note that this simplicity has no influence on our main results about the impact of the asymmetry in market potential and in the driving force by firm heterogeneity.

[15] We assume the marginal cost equals to $\sigma - 1/\sigma$ . This allows the price of a representative variety to be unity, like in the standard FC model.

The introduction of regulation costs amends some results from the standard FC model. First of all, regulation costs play the role of dispersion force, similar to the result in Behrens and Thisse (2005)[16]. Since firms have to pay higher regulation costs in the north than in the south, the incentive to locate in the north diminishes. Intuitively, the North must cope with less production (and thus less competition) than in the standard FC model due to the higher regulation costs. The second point, which is the most important mechanism in the discussion below, is that the presence of regulation costs creates a gap in market potential between the countries. With higher regulation costs in the large market, firms can enjoy the benefit from the higher market potential**.** In other words, the burden of higher regulation costs payment protects the higher profits in the north. Thus $(B+\phi B^*) > (\phi B + B^*)$ always holds, as long as the north is larger than the south in market size. This is because B>B* always holds when $s_E$>0.5 in equation (2). Intuitively, the higher regulation costs in the larger market prevent firm location in the large market and deter the agglomeration process. This result contrasts with any other studies. In the NEG literature, the market potential is always equalised through free delocation in equilibrium. (See the standard FC model and Baldwin and Okubo (2004) (2005).) Also in the Melitz type of firm heterogeneity models, the market potential is equalised by free entry.

**Result 1: Regulation costs gap in favour of a small market (lower regulation costs in the small market, and vice versa) works as dispersion force. The presence of the regulation gap between countries leads to a market potential difference between countries: the larger market has the higher market potential.**

### C. The Measurement of the Home Market Effect

A big difference compared to the other papers is the market potential difference between the countries due to the regulation costs gap. This implies that each firm has different levels of production and pure profits between the two countries. Thus, the HME cannot simply measure the relationship between the size of expenditure and the number of firms. Since the HME measures the relationship between the relative size of expenditure and the relative size of production, it should take into account the difference of production between firms located in different countries. To work this out, the production share can be written as a function of the expenditure share:

$$(3)\quad s_P = \frac{(B+\phi B^*)s_n}{(B+\phi B^*)s_n + (\phi B + B^*)(1-s_n)}$$

This can be simplified:

$$s_P = (B+\phi B^*)s_n$$

It follows that the production share weighs the share of the number of firms by their market potential. Figure 1 plots the equation (2) using $s_P$ as index. We add the 45° line, which means no HME (no bias in production share), and the classic HME line (without any regulation costs gap), (1+ϕ)/(1-ϕ)>1, as shown in the FC model and Helpman and Krugman (1985)'s model, for making a good comparison. In the extreme case, if we take a high value of $\beta$ to highlight the dispersion force, the regulation costs term becomes large. This largely dampens the HME and could yield a correlation of less than 1 or even a negative correlation in terms of production and expenditure shares; respectively the reverse HME: the production share is less

[16] Behrens and Thisse (2005) mainly studied the case where a large market has high country-specific entry costs, which is the same as our model.

than proportional to the expenditure share, and the anti-HME: the production share is negatively correlated with the expenditure share. With respect to the home market magnification effect (HMME), we observe the hump-shaped relationship: As trade gets freer, we observe the increased HME with high trade costs (small $\phi$) and the decreased HME with low trade costs (high $\phi$).

Finally, in order to compare with the HME diagram in the previous studies, the equation (2) can be re-written in terms of firm share and expenditure share:

$$(4) \quad (s_n - 0.5) = (s_E - 0.5) \underbrace{\left(\frac{1+\phi}{1-\phi}\right)}_{classical\ HME} \left(1 - \underbrace{\frac{\sigma}{\mu} \frac{2\beta\left((s_n - s_n^2) + \phi/(1-\phi)^2\right)}{(1+\phi)}}_{\text{Regulation costs}}\right)$$

The regulation costs term is always positive and thus dampens the HME as dispersion force. To confirm the analytical solution, we plot the equation in terms of $s_n$ and $s_E$. Figure 1 shows the production share with respect to the northern expenditure share in the world.

**Result 2: The HME is reduced by the presence of regulation costs differences in favour of the small market. The HMME is hump-shaped.**

**Result 3: The HME diagram can be a non-linear production share expenditure share diagram.**[17]

**Result 4: The rise of the regulation costs gap reduces the HME. In particular, the reverse HME (and the anti-HME) could be observed for a high regulation costs gap (a high value of $\beta$ ).**

