Industry Location in Export Processing Zones with Vertical Linkages and Agglomeration*

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Abstract

This paper provides a rationale for the common use of Export Processing Zones (EPZs) in third world countries, as an alternative to liberalising foreign trade for all regions. I use a model from the “new economic geography” literature with vertically linked industries to analyse the effect of an EPZ policy on the location of industry; vertical linkages are important in EPZs since its industry is typically characterised by the assembly of intermediate goods. Industry location is very sensitive to differences in country size and the possibility of multiple equilibria disappears even at small size asymmetries in the relative size of countries. Therefore, a small country can lose industry when liberalising trade with a larger trading partner. On the other hand, if mutual trade costs are only reduced between the EPZ part of the Home country and the Foreign country, the EPZ turns into a so-called “hub” and the centre of downstream manufacturing. Upstream production locates in the rest of the Home country outside the EPZ. Industry becomes segregated rather than agglomerated; upstream and downstream industry locate in different regions. Moreover, the viability of the EPZ hinges on the permission of firms based in the EPZ to also sell goods domestically and not only for exports. Finally, a policy of only allowing downstream firms in the EPZ—a common feature of many zones—expands the range of trade costs for which agglomeration in Home is viable and reduces the wage inequality between the EPZ and the part of Home that is not covered by the zone.

JEL Codes: F10, F13, L10, O40.

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1 Introduction

The number of Export Processing Zones (EPZs) has grown rapidly in the last 20 years. According to ILO figures, EPZs in a total of 130 countries in the year 2006 employed 66 million people worldwide—of which 40 million were in China—and in many developing countries, EPZs accounted for around 80% of total exports. This can be compared to only 25 countries permitting EPZs in 1975.\(^1\) This is to some extent inspired by the success of EPZs in China, which has fifteen proper zones of this kind and several more with similar setups. Shenzhen, the most cited example, has been a thriving area of commerce and industrial activity.

The most common feature of an EPZ is that tariffs and other taxes on imported intermediate goods, equipment and production in the zone are either removed or significantly reduced. Administrative procedures for registering firms and foreign employees are often simplified and bureaucracy is reduced. Regulations and taxes on labour are typically more favourable for foreign firms in these zones than in the rest of the country.\(^2\) Industry in EPZs is typically characterised by the assembly of intermediate products imported from abroad or the domestic region of the host country. The exact definition of an EPZ in this paper is the construction of a zone in a part of the home country into which foreign intermediate goods can be imported at substantially lower tariff rates than to the rest of the country. Goods that are assembled in the zone (i.e. goods cannot be shipped directly through the zone) can either be exported to foreign countries or sold inside the home country. This feature of the model only holds in some zones, but it is key to the argument in this paper of how EPZs can benefit a small liberalising economy.

The traditional neoclassical trade literature (such as Ricardian or Heckscher-Ohlin theory) would typically conclude that an EPZ is a second-best solution.\(^1\) Boyenge (2007). \(^2\) See Madani (2004) for an excellent description of EPZs today.
Instead, liberalising trade for the whole country would be the first-best trade policy, since the EPZ policy only introduces a distortion as compared to a country-wide liberalisation. Essentially interpreting an EPZ as a partial liberalisation (i.e. with a limited geographical scope), this paper provides a rationale for why a geographically limited liberalisation such as an EPZ can be preferable for a smaller country to liberalising trade for all regions. This is done by using theory from the “new economic geography” literature.\textsuperscript{3} Dynamics related to vertical linkages between industries produce forces of industrial agglomeration. In such a setting, trade liberalisation for all parts of the small country can lead to an outflow of industry from the smaller country. An EPZ (from which firms are also allowed to sell to the home market), on the other hand, can make industry remain in the country and also attract industry from abroad.

More specifically, I use a two-region model, developed by Venables (1996), where agglomeration forces are due to the vertical structure of industry. The vertical structure is important for understanding EPZs, as these are typically characterised by the assembly of intermediate goods into final goods. An upstream manufacturing sector supplies intermediate goods needed for the production of final goods in the downstream sector. This results in “forward and backward linkages”\textsuperscript{4} as the two sectors both benefit from being geographically close to each other. This paper uses a three-region version of the model with asymmetric region size and trade costs.\textsuperscript{5} Therefore, the analysis can highlight important aspects of EPZs: market access, cost and demand linkages between intermediate and final goods producers and industry location. It neglects other aspects such as factor flows in the shape of foreign direct investment and labour migration as well as wage asymmetries between countries stemming from, for example, differences in productivity or factor endowments.

