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**Globalisation and Urban Polarisation**

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## **Abstract**

External trade affects the internal spatial structure of an economy, promoting growth in some cities or regions and decline in others. Internal adjustment to these changes has often proved to be extremely slow and painful. This paper combines elements of urban and international economics to draw out the implications of trade shocks for city performance. Localisation economies in production of internationally tradable goods mean that cities divide into two types, those producing tradables and those specialising in sectors producing just for the national market (non-tradables). Negative trade shocks (and possibly also some positive ones) reduce the number of cities engaged in tradable production, increasing the number producing just non-tradables. This has a negative effect across all non-tradable cities, which lose population and land value. Remaining tradable cities boom, gaining population and land value. Depending on the initial position, city size dispersion may increase, this raising the share of urban land-rents in national income and reducing the share of labour.

Key words: Globalisation, urban, de-industrialisation, rustbelt, polarisation  
JEL Codes: F12; R11; R12

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## 1. Introduction

The benefits of globalisation for consumers are spread widely across income groups and regions in a country, but the production impact is concentrated on particular sectors and firms. This sectoral concentration maps into differential impacts on towns and cities, as well as on skill types. Adjustment to such spatially concentrated shocks seems, from the experience of many countries, to be particularly difficult. Cities in the rustbelt of the US or former manufacturing areas in the north of the UK and northern France have spent decades in relative, and sometimes absolute, decline. The more recent experience of the China trade shock has been mapped into regional impacts, in particular by the work of Autor et al. (for a survey see Autor et al. 2016). In this work adjustment failure is viewed as a consequence of labour market rigidities, typically a combination of inadequate labour mobility and/or wage flexibility, leading to an outcome with persistently low levels of employment in affected areas.<sup>1</sup>

This paper explores a different mechanism through which trade or technology shocks create persistent regional and urban inequalities. We assume a perfectly functioning labour market – with factor mobility and wage flexibility – and focus on the difficulties faced in establishing new tradable sectors in cities that have lost a traditional tradable goods sector. The difficulties arise as many of these sectors are subject to agglomeration economies that create a first-mover problem; in the absence of coordinated behaviour, it is not profitable to start a new activity in a new place. This problem is compounded by the fact that, within a country, factor mobility limits the magnitude of spatial wage variation meaning that costs do not fall enough to attract activity into a place that has experienced a negative shock. In short, the usual mechanisms of comparative advantage do not operate to draw activity into an adversely affected area.

We show circumstances under which trade shocks – positive as well as negative – lead to a polarisation of the urban structure as some cities boom and others decline. Declining cities maintain economic activity, but it is in sectors producing non-tradable goods and services. As an increasing number of cities are relegated to specialising in these sectors the relative price of non-tradables declines, amplifying the gap between cities. The counterpart of cities that have lost tradable sectors are booming cities that have retained tradable goods or service sectors. These expand, driving up land prices in these cities and possibly also the share of rent in income (actual and imputed to land and property owners). These booming cities are as

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<sup>1</sup> Research on the impact of trade on regional and urban performance is reviewed by Autor et al. (2016) including their influential work on the impact of Chinese competition on the US labour market. Variation in regional exposure to import competition (via the industrial structure of the region) is used to establish the negative impact of this competition on manufacturing employment and consequent higher unemployment in the US (Autor et al. 2016) and Norway (Balsvik et al. 2017). In Spain the response has been higher employment in other sectors (Donoso et al. 2014).

much a feature of trade shocks as are declining cities that have lost competitiveness in tradable goods production.<sup>2</sup>

The paper presents a simple model of this process, combining elements of urban economics and international trade. At the heart of the model are three features. The first is the presence of agglomeration economies, i.e. external economies of scale, operating at the city or region level and within a particular productive sector (localisation economies). It is this that gives rise to spatial clustering of sectors, meaning that different cities within a country will undertake different economic activities and that trade shocks will impact different areas in different ways. The model assumes that all tradable sectors are subject to these economies, although non-tradable sectors are not. A further consequence of agglomeration economies is that it is difficult to establish new centres of production for tradable goods. A city that has lost a traditional sector offers neither low enough factor prices nor any productivity advantage in a new sector. Coordinated action by firms – or a ‘large developer’ – can solve the problem, but without this no firm wants to be the first in the sector to establish in a new location, uncertain as to whether it will be followed by other firms which will create the cluster and raise productivity.

The second feature is that we distinguish between tradable and non-tradable sectors, where by non-tradables we mean goods produced for the national rather than the international economy, and hence have their price set domestically rather than fixed at world prices.<sup>3</sup> A central feature of the model is that cities in a country will divide between those producing tradables and those producing non-tradables. Trade shocks may cause cities to switch activity with, for example, cities that lose their tradable sector due to import competition defaulting to non-tradable production.

The third feature is that, within a country, the performance of a city depends largely on its absolute advantage, not its comparative advantage. If a *country's* export sector has a negative shock the adjustment mechanism is a real depreciation, i.e. a reduction in its wage and unit costs relative to its trading partners, and this reduction continues until other sectors become competitive. If a *city* within a country suffers a negative shock there may be little flexibility of relative wages between regions because factor mobility means that labour markets are tightly integrated. Of course, there are some immobile factors, such as land and houses. Their prices will fall in the adversely affected region but since these factors only represent a small fraction of costs they have little leverage in bringing other sectors to the point of

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<sup>2</sup> This has evidently been a dramatic feature of the US and UK economies. See Moretti (2013) for a discussion of the issues, and Florida (2017) for US experience of booming cities.

<sup>3</sup> It would be possible, but not qualitatively interesting, to add truly local non-tradables (haircuts, restaurants), just serving the local city market.

competitiveness.<sup>4</sup> This will be particularly the case in the presence of localisation economies and coordination failure.