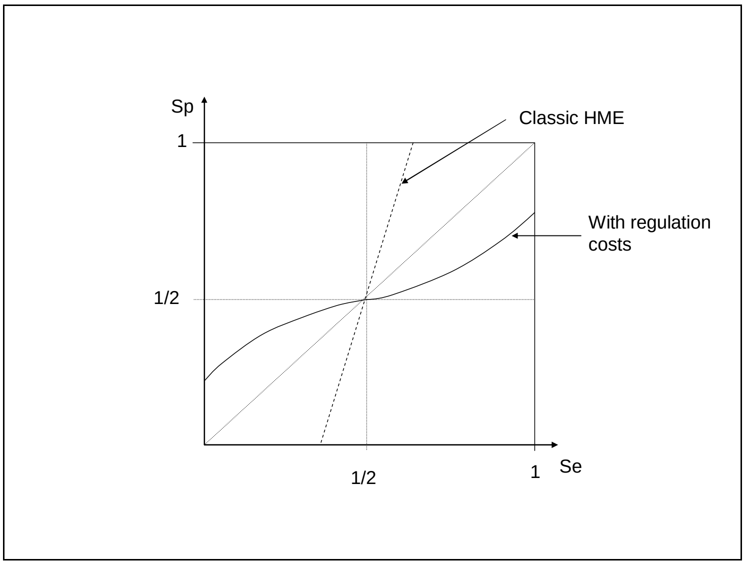


**Figure 1: The Effect of Regulation Costs Gap on the HME**

[17] The non-linear diagram was found also in Crozet and Trionfetti (2005), although the framework is totally different from ours: both IRS and CRS sectors are costly traded in the Helpman and Krugman (1985) model.

# 3. Introduction of Firm Heterogeneity

### A. Specification

Having described the basic properties of the FC model with regulation costs gap, we can now turn to the introduction of firm heterogeneity, keeping the utility function and demand function as in the last section.[18] We introduce firm marginal cost heterogeneity following the manner of Baldwin and Okubo (2004) and (2005) and Okubo (2005), which do not cover all features in Melitz (2003): marginal costs differences without free entry but with delocation. As seen in Figure 2, we model firm heterogeneity in marginal costs, 'a', according to the Pareto distribution, bounded between 0 and 1. We define f(a) as the density function and F(a) as the cumulative density function:

$$f(a)=\rho\left(\frac{a^{\rho-1}}{{a_0}^{\rho}}\right)=\rho a^{\rho-1},\ 1\equiv a_0\geq a\geq 0,\quad \rho\geq 1$$

$$F(a)=\left(\frac{a}{a_0}\right)^{\rho}=a^{\rho}$$

where ρ is a shape parameter. A higher ρ induces a more concentrated distribution of firms at the end of the spectrum (close to a=1), which implies the convergence to homogeneity when ρ goes to infinity. The average marginal cost is given by ρ/(ρ+1). High ρ means a higher average marginal cost. We assumes a continuous drawing of firms from the underlying distribution F[a], with support [0; 1]; this yields a mass of potential firms nF[a] in north and n*F[a] in south (n>n* since the northern market is larger).

### B. The Perfect Spatial Sorting (two-way sorting)

As in the homogeneous firms model, firms face a trade-off between higher regulation costs payment and higher operating sales and profits in the larger country, and vice versa. The gap of operating profits comes from market potential difference between the countries due to the regulation costs gap:

$$(5)\quad \pi_N-\pi_S=\frac{\mu}{\sigma}(1-\phi)\left(B-B^*\right)p^{1-\sigma}-\beta(2s_E-1)$$

Different from the homogeneous-firms trade model, the gap of operating profits is different across firms due to marginal cost differences (firm heterogeneity): the highest productivity firms make the biggest profits, as seen in Melitz (2003) and Baldwin and Okubo (2004).

Furthermore, different from the other heterogeneous-firms trade models, the regulation costs gap is location-dependent. Combined with these two features, the gap of pure profits is proportional not only to each firm's productivity but also to the market potential in each country. Consequently, this productivity-dependent and country-dependent operating profit leads to a spatial sorting of firms between countries in response to their own productivity. The Nash equilibrium is a perfect spatial sorting; all high productivity firms concentrate in the bigger market while low productivity firms locate in the small market.[19] Due to free relocation all firms can relocate seeking higher profits. High productivity firms can get higher profits in the large expenditure market as a return for higher regulation costs payments. On the other

[18] Note that the demand side is still homogeneous, i.e. identical consumers, which are not affected by firm heterogeneity. Also, no demand linkage is still satisfied by the quasi-linear utility function.