\textsuperscript{3}See Fujita, Krugman, and Venables (2001) or Ottaviano and Puga (1998) for an overview.  
\textsuperscript{4}This term is due to Hirschman (1958).  
\textsuperscript{5}An analysis of the model with more than two regions is done in Puga and Venables (1997).
Shenzhen is the most successful EPZ in China—and possibly in the world—in terms of industrial growth. Previously a fishing village, it was in 1979 chosen by China’s leader, Deng Xiaoping, to be the first EPZ in the country; EPZs in China are known as Special Economic Zones. Shenzhen’s close proximity to Hong Kong contributed to this decision. Figure 1 describes the evolution of some variables that are key to this paper; Shenzhen is compared to China at the national level. The direction of how the variables change over time is similar for the two economies, but the changes are of greater magnitude in Shenzhen than in China as a whole. This paper focuses on the location of industry and the pattern is very clear in this case: there is an outflow of agriculture and primary industry from the zone and an inflow of secondary industry. The development in Shenzhen is clearly starker than at the national level. As is well known, GDP growth has been very rapid in China but even more rapid in Shenzhen. The development of Shenzhen is described here since it is one of the most successful examples of an EPZ attracting foreign industry.

The main results of the paper are that creating an EPZ can be preferable for the home country to conducting a country-wide liberalisation. Industry location is very sensitive to differences in country size and the possibility of multiple equilibria disappears even at small size asymmetries in the relative size of countries. Therefore, a small country can lose industry when liberalising trade with a larger trading partner. On the other hand, if mutual trade costs are only reduced between the EPZ part of the Home country and the Foreign country, the EPZ turns into a so-called “hub” and the centre of downstream manufacturing. Upstream production locates in the rest of the Home country outside the EPZ. Industry becomes segregated rather than agglomerated; upstream and downstream industry locate in different regions. Moreover, the viability of the EPZ hinges on the permission of firms based in the EPZ to also sell goods domest-

\[^{6}\text{Naturally, Shenzhen is part of the aggregate Chinese data, but a very small part.}\]
Figure 1: The change in industry location in Shenzhen and in China as a whole.

cally and not only for exports. Finally, a policy of only allowing downstream firms in the EPZ—a common feature of many zones—expands the range of trade costs for which agglomeration in Home is viable and reduces the wage inequality between the EPZ and the part of Home that is not covered by the zone.

That the Venables (1996) model, at intermediate trade costs, creates industrial segregation—upstream and downstream industries locate in different regions—instead of agglomeration, in this specific setting, is a new result for the Venables (1996) model. This is, however, not a contradiction to the original model, in which vertical linkages cause agglomeration, since agglomeration still takes place in one of the two countries (Home in this case), but what is new is that it segregates within the Home country. The reason is that upstream firms only need to be close to the concentration of downstream firms, while downstream firms seek good market access to consumers worldwide.
The paper is structured as follows. Section 2 describes previous literature that has examined EPZs, although in a rather different theoretical setting, as well as literature that has used a similar theoretical setting as in this paper but for different research questions. Section 3 outlines the model used in the paper and shows how my additional assumptions of size asymmetry and three regions affect the set of equilibria. Section 4 describes the different ways in which an EPZ can be modelled and analyses the effects of such a policy on industry location in each setting. Section 5 offers a short summary and concluding comments.

2 Related literature

Economic theory has somewhat failed to explain advantages of EPZs and how these create welfare and affect economic activity. Following Hamada (1974), a series of contributions have analysed EPZs in a theoretical setting based on Heckscher-Ohlin models. These include Hamilton and Svensson (1982), Miyagiwa (1986), Wong (1986), Young (1987), Young and Miyagiwa (1987) and Devereux and Chen (1995). As previously mentioned, this analysis has not been very consistent with the rapid growth of EPZs. And, as argued in Devereux and Chen (1995), the academic literature is very rarely cited among policymakers in the EPZ debate. Hamada writes that: “One of the limitations of this paper is that it abstracts almost totally from the regional aspect of the duty-free zone: the spatial aspect is taken into consideration only in the form of the possible absolute limit on the level of activities in the duty-free zone”. This paper is an attempt at analysing the EPZ policy exactly from a spatial viewpoint.

Some would argue that an EPZ is nothing but a form of Preferential Trade Agreement (PTA) as the country lowers the barriers to trade towards one specific

\footnote{Hamada (1974), p. 226.}
region and only part of the home country is affected. Puga and Venables (1997) provide an analysis of PTAs which lies close to this paper. They use the model by Krugman and Venables (1995) which has a dynamic similar to that of Venables (1996). Here, however, there is only one industrial sector and agglomeration of production is due to the fact that firms are horizontally linked; firms use the output of other firms within the same industry as intermediate inputs. One of the experiments in Puga and Venables (1997) is to create a PTA of a “hub-and-spoke” type. An example of this is when two countries have a free trade agreement but one of these countries reduces the bilateral trade costs when trading with a third country. Agglomeration of industrial activity occurs in the country that has reduced bilateral tariffs with both of the other countries. Good access to both foreign markets makes it an industrial “hub”. It can be argued that this is exactly what an EPZ is in my setting. This would, however, neglect some important differences. Industry in EPZs is often engaged in the assembly of intermediate products and the goal of many countries setting up EPZs is to create links between the primary (upstream) industry of the domestic region and the secondary (downstream) industry in the EPZ. Through the lens of Puga and Venables (1997), I therefore analyse a “hub-and-spoke” agreement in a model with two vertically linked industrial sectors, as opposed to a single horizontally linked industry. I also have a congestion force by dropping the assumption that labour is perfectly elastic and that nominal wages increase when the employment of labour increases in the manufacturing industry. The results are similar in the sense that agglomeration of the downstream industry arises in the EPZ (or hub) but also generates new results. First, industry “segregates” in the two regions with free trade; the upstream sector locates in the “spoke” and the downstream sector in the hub. Second, using the two-sector model, I can also analyse a case which is common in EPZs, namely that it gives preferential treatment to
downstream industry or bans upstream industry. Such a policy strengthens the dynamics mentioned above. Finally, my paper has a different angle as the welfare analysis is very different from a PTA; both the EPZ and the domestic region belong to the same country.