Model essentials are set out in simple form in section 2 and the core of the paper is section 3 which looks at the adjustment of the economy to trade shocks. A novelty of the paper is that the equilibrium division of cities between tradable and non-tradable is not unique. In the full model of section 3 trade shocks shift the equilibrium set, so their impact depends on the economy's initial point in this set, i.e. the initial division of cities between tradable and non-tradable production. In a wide range of cases we show that sufficiently large shocks – both negative and positive – will have the effect of knocking out some established centres of tradable activity and thereby increasing the number of cities producing only non-tradables. We maintain the assumption of full employment but show how switching between activities impacts the entire economy, changing the size distribution of cities and the distribution of income. Cities that retain tradable goods sectors boom and per capita income in the economy may rise. However, the principal beneficiaries are property owners in the booming cities and, depending on the initial position, the share of rent in national income may increase.

## **2. Tradable and non-tradable cities.**

### **2.1 The model:**

A small open economy contains an exogenously determined number of cities,  $M$ , in which all production takes place. We assume in this section that the economy is endowed with a single factor of production, labour in quantity  $L$ , and that there are two types of productive sectors, tradable and non-tradable. In the following section we give the two factor (i.e. two skill level) and three productive sector version.

Labour is mobile between cities, and each city has a geographical structure of the usual Alonso-Mills-Muth form, in which jobs are located in the central business district (CBD), workers occupy residential land, commuting is costly, and land rent adjusts to make workers indifferent between residential locations. Cities can potentially produce either non-tradable goods, becoming a 'type-N' city, or tradables, becoming 'type-T'. Non-tradables are freely traded within the country, but not internationally; they can be thought of as some food sectors, retail and wholesale trade, distribution, customer service centres, and national financial, professional, personal and government services. They are produced under constant returns to scale, and their price is set on the national market. Tradable goods are freely tradable globally at fixed world prices and are subject to city specific agglomeration

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<sup>4</sup> Although price adjustment of immobile factors generally cannot induce a real depreciation that fully offsets a negative shock it can slow down the movement of mobile factors, as argued by Glaeser and Gyourko (2005).

economies. Tradables can be thought of as a number of different goods or sectors, but all are symmetric and price-taking, and the key point is the city specificity of agglomeration (or localisation) economies.<sup>5</sup> This ensures that each city will specialise, being either type-T (specialising in a single tradable sector), or type-N (producing only non-tradables). The number of type-T cities is endogenous and denoted  $M_T$ , and the remainder are type-N, producing non-tradables ( $M_N = M - M_T$ ).<sup>6</sup>

The price of tradables is  $p_T$ , exogenously fixed at the world level, and the number of workers employed in each type-T city is denoted  $L_T$ . Localisation economies mean that productivity,  $q$ , in each of these cities is increasing in the level of employment in the city,  $q'(L_T) \geq 0$ .

Labour is the only input to production, so the wage is value productivity,

$$w_T = p_T q(L_T). \quad (1)$$

Employment in type-N cities is  $L_N$  and the wage is  $w_N$ . Non-tradables are, by definition, tradable within the country but not abroad, so their price,  $p_N$ , is determined at the national level. We assume that one unit of labour produces one unit of non-tradable output, implying  $p_N = w_N$ . The price (and hence wage) of non-tradables is determined by market clearing condition

$$(M - M_T)L_N w_N = \theta [M_T w_T L_T + (M - M_T)w_N L_N]. \quad (2)$$

The left hand side is the value of supply of non-tradables, and the right hand side is the value of demand, where the term in square brackets is total income and  $\theta$  is the share of income spent on non-tradables. This share is derived from assuming that *all* expenditure in each city goes on a composite good,<sup>7</sup> which is a Cobb-Douglas aggregate of tradables and non-tradables with price index  $P = p_T^{1-\theta} w_N^\theta$ . We take tradable goods as the numeraire, so  $p_T = 1$  and the price index of the composite good is

$$P = w_N^\theta. \quad (3)$$

Workers' per capita utility in a city of type- $i$  is  $u_i = (w_i - bPL_i)/P = w_i/P - bL_i$ . The term in brackets is the wage net of urban costs, these consisting of commuting and rent payments. These urban costs increase with city population  $L_i$  at rate  $b$  and are incurred in units of the

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<sup>5</sup> In section 3 the assumption of symmetry of all type-T cities is relaxed, allowing there to be two types. A more general approach would be to have differences in the scale of each tradable goods sector and hence each tradable city, in the style of Henderson (1974).

<sup>6</sup> Venables (2017) analyses the issues faced by a single developing country city with non-tradable production and which is seeking to establish a tradable goods sector.

<sup>7</sup> This is final household expenditure net of rents and commuting costs, spending by recipients of rent income, and commuting costs which are incurred in units of the composite good.

composite good with price index  $P$ . Expenditure net of urban costs goes on the composite good, so utility is spending net of urban costs deflated by the price index. Labour mobility equalises utility across all cities so

$$w_T / P - bL_T = w_N / P - bL_N . \quad (4)$$

Thus, larger cities have to pay a higher nominal wage in order to offset the higher costs of rent and commuting. Finally, national labour market clearing is

$$L = M_T L_T + (M - M_T) L_N . \quad (5)$$

Equilibrium conditional on the number of type-T cities,  $M_T$ , is the solution of the five equations above for endogenous variables  $\{w_T, w_N, L_T, L_N, P\}$ .