[19] These Nash equilibrium features are independent of the probability distribution function of marginal costs. The spatial sorting outcome is not affected by the distribution of firm heterogeneity.

hand, low productivity firms cannot bear higher regulation costs and prefer to locate in the small demand market and get smaller profits.[20] In other words, as seen in Figure 2, there exists one cut-off efficiency level, $a_C$, where there exists indifference in profits between the north and the south, and all firms above $a_C$ are in the south, while all firms below $a_C$ locate in the north. $a_C$ is determined by the following equation:

$$\pi_N(a_C) - \pi_S(a_C) = \frac{\mu}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-1/\sigma}(1-\phi)\left(B-B^*\right)a_C^{\;1-\sigma} - \beta(2s_E - 1) = 0 \qquad (6)$$

**Result 5**: **Firm heterogeneity leads to a perfect spatial sorting in the presence of market potential difference: all high productivity firms concentrate in the large (expenditure share) country and all low productivity firms concentrate in the small (expenditure share) country. Thus, the market potential difference from the regulation costs gap leads to the perfect spatial sorting, resulting in a gap of average productivity between countries.**[21]

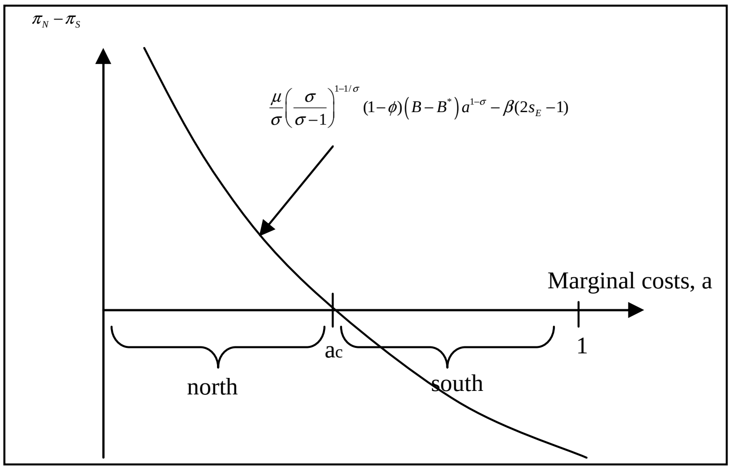


**Figure 2: Relocation Tendency**

Intuitively, when the northern market potential is higher, the north is more attractive than the south. As a consequence of the market potential gap, the most efficient firms located in the large market enjoy the benefit of large (expenditure) market access advantage in the north. However, higher regulation costs in the north crowd out the least efficient firms from the north, because they are not productive enough to cover the high regulation costs with its operating profits. This causes the perfect sorting, creating a productivity gap between countries.

The spatial perfect sorting effect (two-way sorting) in our model stands definitely in contrast to Baldwin and Okubo (2004) and Melitz (2003). In the Melitz model, the perfect spatial sorting never happens: the mass of operating firms is determined by the free entry condition, and over the whole range of productivity, a=0 to 1, firms locate in each market and only a fraction of firms at each level of productivity is determined by the free entry condition.

In Baldwin and Okubo (2004), the spatial sorting is one-way (selection effect): the most efficient firms in the small market are likely to relocate to the large market, while the least efficient firms in the large market stay in the large market. This is because the market

[20] Although the perfect (two-way) spatial sorting cannot be exactly verified by empirical studies, many supported findings have been provided. (See Mion and Naticchioni 2005, Combes Duranton and Gobillon 2004, Head and Ries 2003).

[21] Note that in the homogeneous-firms trade model, there does not exist an average productivity gap due to the identical marginal costs for all firms.

potential in the large market is always higher than in the small market for all firms, but they never incur any high location-specific sunk costs in the large market as in our paper, and consequently the least efficient firms always make higher pure profits in the large market. Therefore, spatial sorting is one-way: only the efficient firms in a small market relocate to the big market.
By contrast to these previous models, the presence of a regulation costs gap together with free relocation results in two-way spatial sorting. The higher regulation costs in the north lead to a higher market potential in equilibrium, causing higher pure profits and average productivity, but on the other hand, firms below a given level of productivity cannot cover the higher regulation costs and relocate to the small country.

**C. The Degree of Competition**
Based on the result of the perfect spatial sorting, we can characterise the manufacturing price index, P=$\Delta^{\frac{1}{1-\sigma}}$. First, Δ, the degree of competition, can be expressed as:

$$(7)\quad \Delta = \int_0^{a_c} p^{1-\sigma} f(a)da + \phi\int_{a_c}^1 p^{1-\sigma} f(a)da = \lambda\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(a_c^{\;1+\rho-\sigma} + \phi(1-a_c^{\;1+\rho-\sigma})\right)$$

$$\Delta^* = \phi\int_0^{a_c} p^{1-\sigma} f(a)da + \int_{a_c}^1 p^{1-\sigma} f(a)da = \lambda\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\phi a_c^{\;1+\rho-\sigma} + (1-a_c^{\;1+\rho-\sigma})\right)$$

$$\text{where } \lambda = \frac{\rho}{1-\sigma+\rho} > 1$$

From equation (7), two points are worthwhile noting. First, $\lambda$, a decreasing function of $\rho$, determines the impact of the average marginal cost on the degree of competition. A lower average marginal cost (small $\rho$ and thus large λ) stimulates overall competition so that Δ rises. Second, the cut-off efficiency level, $a_c$, reflects how the spatial sorting affects competition in each country. The cut-off level is largely dependent on the probability distribution in marginal costs. A high degree of firm heterogeneity decreases the cut-off level marginal cost, if other things are equal. The increased cut-off (for a given degree of firm heterogeneity) promotes competition in the north such that Δ rises.