Puga and Venables (1996) also use a multi-country version of Venables (1996) with several vertically linked manufacturing industries. However, they maintain symmetry in trade costs and analyse a different issue. Instead of focusing on trade liberalisation, they focus on how industry gradually spreads across countries as the economies grow in size.

3 Model

What distinguishes Venables (1996) from other literature in the field is that it generates agglomeration forces through a vertical production structure. In its simplest case, there are two monopolistically competitive sectors: upstream and downstream. Upstream firms produce goods that are used as intermediate inputs by the downstream sector. In a world of trade frictions, the agglomeration force is due to the interaction between these sectors when firms choose location. In a region with a large base of upstream industry, downstream firms face lower production costs as the intermediate goods they use in production do not incur any trade costs. Simultaneously, a large base of downstream firms attracts upstream firms, since they face a high demand for their products. There is also a homogeneous good that is costlessly traded. It is assumed to have decreasing returns to scale and thus acts as a congestion force.

3.1 Structure

The model allows for asymmetric trade costs and region size. I denote the set of regions by $J$. Each region $i \in J$ is endowed with labour, $L_i$, and land, $N_i$. 
There are three sectors in each region: agriculture as well as upstream and downstream industry. These are denoted by \( l \in \{a, u, d\} \). Between each pair of regions there are ad valorem (paid in the numeraire good) trade costs, \( t_{ij}^l \), where \( i, j \in J \), which is the cost of trade in sector \( l \) products between regions \( i \) and \( j \). The first sector, agriculture \((a)\), is perfectly competitive and produces a freely tradable good. Agricultural output will be used as the numeraire. The two remaining sectors are monopolistically competitive. Each firm produces a unique variety. One is denoted as the upstream industry \((u)\) since it produces an intermediate good used by the downstream industry \((d)\). This means that they are vertically linked.

There are three regions indexed by \( J = \{E, D, F\} \) where \( E \) denotes the Export Processing Zone, \( D \) the part of Home that is not covered by the EPZ—this is the “domestic” region—and \( F \) the Foreign country.

The technology of sector \( a \) is strictly concave and the sector is represented by the following revenue function:

\[
\Pi_i^a (1, w_i) = N_i w_i^{-\gamma}
\]  

(1)

where \( w_i \) in country \( i \) is the nominal wage in terms of the numeraire good. \( \gamma \) is assumed to be strictly greater than zero.

The two remaining sectors, \( u \) (upstream) and \( d \) (downstream), are characterised by a monopolistically competitive structure. The model uses the results of Dixit and Stiglitz (1977) and assumes CES aggregators over varieties. The demand levels faced by an industry \( l \) firm in country \( i \) selling to country \( j \) are therefore:

\[
x_{ij}^l = (p_{i,ij}^l)^{-\sigma^l} \frac{E_j^l}{(p_j^l)^{\sigma^l-1}},
\]

(2)

where \( \sigma^l > 1 \) is the sector-specific elasticity of substitution and \( E_j^l \) is the expen-
diture level in country $j$ on sector $l$ goods. $t_{ij}^l \geq 1 \ (t_{ii} = 1 \ \forall i \in J)$ is a standard iceberg trade cost in sector $l$ from country $i$ to country $j$. $P_i^l$ is the general price level of sector $l$ products in region $i$:

$$P_i^{l(1-\sigma)} = \sum_{j \in J} n_j^l \ (p_j^l t_{ij}^l)^{1-\sigma},$$

(3)

where $n_i^l$ is the number of sector $l$ firms in region $i$.

Each firm is subject to a fixed cost, $f^l$. The cost of inputs is denoted by $c_i^l$. Therefore, the profit function can be written as:

$$\pi_i^l = (p_i^l - c_i^l) \left( \sum_{j \in J} x_{ij}^l \right) - c_i^l f^l.$$  

(4)

The sector-specific expressions for $c_i^l$ are:

$$c_{ii}^u = w_i,$$

(5)

for the upstream industry which only employs labour and

$$c_{ii}^d = w_i^{1-\mu} (P_i^u)^\mu$$

(6)

for the downstream industry (which employs labour and the intermediate product produced by sector $u$ in proportions given by $\mu$). Note that the production functions for the two sectors are:

$$f^l + \sum_{j \in J} x_{ij}^u = L_i^u$$

(7)

for the upstream industry and

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*Due to the optimality of "mill pricing" in this context, the price charged in $j$ will be $p_j^l t_{ij}$.}
\[ f^l + \sum_{j \in J} x^{d}_{ij} = k \left( I^d_i \right)^{1-\mu} (x^u_i)^\mu \]  

for the downstream industry, where \( k = \left( \frac{\mu}{1-\mu} \right)^{1-\mu} + \left( \frac{1-\mu}{\mu} \right)^\mu \).