The ‘urban costs’ of a particular worker are divided between commuting costs and land rent according to her residential location relative to the centre of the city.<sup>8</sup> For the edge worker they are entirely commuting costs and for a worker adjacent to the CBD they are entirely rent. If the city is linear and commuting costs are linear in distance then, since the commuting cost paid by the marginal worker (living at the city edge) is  $bPL_i$ , ( $i = T, N$ ), the total of commuting costs and rent city wide is  $bPL_i^2$ . Total commuting costs are half this,  $bPL_i^2/2$ , the remainder being rent. For consistency with eqn. (2) we require that rents are spent on the composite good so real rents (deflated by the price of the composite good) are  $R_i = bL_i^2/2$ . Notice that total real rents are increasing and convex in city size. The quadratic form comes from our assumptions of a linear city with linear commuting costs, but convexity is a much more general property as large cities have both more land and higher average rent.<sup>9</sup> The total utility generated by a city of type  $i$  is the real income of workers plus real land rents,  $u_i L_i + R_i$ .

## 2.2: Equilibria:

Fig. 1 traces out values of variables solving eqns. (1) – (5) as a function of  $M_T$ , with the horizontal axis giving the proportion of cities that are type-T and the vertical giving wages. The figure is constructed with  $q(0) = 1$ ,  $q' > 0$  and with  $\theta = 1/2$ , ensuring the existence of an

<sup>8</sup> For detailed exposition of the Alonso-Muth-Mills model of urban land-use see Duranton and Puga (2015).

<sup>9</sup> In a more general setting, edge commuting costs are  $bPL_i^{\gamma-1}$ , average commuting costs  $bPL_i^\gamma / \gamma$ , total land rent  $R_i = b(\gamma - 1)PL_i^\gamma / \gamma$ . In a linear city  $\gamma = 2$ , and in a circular city  $\gamma = 3/2$ . The condition  $\gamma > 1$  is necessary for edge commuting costs to be increasing with city size (see Henderson and Venables 2009).

equilibrium with an equal number of cities of each type. Other parameter values are given in the appendix.

The market clearing price of non-tradables is  $w_N$ , increasing in the number of cities of type-T since this corresponds to fewer type-N cities and therefore less non-tradable supply. A higher (nominal) wage  $w_N$  attracts migrants, raising urban costs in type-N cities. To continue to equalise utilities across city types (eqn. 4) there must be a decrease in the size of type-T cities; this means lower agglomeration economies and hence the downward sloping wage curve  $w_T = p_T q(L_T)$ .<sup>10</sup> Finally, the horizontal line on the figure,  $p_T q(0)$ , is the wage that could be paid by a single (small) firm that sought to produce tradable goods in a type-N city, and therefore without the productivity advantage of localisation economies.

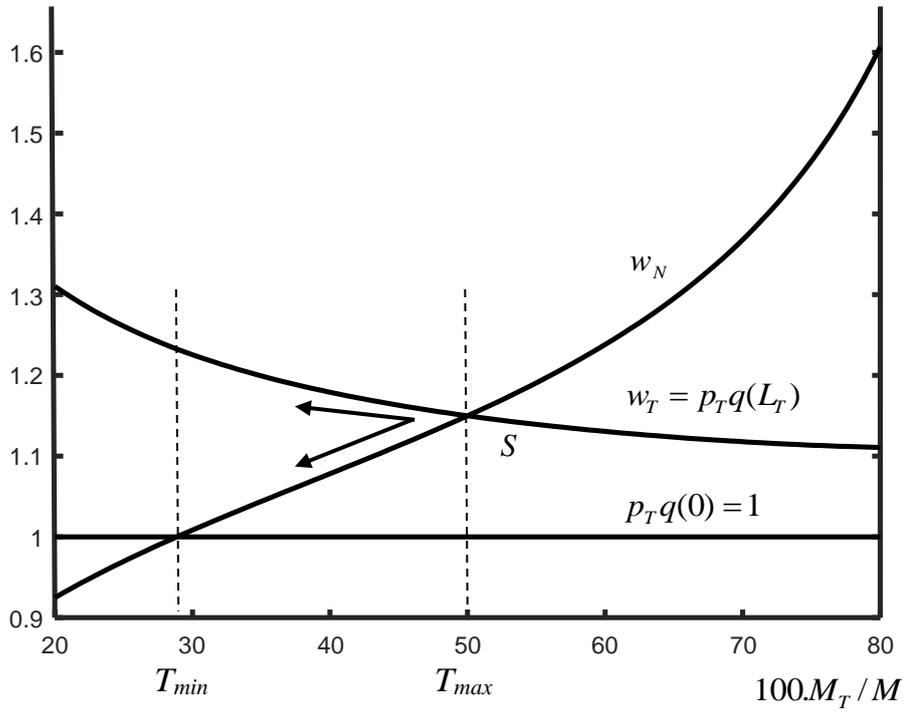
What is the equilibrium number of cities of each type? Points to the left of  $T_{min}$  cannot be an equilibrium since, with  $w_N < p_T q(0)$ , it would be profitable for firms in type-N cities to commence tradable production. Points to the right of  $T_{max}$  cannot be an equilibrium since, with  $w_T < w_N = p_N$ , firms in type-T cities would switch to producing non-tradables. Any value of  $M_T$  in the interval  $[T_{min}, T_{max}]$  is an equilibrium, since no firm in any city has an incentive to switch sector.

The finite size interval  $[T_{min}, T_{max}]$  and associated set of equilibria exists because of agglomeration economies and coordination failure. The vertical gap  $p_T q(L_T) - p_T q(0)$  captures the obstacle faced by a single firm in a type-N city that chooses to produce tradables (with productivity  $q(0)$ ) and has to compete with tradable producers in type-T cities (with productivity  $q(L_T)$ ). Absent coordination failure, the equilibrium would be at point the unique point S, the intersection  $w_N = w_T = p_T q(L_T)$ , with wages, city size and rent the same in all cities. In the example illustrated agglomeration economies are quite modest. At  $T_{min}$  productivity  $q(L_T)$  is 25% higher than  $q(0)$ , but even this modest level of agglomeration economies supports the wide range of equilibria illustrated. In this interval nominal wages are higher in type-T cities than in type-N,  $w_T > w_N$ , more so the fewer tradable cities there are. The price index  $P$  is the same everywhere, so migration equilibrium is supported by type-T cities having higher urban costs, i.e. being larger. Larger size means higher commuting costs for the marginal worker, and higher rents and land values on land at each distance. This is illustrated on fig. 2, giving total real rents in each city. At  $T_{min}$  total city rents are 4.1 times larger in type-T cities than in type-N cities, this being made up of average rents per person (and per unit land) being 2.02 times higher, and city population 2.03 times greater.