# 4. The Effect of Firm Heterogeneity on the Home Market Effect

In this section, first of all, we plot the production share with the expenditure share, as in the usual HME diagram. Next, in order to rigorously examine the effect of firm heterogeneity on the HME, we make a detailed comparison of diagrams between the heterogeneous-firms trade model and the homogeneous-firms trade model, given the same level of overall competition. Finally, we provide an analytical solution to get intuition and explain the forces at work around the symmetric equilibrium.

## A. Home Market Effect (General case)

Following the definition of $s_P$ index in the last section,

$$(8)\quad s_P = \frac{(B+\phi B^*)a_c^{1-\sigma+\rho}}{(B+\phi B^*)a_c^{1-\sigma+\rho} + (\phi B + B^*)(1-a_c^{1-\sigma+\rho})} = (B+\phi B^*)a_c^{1-\sigma+\rho}$$

From the Pareto distribution, $s_n$ can be written as:

$$(9)\quad s_N = a_C^{\rho}$$

As in the standard HME discussion, Figure 4 plots the $s_E$-$s_P$ relation from equations (8) and (10) and also plots the $s_E$-$s_n$ relation from equations (9) and (10)[22]:

$$(10)\quad \pi_N(a_C) - \pi_S(a_C) = \frac{\mu}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-1/\sigma}(1-\phi)\left(B-B^*\right)a_C^{1-\sigma} - \beta(2s_E-1) = 0$$

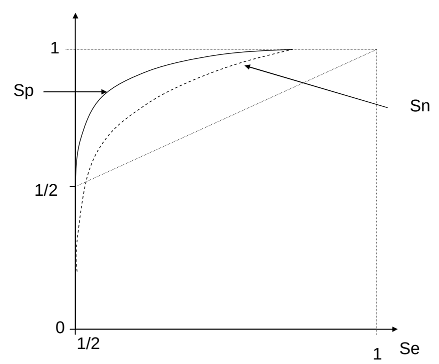


**Figure 3: HME (Production Share and Firm Share)**

[22] To compare with equation (4) in the homogeneous-firms model, we can rewrite equation (10) as

$$\left(a_C^{1-\sigma+\rho} - 0.5\right) = \left(s_E - 0.5\right)\underbrace{\left(\frac{1+\phi}{1-\phi}\right)}_{classical\ HME}\left(1 - \frac{\sigma\lambda}{\mu}\underbrace{\frac{2\beta\left((a_C^{1-\sigma+\rho} - a_C^{2(1-\sigma+\rho)}) + \phi/(1-\phi)^2\right)}{(1+\phi)}}_{Regulation\ costs}\underbrace{a_C^{\lambda-1}}_{heterogeneity}\right)$$

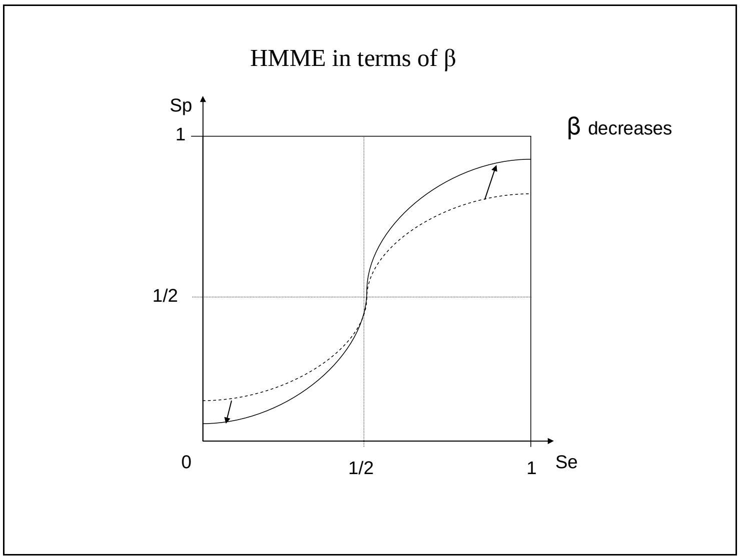


**Figure 4: The Effect of Regulation Costs with Firm Heterogeneity**

First, the HME in terms of production share is still at work as illustrated in Figure 3. However, the reverse HME can be observed like in the homogeneous-firm trade model. Note that without any regulation costs, i.e. $\beta = 0$, the HME is the same as the classical HME, i.e. $\frac{1+\phi}{1-\phi} > 1$. By contrast, if we take a high value of β, then the reverse HME is obtained, as seen in Figure 4. The reverse HME is caused by a sufficient level of the regulation costs gap (high $\beta$), just as in the homogeneous-firm case discussed in the last section.

Second, the diagram is a non-linear diagram and is concave. The concavity results from the decreased productivity in the cut-off level firms. The firms at the cut-off efficiency level, which are indifferent to their location due to identical pure profits, become less efficient ('$a_c$' gradually increases) as the increased sE induces more firms to relocate from the south (low productivity firms agglomeration) to the north (high productivity firms agglomeration).