### 3.2 General equilibrium

Using (2) in (4), the profit maximising behaviour by firms results in the following pricing rule:

\[ p^l_i \left( 1 - \frac{1}{\sigma^l} \right) = c^l_i. \]

Free entry is assumed and from the zero profit condition when (9) is used in (4), the equilibrium level of production is:

\[ \sum_{j \in J} x^l_{ij} = f^l (\sigma^l - 1). \]

It is interesting to note that, in equilibrium, the production level in each firm is independent of the marginal cost. Therefore, total production in sector \( l \) in a country is only determined by the number of firms.

Turning to expenditures, the expenditure on sector \( u \) in region \( i \) depends on the number of downstream firms in the region:

\[ E^u_i = \mu n^d_i c^d_i f^d \sigma^d, \]

since \( f^l + \sum_{j \in J} x^d_{ij} = f^d \sigma^d \) according to (10). So the amount spent by a firm on intermediate products is the expenditure share of intermediate products \( \mu \) times the total cost of production \( c^d_i f^d \sigma^d \).

The amount of expenditure spent by \( i \) on downstream products is
since it is assumed that consumers spend the share \( \beta \) of their income \( Y_i \) on downstream products and \((1 - \beta)\) on agricultural goods.

Full employment gives the following factor market clearing equation:

\[
w_i L_i &= n_i^u c_i^u \left( \sum_{j \in J} x_{ij}^u + f_i^u \right) + (1 - \mu) n_i^d c_i^d \left( \sum_{j \in J} x_{ij}^d + f_i^d \right) - w_i \frac{\partial \Pi_i (1, w_i)}{\partial w_i} \\
&= n_i^u f^u \sigma^u c_i^u + (1 - \mu) n_i^d f^d \sigma^d c_i^d + \gamma N_i w_i^{-\gamma}. \tag{13}
\]

The real wages are:

\[
\omega_i = w_i \left( P_i^d \right)^{-\beta} \tag{14}
\]
since consumers spend \( \beta \) on downstream products.

For the market of a specific variety to clear, (2), (9) and (10) can be used to set the optimal output per firm equal to world demand for its product:

\[
f_i^l \left( \sigma^l - 1 \right) = \left( \frac{\sigma^l}{\sigma^l - 1} \right)^{-\sigma^l} \left( \sum_{j \in J} t_{ij} \left( P_j^l \right)^{\sigma^l-1} E_j^l \right) \tag{15}
\]
for \( l \in \{u, d\} \) and \( i \in J \). If the markets for all varieties as well as the land and labour markets clear, the market for agricultural goods will also clear, by Walras’ law, in equilibrium.

Finally, the output equation is:

\[
Y_i = L_i w_i + N_i w_i^{-\gamma}. \tag{16}
\]

The general equilibrium consists of vectors of goods and factor prices, \( \{ P_i^l, w_i \} \)
and quantities \( n_i^l, Y_i \), \( l \in \{a, u, d\}, i \in J \) such that conditions (3), (13), (15) and (16) are satisfied.

Two forces cause firms to agglomerate. First, there is a demand linkage as upstream firms face a higher demand if they are located close to a large base of downstream industry; the latter is the consumer of upstream goods. Second, there is a cost linkage as downstream firms face lower costs if they are located close to a large base of upstream industry as the cost of production will then be lower when they need not import any intermediate goods from abroad. Working against these centripetal (agglomeration) forces are two centrifugal (congestion) forces causing industry to disperse. First, in a region with agglomeration, there is more intense competition between downstream firms. “Market crowding” gives downstream firms the incentive to locate in regions with fewer competitors. Second, the wage increases with the number of firms, due to the decreasing returns to scale in the agricultural sector. The latter reason becomes more important at lower trade costs, when proximity to consumers is less relevant for the locational choice of a firm.