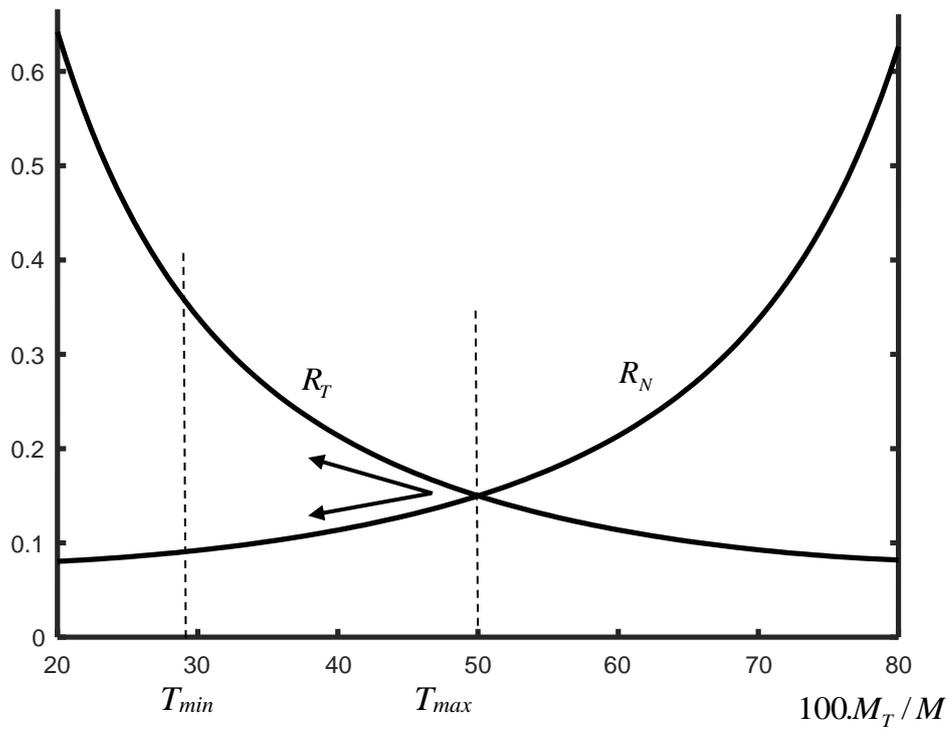
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<sup>10</sup> For stability, each side of eqn. 4 is decreasing in employment in the city type.

**Figure 1: Wages, productivity and equilibria**



**Figure 2: Real rents earned in each city**



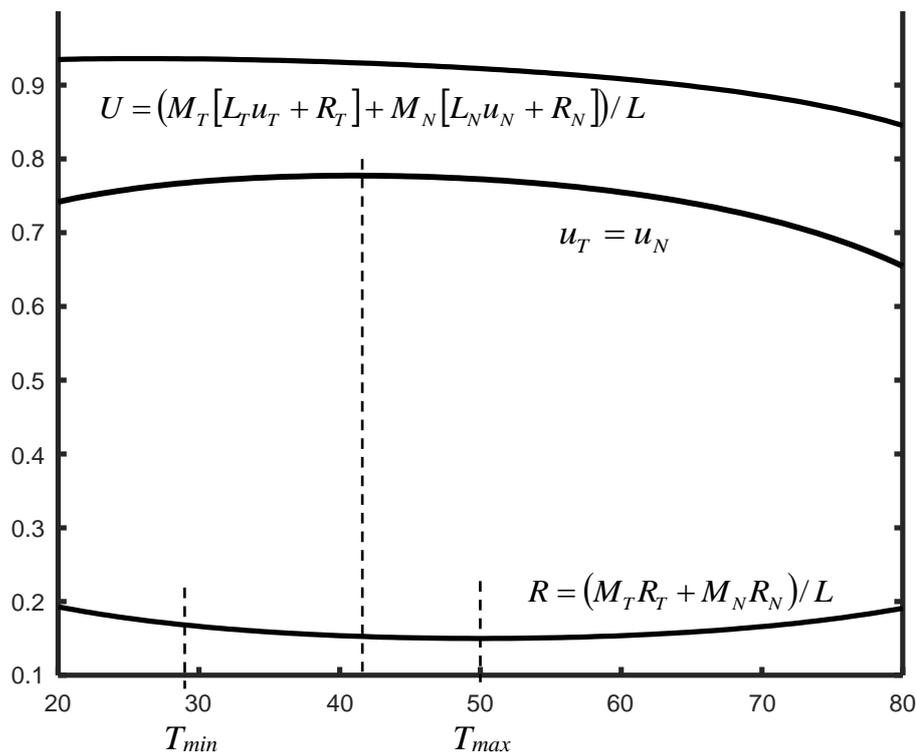
### 2.3: Trade shocks:

How does this economy respond to a shock that impacts a traded good sector? The shock could be either trade or technology, and we suppose (in this section) that it simply removes the country's comparative advantage in some of its tradable sectors and hence in some of its type-T cities. Coordination failure means that these cities cannot easily switch to a new T-sector, so instead become type-N cities. On figs. 1 and 2 this corresponds to movement to the left so, if the economy is initially at  $T_{max}$ , then type-T and type-N cities each follow the paths indicated by the arrows. As type-T cities default to being type-N cities, so the price of non-tradables falls, dragging down nominal wages in all type-N cities. They lose population to remaining type-T cities and – since real wages are equated by migration – this leads to falling rents in all type-N cities and rising rents and land prices in type-T cities (Fig. 2).