In contrast to the convexity in the homogeneous-firms trade model (Figure 1), the concavity shape in Figure 4 implies that firm heterogeneity reduces the dispersion force induced by the regulation costs gap. This comes from the average productivity gap caused by the perfect spatial sorting in the heterogeneous-firms trade model (the average productivity is equal between countries in the homogeneous-firms trade model).

Third, it is also important to note that the impact of trade freeness ($\phi$) on the HME follows a non-linear relationship: a hump-shaped HMME is obtained, as in the homogeneous-firms trade model (Figure 5). With high trade costs, trade cost reduction increases the HME. On the contrary, if trade is almost free, trade liberalisation causes to decrease the HME. This markedly contrasts to the standard FC model and the Helpman and Krugman (1985) model. Also, this is substantially different from Baldwin and Okubo (2004)'s result, in which the HMME is measured by firm share but the HME and the HMME are correspondent to the standard FC model in terms of production share.

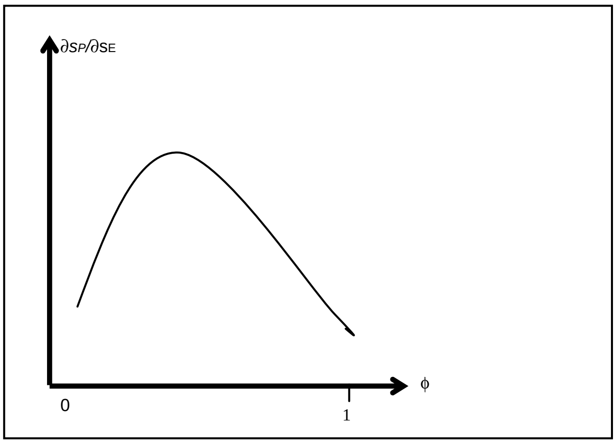


**Figure 5: Trade Liberalisation and the HME**

**B. The impact of firm heterogeneity----a comparison between the homogeneous-firms model and the heterogeneous-firms model**

To highlight the precise impact of firm heterogeneity, we compare the heterogeneous firms trade model with the homogeneous firms trade model by equalising the level of the overall competition. Comparing the degree of competition between equations (1) and (7), we can get the relationship $\Delta_{het}=\lambda\Delta_{hom}$. Using this relationship, we equalise parameter values between the homogeneous (hom) case and the heterogeneous (het) case by keeping σ and λ constant and only controlling $\mu$ :

$$(10) \qquad \underbrace{\frac{\mu_{het}}{\sigma\lambda}}_{heterogeneous\ case} = \underbrace{\frac{\mu_{\text{hom}}}{\sigma}}_{\text{hom}\ ogeneous\ case}$$

Under this condition, Figure 6 plots these two cases:

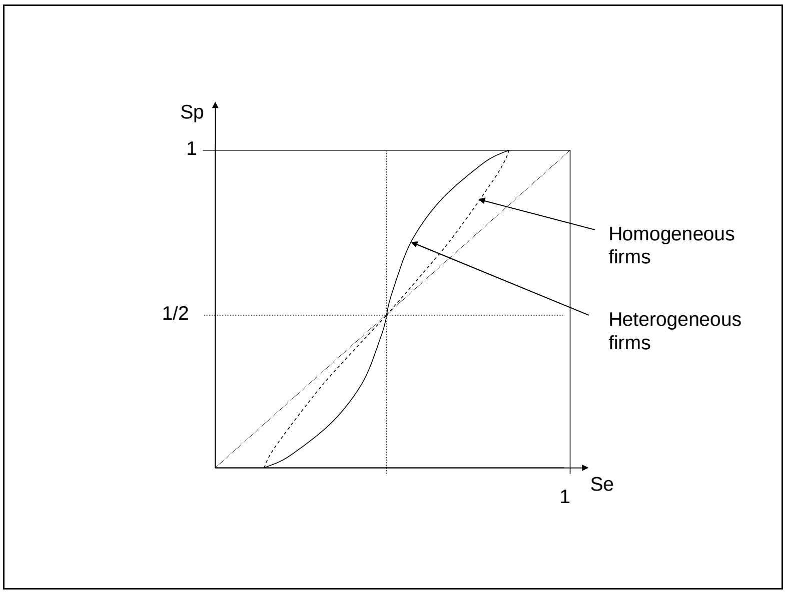


**Figure 6: The Impact of Firm Heterogeneity**

**The average marginal cost in the north is always lower in the heterogeneous case than in the homogeneous case due to the perfect spatial sorting.** In other words, high productivity firms concentrate in the north, while low productivity firms concentrate in the south in the heterogeneous-firms trade model. This leads to relatively more northern production and relatively less southern production. Therefore, the northern production share is higher in the heterogeneous case than in homogeneous case for a given $s_E$>0.5. As a consequence, firm heterogeneity works as agglomeration force and yields more possibilities for full agglomeration.