Figure 2 shows the general equilibria for the downstream industry with two countries of symmetric size and falling trade costs. At very high and very low trade costs, the equilibrium is unique and dispersed. This stems from the fact that the high trade barriers make downstream firms locate as close as possible to their customers. The same logic applies to the upstream firms that sell to downstream firms. At intermediate trade costs, this dispersed equilibrium becomes unstable since the agglomeration forces outweigh the need to locate close to final consumers. Finally, at the very lowest trade costs, proximity to consumers becomes less important. Wage differences due to decreasing returns to scale in agriculture are then the most important determinant and the dispersed equilibrium is once more the only stable equilibrium.
Welfare can be measured by real wages, $\omega_i = w_i \left( P_i^b \right)^{-\beta}$. These are, first, determined by the nominal wage which is a function of the number of firms active in the country relative to country size as in equation (13); this is due to the concavity of the technology used in agriculture. Second, the price index is a function of what proportion of downstream goods that must be imported as can be seen in (3). Third, the price index is determined by the cost of importing the goods produced abroad. Put together, the country which experiences agglomeration will enjoy the highest welfare since its nominal wage will be higher due to a lower amount of workers in agriculture and the fact that it must import a lower share of its consumption goods. However, as trade costs fall towards free trade, industry spreads across countries causing an equalisation of nominal wages and the cost of importing approaches zero. This results in a convergence of real wages at free trade.

For completeness, paragraphs 3.3 and 3.4 examine the effects of the two features not included in the original model: size asymmetry and the inclusion of more than two regions.\textsuperscript{9}

The equilibrium characterised consists of a set of nonlinear equations for two industries and three countries. Analytical expressions for the endogenous variables cannot be found so this paper instead uses numerical methods. I exogenously allocate the shares of downstream firms across the three regions and solve for the endogeneous variables for all combinations. Since the location of upstream firms does not create any agglomeration forces on its own, there is only one equilibrium for a given allocation of downstream firms. By examining the profit levels of firms for all combinations of possible shares of downstream firms for the three regions, it is then possible to determine the existence and uniqueness of any equilibria found. Since there are three regions and two industries, the limitations in computational power restrict me to using grids with

\textsuperscript{9}As mentioned, this case was essentially analysed in Puga and Venables (1997).
the step size for industry shares at a 1 percentage unit and that for trade costs at 0.01. Moreover, I can solve the three-region model for shares of downstream firms for a country only from 6% to 88% of the global number of downstream firms. In the two-region model, I can solve from 0% to 100%, however. To follow Venables (1996) as closely as possible, the parameter values are here assumed to be the same as in that paper.\footnote{The parameter values are assumed to be the following: $\sigma^u = \sigma^d = 6$, $\mu = \frac{1}{2}$, $\beta = 0.2$, $\gamma = 10$, $\Sigma_{i \in J} N_i = 4$ and $\Sigma_{i \in J} L_i = 40$.}

3.3 The importance of size asymmetry

As seen in the previous section, a symmetric two-region model has a unique and stable dispersed equilibrium at high and low trade costs but multiple equilibria can exist at intermediate trade costs, including equilibria with full agglomeration of industry. However, this set of equilibria is very sensitive to the relative size of countries. To illustrate, the second graph in Figure 2 plots the level of equilibria when a small size asymmetry is introduced. The share of world population in country 1 is set to 0.55 and that of country 2 to 0.45. The set of equilibria changes drastically and the range of trade costs for which there is full agglomeration in country 2 (the smaller country), marked in the graph with an asterisk, shrinks as compared to the symmetric case. The range of trade costs for which there is full agglomeration of industry in the larger country 1 is larger than in the symmetric case. At even larger size disparities, only the larger country can be the location where industry agglomerates at intermediate trade costs. The reason is that agglomeration forces in country 1 (country 2) grow (decrease) with the relative size of country 1. In country 1, the effect on wages of an increase in the number of firms is lower since the country has a larger base of production factors and the demand and cost linkages become stronger, since the base of final goods consumers is larger.
Another important conclusion is that, in terms of welfare, a smaller country risks losing at intermediate trade costs due to the outflow of industrial activity to the larger country. This is one reason why a smaller country might be interested in alternative trade policies, such as that of an EPZ which will be discussed in section 4.

### 3.4 The symmetric equilibrium with three regions

Figure 3 shows the set of equilibria with three symmetric regions instead of two. The figure uses the same parameters and shows that the main conclusions are similar to the two-country case:

i) At high trade costs, there is a unique and stable dispersed equilibrium. Moreover, the equilibrium with complete dispersion is now stable for all trade costs, unlike the two-region case.
ii) At intermediate trade costs, there are equilibria with complete agglomeration, i.e. where all industry is located in one region.

iii) There is a unique and stable dispersed equilibrium at low trade costs.

However, there is one additional set of equilibria that did not exist in the two-region case:

iv) At intermediate trade costs, there are equilibria (marked with an asterisk) where industry is “partially agglomerated” and is only located in two regions, leaving one region deindustrialised.

The set of trade costs for which partial agglomeration is possible is larger than the set for which complete agglomeration is possible. This stems from the fact that agglomeration forces do not have to be as strong to result in a partially agglomerated as in a fully agglomerated equilibrium. Since firms are spread out in two locations instead of only one, as in the fully agglomerated equilibrium, wages do not increase to the same extent and competition is not as intense as in the fully agglomerated equilibrium.