Real income effects are shown in Fig. 3. Total real rent (bottom line, expressed per worker) is minimised at the point where rents earned in each city are the same. This is where cities are the same size and is the equilibrium without coordination failure, point S; by convexity of rents in city size, moving away from this point in either direction raises total real rent. Total utility (top line) is decreasing with the number of type-T cities throughout the equilibrium range, and is slightly (1.4%) higher at  $T_{min}$  than at  $T_{max}$ . This surprising result (and the implication that the point without coordination failure, S on Fig. 1, is inefficient) comes from the fact that remaining type-T cities are larger the smaller is  $M_T$ , so the economy is achieving greater economies of scale. (If the productivity gap  $q(L_T) - q(0)$  were constant for all  $L_T > 0$  then total utility would be maximised at S where  $T = T_{max}$ ). Reducing the number of type-T cities reduces worker's utility relative to rents throughout the equilibrium range, but fuller exploitation of economies of scale enables an absolute increase over part of the range.

In summary, a negative shock with direct effect on a single city gives the following equilibrium effects. This city defaults to non-tradable production meaning that the adverse consequences are felt across all N-cities which experience falling nominal wages, population loss and falling real rents. Remaining tradable cities boom, gaining population and nominal wage increases. However, the largest part of the gain is captured by those fortunate enough to own land in these remaining tradable cities.

**Figure 3: Real incomes**



### 3. Trade shocks, skills and cities.

The model of the previous section focuses on the domestic economy and enables a few points to be made in a simple fashion. However, it does not contain a full model of trade and its wider impact on the economy. We now add this, modelling the trade shock as a change in world prices faced by the country.

#### 3.1: The model

We now assume that there are two types of tradable sectors, A and B, and model the trade shock as an increase in the world price of products in type-A sectors.<sup>11</sup> As before, tradable sectors have localisation economies, so cities will specialise in a particular sector, giving cities of type-A, B, N; subscripts denote city-type so, for example,  $x_i$ , is output in a city of type  $i = A, B, N$ . There are two factors of production which we think of as two labour skill levels, and we assume that the three sectors, A, B and N have different factor intensities. Changes in prices of tradable goods then lead directly to changes in factor prices through Stolper-Samuelson effects, although different in detail because of increasing returns to scale

<sup>11</sup> In the simulations that follow we assume that products and sectors are otherwise symmetric and that the initial equilibrium is symmetric. It follows that there is (locally) no trade and no terms of trade effect.

in the tradable cities. All products are consumed domestically so price changes have a direct impact on the price index,  $P$ , as well as changing the structure of production in the economy.

The formal structure of the model is as follows. Production functions in the three sectors are

$$x_N = X_N(L_N, K_N), \quad x_T = q(x_T)X_T(L_T, K_T), \quad T = A, B, \quad (6)$$

where  $q(x_T)$  captures localisation economies in the tradable cities,  $q'(x_T) \geq 0$ , and the two factors (labour skills) are denoted  $L, K$ . Factor demands are implicitly derived from marginal value products, where  $p_T, T = A, B$  are the prices of the two types of tradables and  $w$  and  $r$  denote the prices of the two factors<sup>12</sup>

$$w_N = p_N \frac{\partial X_N(L_N, K_N)}{\partial L_N}, \quad r_N = p_N \frac{\partial X_N(L_N, K_N)}{\partial K_N}, \quad (7)$$

$$w_T = p_T q_T(x_T) \frac{\partial X_T(L_T, K_T)}{\partial L_T}, \quad r_T = p_T q_T(x_T) \frac{\partial X_T(L_T, K_T)}{\partial K_T}, \quad T = A, B.$$

The price of non-traded goods comes from market clearing equation

$$(M - M_A - M_B)p_N x_N = \theta [M_A p_A x_A + M_B p_B x_B + (M - M_A - M_B)p_N x_N]. \quad (8)$$

hence  $p_N x_N = \theta [M_A p_A x_A + M_B p_B x_B] / (1 - \theta)(M - M_A - M_B)$ .

The composite good is made up both types of tradable and the non-tradables, according to  $P = p_N^\theta p_A^{\theta_A} p_B^{\theta_B}$ , with  $\theta + \theta_A + \theta_B = 1$ .

We assume that urban costs increase in the number of workers, simply adding the two types of labour. The utilities of workers of type  $L, K$  in city of type  $i$  are therefore  $u_i^L = w_i / P - b(L_i + K_i)$ ,  $u_i^K = r_i / P - b(L_i + K_i)$ ,  $i = A, B, N$ . For each type of worker mobility equalises utility across cities, so

$$w_N / P - b(L_N + K_N) = w_T / P - b(L_T + K_T), \quad T = A, B. \quad (9)$$

$$r_N / P - b(L_N + K_N) = r_T / P - b(L_T + K_T), \quad T = A, B.$$

Factor market clearing equations are

$$L = M_A L_A + M_B L_B + (M - M_A - M_B)L_N, \quad (10)$$

$$K = M_A K_A + M_B K_B + (M - M_A - M_B)K_N.$$

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<sup>12</sup> Firms do not internalise localisation economies in their hiring decisions, so  $q(x_T)$  is assumed constant in derivation of marginal products.

Equilibrium conditional on the number of cities in the tradable sectors,  $M_A, M_B$ , is the solution of the above equations for output, factor prices, factor allocation to cities and the price of non-tradables.