**Result 6**: **Firm heterogeneity works as agglomeration force by dampening the dispersion force induced by the regulation costs gap.**

Intuitively, as shown in the last section, the market potential is not equalised due to the regulation costs gap. However, since firms are identical in productivity in the homogeneous case, the regulation costs gap translates into different market potentials but no spatial sorting occurs and average productivity is always the same between the countries. Therefore, the productivity gap does not exist in the homogeneous-firm model. By contrast, our heterogeneous-firm trade model features a substantial average productivity gap between the countries due to the perfect spatial sorting. As a result of the sorting, the average productivity must be higher in the north. This higher average productivity increases the production share in the north, because firms can bear the higher regulation costs more easily. Hence, the share of northern production is higher than in the homogeneous-firms model.
A further comparison can be made with respect to the other heterogeneous-firms trade models. In Melitz (2003), the free entry model without relocation, firms with all levels of production always stay in the market and instead the number of firms is adjusted so as to equalise the market potential between countries. Even more importantly, Baldwin and Okubo (2004) and (2005), the delocation model without free entry, suggested that the HME in terms of production share in their heterogeneous-firms model corresponds to the one in the homogeneous-firms model (Martin and Rogers, 1995). Therefore, they concluded that firm heterogeneity works as dispersion force only in the share of number of firms, but it has no influence on the production share.

### C. Another Home Market Magnification Effect---TBT

The traditional discussion on trade liberalisation focused on reducing trade costs. However, many other kinds of barriers still remain in place among the developed countries such as different production standards, technical regulations, and competition policy. Many large differences in regulations create obstacles for producers and exporters. Since these barriers crucially impede free international trade and investment in the current low-trade-costs world, the WTO has put the issues on the table in the technical barriers to trade agreement (TBT). The WTO agreement encourages countries to appropriately adopt international standards as much as possible, although each country is not necessarily required to change its level of standards for keeping diversity. Turning to our model, the regulation costs harmonisation in the profit function represents the decrease of ‘$\beta$’, which can be a policy variable. Accordingly, the TBT agreement can be thought of as a reduction of $\beta$. Now, our paper provides another notion of the HMME: the HMME in terms of regulation costs, $\beta$, where the traditional HMME has focused only on trade costs reduction, $\phi$. From equation (6), we can induce the following relationship:

$$(11) \qquad \frac{\partial^2 s_P}{\partial s_E \partial \beta} < 0$$

This implies that the reduction of β, i.e. the harmonisation in the market regulation policy between countries, promotes the HME for any level of β. As the TBT agreement promotes the harmonisation of regulation policies across countries, the regulation costs are reduced. As a result, it promotes production more than proportional in the large country. This is another HMME. [23]

**Result 7: The regulation costs reduction and harmonisation, β, increases the HME for any levels of regulation costs. This is the HMME in terms of TBT agreement.**

## D. The Home Market Effect around the symmetric equilibrium (local analysis)

To analytically solve and get more intuition, we provide the simple representation of the HME around the symmetric equilibrium (i.e. sE around 0.5), which is useful to confirm the previous results on the forces of firm heterogeneity. Moreover, this local analysis makes it possible to obtain the critical values of the regulation costs gap for the reverse HME and the anti-HME around the symmetric equilibrium. The total differentiation around the symmetry is given by:

$$(12) \quad \left.\frac{ds_P}{ds_E}\right|_{s_n=0.5, s_E=0.5} = \frac{\left(\frac{1-\phi}{1+\phi}\right) - \frac{2\phi}{(1+\phi)^2}\frac{\beta\sigma\lambda}{\mu}0.5^{\lambda-1}}{\left(\frac{1-\phi}{1+\phi}\right)^2}$$

As in the traditional HME discussion, two opposing forces are at work in our model: *a market access effect (MAE)*, which creates a centripetal force, and *a market crowding effect (MCE)*, which creates a centrifugal force[24]. The MAE corresponds to nominators, while the MCE reflects the denominators in equation (12). The MCE is affected only by ϕ. By contrast, the MAE is affected by firm heterogeneity and the regulation costs difference. Compared to the HME results in the standard FC model and Helpman and Krugman's model, the MAE is lowered by an increase in regulation costs as well as by a low degree of firm heterogeneity (high λ). Hence, it is more likely to find a negative relationship between sP and $s_E$ (anti-HME) for a sufficiently large regulation costs gap and a low degree of firm heterogeneity. As the regulation costs gap increases, the small country attracts more firms from the large country. Moreover, less firm heterogeneity promotes the possibility of the reversed HME and the anti-HME.

### Critical values for the reverse HME and the anti-HME

[23] It is also worth noticing that such regulatory harmonization reduces the impact of firm heterogeneity on the location of production.