4 The effects on location of an Export Processing Zone

4.1 Geographical setup

Before describing the details of the setup used in the analysis, it is instructive to consider the world that will be described in this paper in the following way. There are two countries of similar size. The first, Foreign, is fully integrated but the second country, Home, is divided into two regions with a very small bilateral trade cost. In terms of results, this has the same effect as the home country being smaller than the Foreign country. The home country should be considered as a developing country that joins the process of globalisation in
the sense that it faces decreasing trade costs with the rest of the world. It is a well-known fact that the past thirty years have seen a global integration of markets due to falling costs of trade. This need not only be due to the fall in variables directly linked to government policy, such as import tariffs or export taxes. Technological improvements have created cheaper transport systems and improvements in information technology have made it easier for exporters to locate foreign buyers and reduced shipping times. The home country, faced with decreasing trade costs towards the Foreign country, can choose between liberalising trade for both its regions or constructing an EPZ. The latter case will here be portrayed as a partial liberalisation of trade from a geographical point of view. Only the EPZ region will face lower costs of trade with Foreign, whereas the domestic zone will be protected and retain high trade costs. Moreover, labour cannot move within Home. This is a strong assumption since labour
migration often takes place into EPZs. However, it is also often very costly to move. Going back to the example of China, the Shenzhen zone is protected by barbed wire and police preventing a completely free movement of labour.

From a technical point of view, the construction of an EPZ will be modelled in the following way. Figure 4 provides an illustration. The world consists of three regions: \( J = \{D, E, F\} \) where the definitions are the same as described above. The trade costs within Home (i.e. between \( E \) and \( D \)) are very small but not zero.\(^{11}\) This seems realistic since there will always be some cost involved (due to bureaucracy or simply distance) between the interior of a country and the EPZ. Before the EPZ is constructed, the import tariff structure towards Foreign from Home is uniform across \( DOM \) and \( EPZ \) at \( t_{F,E}^{\text{initial}} = t_{F,D}^{\text{initial}} \). The Foreign

\(^{11}\)A trade cost \( t_{i,j} \) denotes the cost of shipping goods from region \( i \) to region \( j \).
country starts with a common tariff for both regions in Home: $t_{E,F}^{initial} = t_{D,F}^{initial}$. The case is then analysed when $t_{E,F}$ and $t_{F,E}$ both decrease towards free trade. This is referred to as the case of bilateral trade liberalisation in the remainder of the paper. In the second case, to which I will refer as unilateral trade liberalisation, $t_{F,E}$ decreases towards free trade but $t_{E,F}$ remains at $t_{E,F}^{initial}$. It turns out that how the import tariff in Foreign changes has a dramatic effect on the locational choice of firms.

Regional size will be such that the two countries, as a whole, will be of similar size so that $L_F = L_E + L_D$ and the two regions in Home are of the same size so that $L_E = L_D$. The same relationship holds for land endowments.

Modelling the EPZ policy by gradually reducing the trade cost between the EPZ and the foreign region is a very simplified way of describing an EPZ policy. However, I argue that by introducing an EPZ, the government is, in fact, exactly trying to facilitate trade between the EPZ and foreign countries. This is the core of the government’s intentions. Therefore, the trade cost in the model could be viewed in a rather abstract way; it also incorporates customs bureaucracy, waiting time for release by customs and general institutional quality.

I also argue that an EPZ policy is, in practice, similar to introducing a marginal trade cost between the domestic region and the EPZ. To prevent socially distortive labour movements and illegal imports, many EPZs are well guarded and it is marginally more costly to trade between the domestic region and the EPZ as compared to trading within the domestic zone.

4.2 Benchmark: opening both regions in Home to trade

In order to compare the EPZ policy to the alternative of opening both regions to foreign trade, the benchmark case would be an equiproportional reduction of

\[\text{The structure of trade costs and how they change in this case is similar to the "hub-and-spoke" agreement analysed in Puga and Venables (1997).}\]
tariffs that reduces all bilateral external trade costs between Home and Foreign. The effect of this policy is shown in Figure 5.\textsuperscript{13} Here, at high trade costs, there is only one unique and dispersed equilibrium—in the sense that all regions contain a strictly positive number of firms in both industries—where Foreign contains the larger share of both industries. At the highest trade costs, the share of firms in each region reflects the share of the world population in that region. However, as trade is liberalised, an increasing number of firms relocate to the large country and the share of firms in both industries in Foreign exceeds its share of factor endowments. The forces of agglomeration grow, as previously described, whereas the proximity to final goods consumers decreases in importance. For trade costs lower than a certain level, there is no longer any dispersed and stable equilibrium, only two stable and fully agglomerated equilibria. In the first, all firms in both industries are located in the Foreign country.\textsuperscript{14} In the other equilibrium, all firms are located in the home country. In this case, they will be evenly distributed between the two regions in Home since at any other equilibrium, the costs will be asymmetric in the two home regions and make firms move from the region with higher costs (and more firms) to that with lower costs (and fewer firms) until the costs converge.

However, if the economy starts at a high level and trade costs are gradually reduced, the economy will end up in the first equilibrium with all industry located in the Foreign country. This is because the economy will remain along the path of stable equilibria where the industry increasingly relocates to the

\textsuperscript{13}The trade cost between the EPZ and the domestic region is here and throughout the remaining analysis set at $t_{E,D} = t_{D,E} = 1.02$. Another counterfactual already discussed is the two-country case described in Figure 2 where one country is smaller. The results from that case and what is described here are similar.