We assume that all workers – skilled and unskilled, and at all locations – occupy the same amount of land and, as before, urban costs are derived from commuting costs which total  $b(L_i + K_i)^2 P / 2$ , and rents  $b(L_i + K_i)^2 P / 2$ , so that real rents are  $R_i = b(L_i + K_i)^2 / 2$ ,  $i = A, B, N$ . Total utility in a city of type  $i$  is

$$U_i = u_i^L L_i + u_i^K K_i + R_i, \quad i = A, B, N. \quad (11)$$

### 3.2: Equilibria:

As in section 2, localisation economies and coordination failure create a set of equilibria. This is the set of city combinations,  $\{M_A, M_B, M_N = M - M_A - M_B\}$  at which no deviation by a worker or single (small) firm is profitable. If cost functions dual to production functions  $X_i$  are denoted  $c_i(J)$  where  $(J)$  represents evaluation at the factor prices of a city of type  $J = A, B, N$  then the equilibrium set of city locations meet the following conditions:

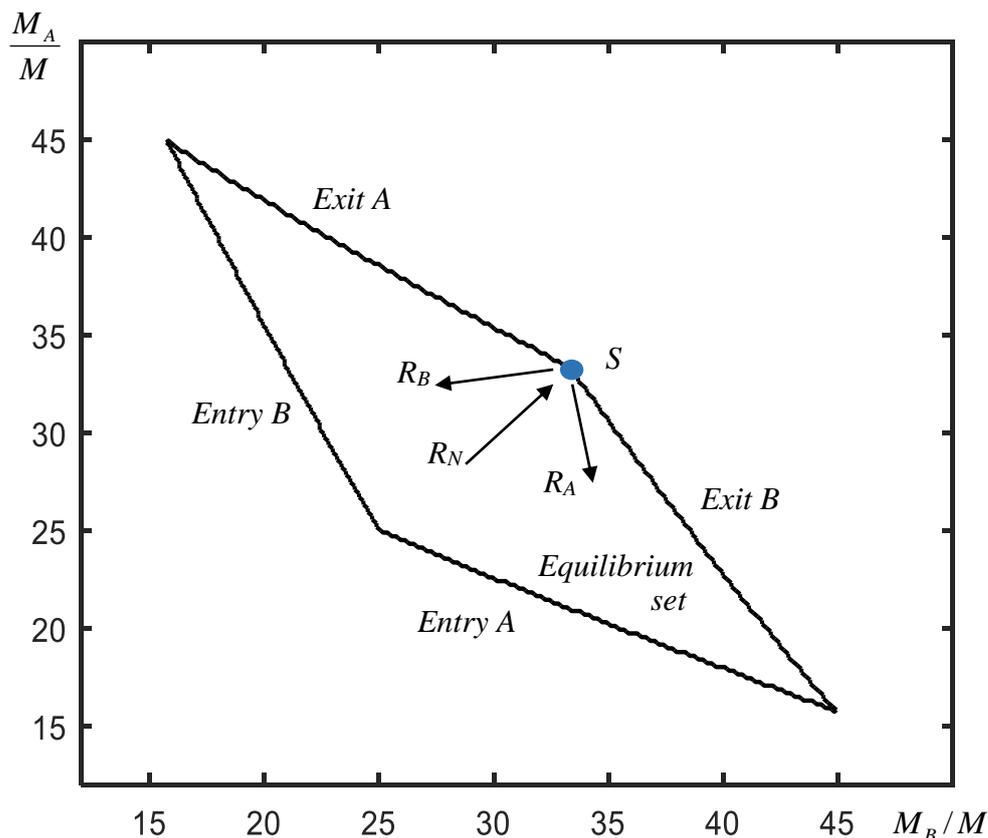
$$\begin{aligned} p_N = c_N(N) &\leq \{c_N(A), c_N(B)\}, \quad p_A = c_A(A)/q_A(x_A) \leq \{c_A(B)/q_A(0), c_A(N)/q_A(0)\}, \\ p_B = c_B(B)/q_B(x_B) &\leq \{c_B(A)/q_B(0), c_B(N)/q_A(0)\}. \end{aligned} \quad (12)$$

Thus, looking at the last of these,  $c_B(B)/q_B(x_B)$  is the unit cost of producing sector-B goods at type-B city factor prices and output scale (hence productivity  $q_B(x_B)$ ). At an equilibrium it must be the case that this equals the price  $p_B$  and is (weakly) less than the unit cost of producing sector-B goods in cities of type-A and N, given their factor prices and the fact that they have no agglomeration economies received from sector-B production.

The equilibrium set of city combinations is illustrated on Fig. 4, which has numbers of type-A and type-B cities on the axes (so the number of non-tradable cities follows from  $M_N = M - M_A - M_B$ ). The figure is constructed for a symmetric example in which consumption shares for the 3 types of goods are the same  $\theta = \theta_A = \theta_B = 1/3$ , national endowments of the two factors are equal, and production functions are Cobb-Douglas, with and the same returns to scale in each of the tradable sectors, A, B (see appendix).  $L$  shares in each sector are  $\lambda_A = 0.25$ ,  $\lambda_N = 0.5$ ,  $\lambda_B = 0.75$ , i.e. sector A is the most skill intensive, followed by non-tradables with sector B least skill intensive. Prices of tradables are  $p_A = p_B = 1$ . The lozenge shaped area is the equilibrium set, i.e. the set of values

$\{M_A, M_B, M_N\}$  that satisfy inequalities (12).<sup>13</sup> Point S is the equilibrium without coordination failure, and elsewhere in the set the obstacles to entry created by coordination failure gives a smaller total number of tradable cities,  $M_A + M_B$ , and larger number of non-tradable.

**Figure 4: The equilibrium set**



The edges of the lozenge define points at which different sectors are equi-profitable in cities of a particular type. To be precise, the boundaries are:

- East boundary: exit type-B:  $p_B = c_B(B)/q_B(x_B)$ ,  $p_N = c_N(B)$ .
- West boundary: entry type-B:  $p_N = c_N(N)$ ,  $p_B = c_B(N)/q_B(0)$ .
- North boundary: exit type-A:  $p_A = c_A(A)/q_A(x_A)$ ,  $p_N = c_N(A)$ .
- South boundary: entry type-A:  $p_N = c_N(N)$ ,  $p_A = c_A(N)/q_A(0)$ .