[24] In the standard (homogeneous-firm) FC model and Baldwin and Okubo (2004) (heterogeneous-firm FC model), the HME in terms of production share is written as

$$\left.\frac{ds_P}{ds_E}\right|_{s_E=0.5} = \frac{\left(\frac{1-\phi}{1+\phi}\right)}{\left(\frac{1-\phi}{1+\phi}\right)^2}$$

Now, we derive critical β values for the reverse HME and the anti-HME around the symmetric equilibrium. The value of β to allow the reverse HME, namely $\hat{\beta}$, is given by[25]:

$$(13)\quad \left.\frac{ds_P}{ds_E}\right|_{s_E=0.5} = 1 \Leftrightarrow \frac{\mu}{\sigma\lambda}\frac{(1-\phi)}{0.5^{\lambda-1}} = \hat{\beta}$$

Similarly, we can derive the critical value for the anti-HME, $\tilde{\beta}$:

$$(14)\quad \left.\frac{ds_P}{ds_E}\right|_{s_E=0.5} = 0 \Leftrightarrow \frac{\mu}{\sigma\lambda}\frac{(1+\phi)}{2\phi}\frac{(1-\phi)}{0.5^{\lambda-1}} = \tilde{\beta}$$

$$\left.\frac{ds_P}{ds_E}\right|_{s_E=0.5} < 0 \Leftrightarrow \frac{\mu}{\sigma\lambda}\frac{(1+\phi)}{2\phi}\frac{(1-\phi)}{0.5^{\lambda-1}} > \tilde{\beta}$$

Note that $\tilde{\beta} > \hat{\beta}$ always holds. If β is less than $\hat{\beta}$, the usual HME can be observed. However, the reverse HME can be found with β larger than $\hat{\beta}$ but less than $\tilde{\beta}$. In turn, the anti-HME can be found for values of β larger than $\tilde{\beta}$.

**Result 8: Firm heterogeneity, ceteris paribus, promotes the agglomeration process by means of raising the market access effect. Hence, firm heterogeneity promotes the HME and reduces the possibility of the reverse HME and the anti-HME.**

**Result 9: The higher regulation costs, β, ceteris paribus, induce the reverse HME and the anti-HME.**

# 5. Regulation Policy Implication

This section discusses some more implications on regulation policy, β**,** based on our heterogeneous-firms trade model. Our crucial results are different market potential and average productivity discrepancy due to the regulation costs gap. Here, we discuss one of many possible policies. We examine the harmonisation of regulation policy through international agreements when policy aims at enhancing welfare.

**Regulatory harmonisation**

In this section, we discuss regulation policy harmonisation by means of welfare in the framework of two countries with almost equal market sizes (local analysis in section 4). Suppose the model with a substantial regulation costs, i.e. a large β, around symmetric equilibrium: sE=0.5+ε. We consider a substantially high level of country specific regulation costs, but the regulation costs gap is small due to similar market sizes. First of all, welfare can be represented as the indirect quasi-linear utility function: $U = E - \mu + \mu \ln(\mu\Delta^{\frac{1}{\sigma-1}})$ in the north and $U^* = E^* - \mu + \mu \ln(\mu\Delta^{*\frac{1}{\sigma-1}})$ in the south.

From the equation (5), the market potential gap, B>B*, can always be found as long as a regulation costs gap exists. This relationship induces Δ<Δ* when sE is around 0.5. This means that the relatively large country has a lower degree of competition. Utilising this

[25]We must ensure that the least efficient firm in the south still have a non negative pure profit. This leads to the following condition on $\beta$, which is also compatible with the values of $\hat{\beta}$ and $\tilde{\beta}$ : $\pi_S > 0 \Leftrightarrow \beta < \frac{2\mu}{\sigma\lambda}$

relationship, the northern welfare is less than southern one: U<U*. All the people in the relatively small country can gain higher welfare than in the relatively large country around the symmetric equilibrium. In this situation, a small number of the northern high productivity firms supplies a bunch of products with lower prices but the number of its produced varieties is very small (less varieties but more production), consequently lowering $\Delta$, while a large number of the southern low productivity firms produce smaller quantities (for each firm) with higher prices (more varieties but less per-firm production and higher price) and consequently increases $\Delta^*$. This is consistent with the result in Figure 4, in which sN is close to 0 but sP is more than 0.5 around symmetric equilibrium. This lower welfare in the north triggers more incentive for the north to harmonise regulation policy. Therefore, if governments can control $\beta$ by regulation policy to enhance welfare, the north (a relatively large country) has more incentive to reduce $\beta$ and could initiate an international regulatory harmonisation agreement. This result might more or less reflect the stylised facts that small developing countries are likely to have a negative attitude to the international harmonisation agreements (TBTs international agreements in the WTO). This is also consistent with the result of Ganslandt and Markusen (2001).[26]