\textsuperscript{14}When running the numerical simulations of the equilibrium with three regions, I have not been able to find any solutions for cases where the share of the downstream industry is below 6\% in any region. Therefore, 88\% constitute the maximum possible share. Thus, when the share of downstream industry is at 6\% for a specific region in the remaining figures, it means that agglomeration forces are sufficiently strong in other regions, such that the region has no remaining downstream industry.
Figure 5: Stable equilibria of industry location when both regions in Home reduce the bilateral trade costs with Foreign.

Foreign country. After the break point at $t = 1.25$, the economy will jump to the equilibrium where all industry is located in Foreign. Therefore, the opening of the home country to trade will result in deindustrialisation as all industry will be located in the Foreign country. For the economy to arrive at the equilibrium with full agglomeration in Home, some type of strong exogenous force must be introduced.

The home country would therefore lose its industrial base when trade is liberalised with the foreign country which would also result in a drop in real wages in Home.
4.3 EPZ policy: Bilateral liberalisation between only the EPZ and Foreign

The alternative on which this paper focuses is a partial opening of the home country to foreign trade: the construction of an EPZ. This policy is analysed in this section. The EPZ policy is modelled as a decrease in bilateral trade costs between the EPZ and the Foreign country. When the bilateral tariff reductions occur between the EPZ and Foreign, the EPZ becomes the region with the best market access as it can access both the domestic interior and Foreign at low trade costs. Figure 6 shows the result of simulating this policy experiment.

At high trade costs, the economy has the same characteristics as in the previous case, with industry located in the different regions according to regional size. Within the home country, industry is evenly distributed between the two regions due to cost pressure. However, as trade is liberalised between the EPZ and Foreign, firms in both sectors relocate into the EPZ. Downstream firms do this since the market access of the EPZ improves relative to other regions. This is reinforced by agglomeration forces and occurs until the trade cost \( t^* \) is reached. At this point, the costs in the EPZ have risen to the point where some upstream firms instead locate in the domestic region. This is the region with the best market access to the base of downstream firms in the EPZ but it has lower costs than the EPZ due to the lower number of firms.

At trade costs lower than \( t^{**} \), no dispersed equilibrium is stable and full agglomeration occurs in the home country. The entire downstream industry is now located in the EPZ, but most upstream industry is located in the domestic part of Home. The reason why not all upstream industry is located in the domestic part is that the small trade cost between the domestic part and the EPZ makes it more profitable for some upstream firms to locate in the EPZ, despite the higher wages. No firms from either industry are located in the
Foreign country; this phenomenon is referred to as a “segregation” of industry in Home.

Finally, at the lowest levels of trade costs, the upstream industry locates such that Home and Foreign, respectively, have equal amounts of the upstream industry. Within Home, more upstream firms locate in the domestic region than in the EPZ. The downstream industry remains completely agglomerated in the EPZ as this is still the region with the best market access—the bilateral trade cost between the domestic region and Foreign remains at a high level—and the lowest cost since the upstream industry is spread out in all three regions.

The simulation shows that a partial liberalisation of trade on behalf of the home country is preferable for its industrial activity to the policy of liberalising foreign trade for both regions. The key mechanism is that Home attracts industry by forcing firms that want to sell products to its entire market (i.e. also the domestic region) at low trade costs to locate within its borders. Thus, Home creates one region in the world where market access is most favourable to firms and thereby draws industry from the foreign country to itself. In terms of welfare, real wages in Home with an EPZ are higher throughout than with a liberalisation of trade costs for both domestic regions. This is due to the fact that with the EPZ policy, the location of industry both increases the wages in Home (since less labour is employed in agriculture) and reduces its price index since final goods need not be imported.

Another interesting conclusion is that industry becomes partially segregated in the home country. The main part of upstream production is carried out in the domestic zone and then shipped to downstream producers in the EPZ. This is in contrast to the two-region framework of Venables (1996) where the main conclusion is that the two sectors locate in the same region. Thus, the combination of low trade costs between the EPZ and the domestic zone and large trade
costs between the domestic zone and Foreign cause downstream firms to locate in the EPZ where they have the best access to consumers. Upstream firms, on the other hand, take advantage of the lower wages in the domestic zone and the simultaneously good access from the domestic zone to its buyers, which are all located in the EPZ. As trade costs fall further, the price of immobile factors becomes the most important determinant for the location of the upstream sector. Upstream firms then move so that they are spread out according to the countries’ shares of production factors. However, the downstream sector remains agglomerated in the EPZ since it remains the best region both in terms of market access and the cost of intermediate products.

This is in line with stylised evidence saying that EPZs are typically characterised by the assembly of intermediate products produced outside the zone.