<sup>13</sup> The formal definition of a lozenge is a rhombus with acute angles of less than  $45^\circ$ . The word is used less precisely (e.g. in heraldry) as a diamond shape. We use the less precise definition.

Thus, on the east boundary factor prices and productivity in a type-B city are such that price equals unit cost in type-B production; additionally, the prevailing price of non-tradables is equal to the unit cost of non-tradable production at type-B city factor prices. Crossing this boundary (leaving the lozenge) sector-B production becomes unprofitable and the city switches to non-tradables, hence the label ‘exit-B’. On the west boundary factor prices in a type-N city are such that, as well as  $p_N = c_N(N)$ , unit cost in type-B production equals price  $p_B$ , even in the absence of any type-B production (i.e. with productivity  $q_B(0)$ ). Crossing this boundary (entering the lozenge) would cause a type-N city to switch to type-B, hence the label ‘entry-B’. The boundaries are slightly convex, not straight lines as they may appear to be in the figure.

At point S, in this symmetric case, all cities are the same size and have the same rents. Moving away from this point city sizes and rents change, and the arrows indicate directions in which rents of each city type are increasing most sharply (they are normals to iso-rent contours through S). Thus, moving along the  $45^\circ$  ray from the origin towards S increases rents in each non-tradable city,  $R_N$ ; along this ray there are fewer type-N cities but they are larger and hence have higher rents. Moving to the west reduces the number of type-B cities, increasing their size and hence increasing rents, as indicated by arrow  $R_B$ . Responses in type-A cities mirror this. Changes in the number and size of cities change the output of each sector, so an increase in  $M_B$  and associated reduction in  $x_B$  has a net positive effect on total sector-B output,  $M_B x_B$ . It follows that the economy is an exporter of sector-B east of the  $45^\circ$  line, and an importer to the west.

Maintaining the assumption of symmetry, the shape of the lozenge depends on parameter values in the following way. More similar labour shares,  $\lambda_A, \lambda_B$ , leave points on  $45^\circ$  line unchanged, while the north-west and south-east vertices are stretched out, creating a superset of the lozenge illustrated. In the limit, with equal labour shares, the equilibrium set is the area between two parallel lines through the two vertices on the  $45^\circ$  line. Greater increasing returns shift the south and west frontiers respectively down and the left, leaving point S unchanged and extending the length of the north and east boundaries, again creating a superset of the lozenge illustrated. Reducing increasing returns has the opposite effect, in the limit (constant returns to scale) reducing the equilibrium to point S. Varying urban commuting costs,  $c$ , is qualitatively similar, with higher costs reducing the size of the lozenge, as this has the effect of constraining city size and opportunity to exploit localisation economies.

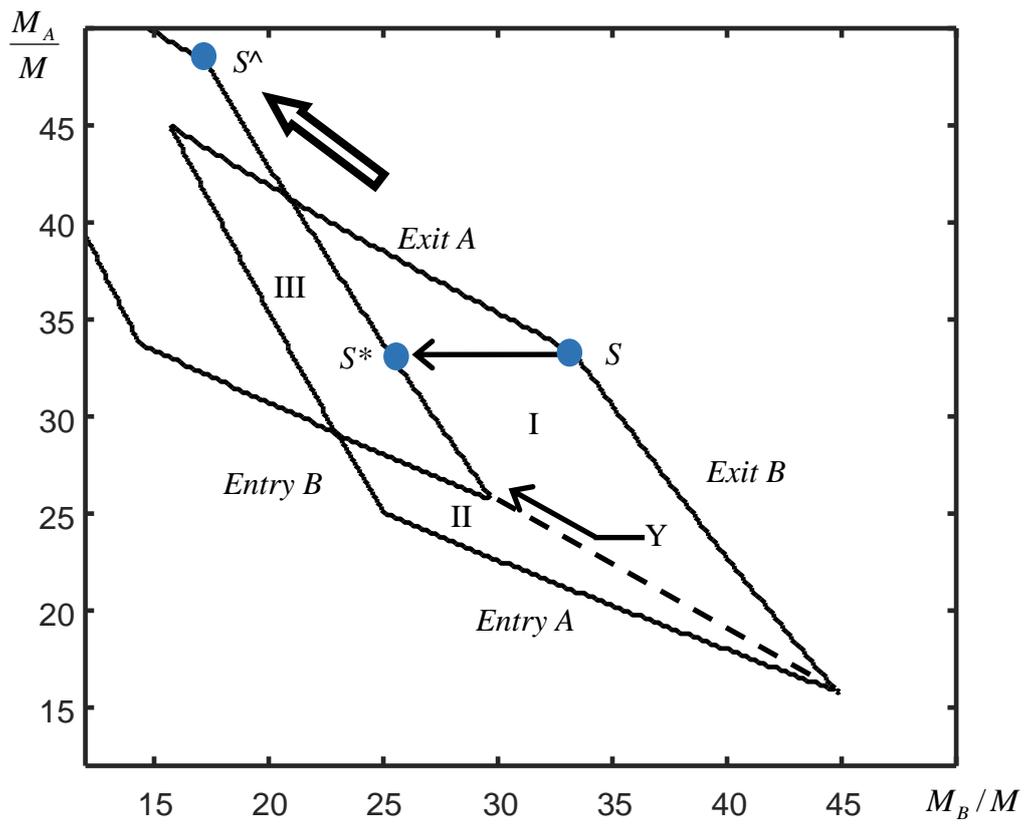
### 3.3: Trade shocks

We model globalisation as a fall in the world price ratio  $p_B / p_A$ . The change is exogenous, and is due to either a supply or demand shock in the rest of the world. It could take the form of either a fall in  $p_B$  or increase in  $p_A$ , depending on choice of numeraire. The relative price change shifts the equilibrium set up and to the left as illustrated by the bold arrow in Fig. 5 (illustrated for a change from  $p_B / p_A = 1$  to  $p_B / p_A = 0.8$ ) giving the new lozenge, overlapping with the original. We start the analysis by assuming that the initial equilibrium is at point S, and then look at the implications of different initial positions.