# 6. Conclusion

We studied the Home Market Effect in the presence of country-specific sunk costs, i.e. regulation costs, to reflect the on-going trade liberalisation with respect to technical trade barriers. We modelled firm heterogeneity and regulation costs with delocation but without free market entry. The regulation costs, proportional to market size, work as a dispersion force due to higher regulation costs in the large country. This could cause the reverse HME, the anti-HME and humped-shape HMME in terms of production share, contrasting with Baldwin and Okubo (2004) which suggested no impact of firm heterogeneity on the HME in terms of production share. Also, firm heterogeneity results in a perfect spatial sorting (two-way sorting) in our model: all high productivity firms concentrate in the large country, while the small country attracts all low productivity firms, causing higher average productivity and market potential in the large country. As a result, firm heterogeneity works as agglomeration force through dampening the dispersion force caused by the regulation costs gap. This perfect sorting result is very important in our paper and largely depends on the presence of regulation costs differences. In other words, the regulation costs gap crucially affects the location of production and average productivity. This reflects the importance of the TBT and regulatory harmonisation. Furthermore, the TBT issue has been discussed: the reduction of regulation costs through harmonisation in standards and regulation policy. We suggest that this kind of liberalisation could promote the HME (pro-HMME in terms of regulatory liberalisation). As policy implications, our model would predict that larger countries could take initiative in international agreements on regulation and standards, while the small countries are likely to hesitate to agree with international standards and stick to their own country-specific regulations.

[26] They concluded that a smaller and poorer country cannot get the international standards and only a large country can enjoy the benefits of international agreements.

**Appendix 1: Robustness Check**

This Appendix aims at showing how our main results in our model are robust in various specifications for regulation costs. In our model the regulation costs are assumed to be a linear function of expenditure (population) share for the simplicity. However, even if we drop this assumption and introduce a non-linear function, the qualitative results never change under the condition of **higher regulation costs in the north**. Further, even in the case of the regulation costs influenced not only by the location of production but also by the export market in a certain degree (for instance, $R_N = \beta(s_E + \delta(1-s_E))$, where δ<1), the results can be fully kept as in our main model.
Another thought experiment is fixed regulation costs (meaning that $R_N$ and $R_S$ are constant and exogenous), which are higher in the big country but are not proportional to its population and market size. In this set-up, although a symmetric relationship between sE and sP collapses (i.e. the HME phase line never cuts 0.5-0.5 point in sP-sE diagram), the qualitative results are the same as in our model. Equation (10) can be rewritten as:

$$(10) \Leftrightarrow \left(a_C^{1-\sigma+\rho} - 0.5\right) = \left(s_E - 0.5\right)\left(\frac{1+\phi}{1-\phi}\right) - \frac{\sigma\lambda\left(R_N - R_S\right)}{\mu} \frac{\left((a_C^{1-\sigma+\rho} - a_C^{2(1-\sigma+\rho)}) + \phi \big/ (1-\phi)^2\right)}{(1+\phi)} a_C^{\lambda-1}$$

Again, the presence of a regulation cost gap in favour of the south reduces the northern production share, and allows the spatial sorting of firms where the most efficient firms locate in the north. This leads to raise an average productivity gap in the north, increasing its share of production compared to the homogeneous case. Thus, all qualitative results are kept.
Finally, ignoring the empirical evidence by Mulligan and Schleifer (2004) of a positive correlation of regulation costs with population and market size, we consider an opposite case as thought experiment: higher regulation costs in the small country and lower regulation in the large country. In this set-up, regulation costs work as agglomeration force and promote the HME. Firm heterogeneity causes a totally opposite direction of the two-way sorting, in which all low productivity firms concentrate in the large country while all high productivity firms locate in the small country. However, importantly these results do not seem to be feasible in the actual world and definitely contradict any recent empirical studies. Lafourcade and Mion (2003) and Alsleben (2005) have shown empirical evidences that large firms are more likely to be found in agglomerated areas, which have a big market size and large expenditure. For this reason, following Mulligan and Schleifer (2004) and Demsetz (1972), our model sets up the regulation costs function that is positively correlated with population.

**Appendix 2: The Hump-shaped HMME—an analytical solution**

Differentiating the equation (12) in terms of ϕ, we can derive:

$$\frac{\partial^2 s_P}{\partial s_E \partial \phi} = \frac{2}{(1-\phi)^2}\left(1 - \frac{1+\phi}{1-\phi}\alpha\right); \ \ where\ \alpha \equiv \frac{\sigma\beta\lambda}{\mu} 0.5^{\lambda}$$

A positive value in the large bracket causes $\frac{\partial^2 s_P}{\partial s_E \partial \phi} > 0$ (HMME), while a negative value results in $\frac{\partial^2 s_P}{\partial s_E \partial \phi} < 0$ (reverse HMME). With high trade costs, $\frac{1-2\alpha}{1+2\alpha} > \phi$, the HMME cab be found, while the reverse HMME can be observed with low trade costs, $\frac{1-2\alpha}{1+2\alpha} < \phi$. This means that, as trade gets freer, the HME first rises and then falls.

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