Figure 6: Stable equilibria of industry location when the bilateral trade costs between the EPZ and Foreign fall.
4.4 When the foreign country maintains high import tariffs

Naturally, the previous analysis hinges on the fact that the foreign country dismantles its trade barriers at the same rate as Home. It was argued above that the process of globalisation has reduced trade costs between all countries but it is still interesting to see what the effect would be if the foreign country retains its import tariffs at the initial level. In this case, the only trade cost that decreases is the EPZ’s import tariff towards the foreign country.

However, a general result in models of the new economic geography literature is that a unilateral trade liberalisation leads to an outflow of industry from the liberalising country. This result also holds here. The reason is that the protected country will be the country from which firms have the best market access, since they can produce both for the market where they operate without trade costs and export at a lower trade cost than if they were located in the other country. In fact, this is often viewed as a problematic feature of the field since, in reality, high import tariffs are usually not the best trade policy for attracting industry. Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003)\textsuperscript{15} provide a detailed discussion of this issue.

Figure 7 shows that this result also holds in the current context. It shows the result when only the EPZ reduces its import tariff, while the Foreign import tariff remains high. The result is completely different from the case in the previous section. Starting with the same case as before with high symmetric trade costs, the liberalisation of trade makes firms relocate into Foreign. First, downstream firms from the EPZ relocate to Foreign, due to the improvement in market access in that zone. This also makes upstream firms relocate to Foreign since their market, downstream firms, grows larger in that country. This

\textsuperscript{15}Chapter 12.
Figure 7: Stable equilibria of industry location when only the EPZ reduces its import tariff.

process continues and when the import tariff of the EPZ is $t^*$, the forces for agglomeration are so strong that all industry is located in the foreign country. The import tariff of the Foreign country is the variable that changes the outcome. By retaining a high barrier for foreign firms, the forces for agglomeration make firms locate in the Foreign region to take advantage of the Foreign market but increasingly also that of the EPZ. From the perspective of vertical linkages between intermediate and final good producers, the EPZ policy favours Home in terms of industry location and welfare only if Foreign simultaneously reduces its import tariffs.
4.5 A policy of banning upstream firms in the EPZ

Some EPZs have the feature that they focus on, or only allow, industry of a more advanced nature. This can be modelled as only allowing downstream firms in the EPZ and exogenously setting the share of upstream industry in the EPZ to zero. The result of such a policy is shown in Figure 8, which uses the case where the bilateral trade cost between the EPZ and Foreign decreases. The policy simply reinforces the results from the bilateral case described in Section 4.3. The segregation of industry within Home at intermediate trade costs now becomes complete.

Moreover, agglomeration of industry in Home occurs earlier as trade costs fall. Conversely, agglomeration can be sustained at a higher level of trade costs. When upstream firms are banned in the EPZ, they locate in the same proportions between Home and Foreign as in the unrestricted case (as can be seen when comparing Figures 6 and 8). However, within Home, these firms now all locate in the domestic region, thus making inputs for downstream firms in Foreign more expensive than in the unrestricted case. Therefore, it is possible to sustain a complete agglomeration of downstream activity in the EPZ at a higher trade cost. The simulations show that since it makes more firms locate in the domestic zone and fewer in the EPZ, this policy reduces the wage difference between the domestic zone (wage inequality in Home is lower) and the EPZ compared to the policy described before in Section 4.3.

5 Conclusions

This paper provides a rationale for the common use of Export Processing Zones in third world countries. It demonstrates the viability of an EPZ policy as an alternative to the liberalisation of trade for all regions in a small country. This
Figure 8: Stable equilibria of industry location when upstream firms are banned in the EPZ and bilateral trade costs fall between the EPZ and Foreign.
is done using a model capturing an important aspect of EPZs, namely that they are typically characterised by the assembly of intermediate products into final goods. A vertical structure of industry also means that there are possible forces of agglomeration determining the location of industry due to demand and cost linkages between upstream and downstream sectors. When a small country liberalises trade for all its regions, these forces can make industry leave for the larger Foreign country. Constructing an EPZ (a partial opening of the country), however, can generate forces that make final good producers take advantage of the superior market access in the EPZ and locate in that zone. From the EPZ, firms can sell to consumers both in Home and Foreign at lower trade costs. This makes upstream firms locate in the domestic part (outside the EPZ) of the home country in order to be close to the downstream sector while taking advantage of the low wages outside the EPZ.

It also shows that these effects generate an outcome that is often discussed in the policy debate: that the domestic region of the home country produces intermediate products that are then assembled by the downstream industry in the EPZ. Industry segregates so that all downstream producers are located in the EPZ while upstream producers are based outside the EPZ.

Two policy conclusions emerge from the analysis. First, the viability of an EPZ is strongly reinforced by allowing firms in the EPZ to also sell their goods domestically. This is key to making the EPZ the region with the best market access and it is also more important the larger is the home country. Second, a policy of banning upstream producers in the EPZ reinforces this pattern. It expands the range of trade costs for which the agglomeration of industry in Home is viable but also reduces the wage inequality between the domestic zone and the EPZ in Home.
References