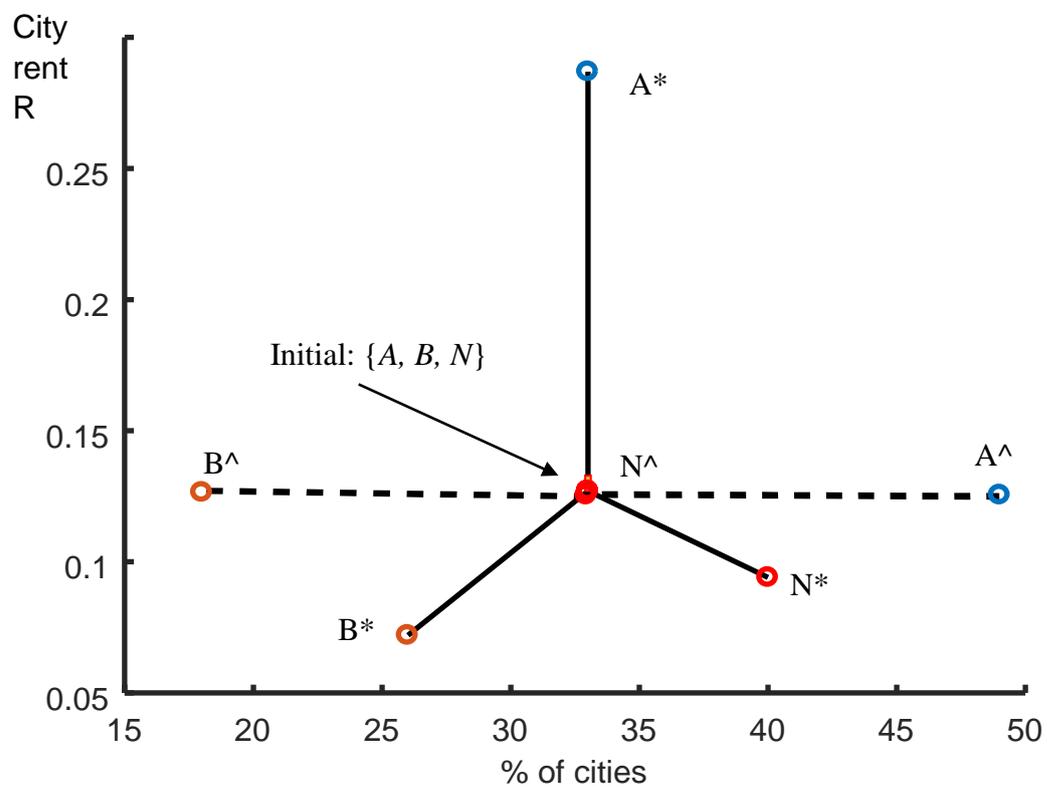
Without coordination failure the equilibrium would shift from S to point S<sup>^</sup>, with type-B cities switching costlessly to become type-A. But coordination failure means that conversion to type-A cities does not occur; it is not profitable for any firm to start type-A activity in a city specialised in type-B or N. There is instead horizontal movement, so starting at S the equilibrium moves towards S\* as type-B cities default to becoming type-N. It is helpful to think of this as a continuous process of change. As the lozenge starts to move north-west so point S ceases to be an equilibrium because B-production makes a loss and N-production becomes profitable. The equilibrium is dragged to the west by the exit-B boundary of the lozenge.

Figure 6 maps out the changes in city numbers and in rent, plotting the number of cities of each type (horizontal axis) and the rent each city earns (vertical axis). In the initial symmetric position there are the same numbers of cities of each type, and all have the same total rent. Other points give outcomes reached with  $p_B / p_A$  reduced from unity to 0.8. Points {A<sup>^</sup>, B<sup>^</sup>, N<sup>^</sup>} are points without coordination failure. City sizes and rents are unchanged and type-B cities have simply developed type-A sectors. Points {A\*, B\*, N\*} are points with coordination failure (corresponding to S\* on fig. 5). The number of type-A cities remains constant, while some type-B cities switch to non-tradable production. These changes are accompanied by changes in rents and city sizes (with sizes growing as the square root of rents). Rents in type-A cities increase by 126%, while those in remaining type-B cities fall by 43%. The number of type-N cities increases causing the price of non-tradables to fall, shrinking all such cities and reducing their rents by 26%. Total real rents across all cities increase by 22%.

**Figure 5: A trade shock:**



**Figure 6: Globalisation and city specialisation: initial equilibrium at S**



There are also changes in the wage of each type of labour, with an increase in wages of skilled labour (intensive in sector-A) and fall in wage of unskilled. These are driven by Stolper-Samuelson effects, although modified by the productivity effects of changing city size. The wage effects are smaller in the presence of coordination failure (point  $S^*$  compared to  $S^\wedge$ ). The reason comes from assumed factor intensities. Absent coordination failure, workers leaving the most unskilled intensive sector (B) are re-employed in the most skilled intensive sector (A). With coordination failure this sector expands less (entirely within, rather than across cities), while the non-tradable sector grows. This has intermediate skill intensity, so is able to re-employ dislocated unskilled labour with small general equilibrium price change. There is a small (approximately 2%) increase in aggregate real income in moving to either  $S^*$  or  $S^\wedge$ , this driven largely by a terms of trade improvement.<sup>14</sup>

Finally, we re-emphasise that these changes are driven by a fall in relative price,  $p_B / p_A$ , i.e. by any combination of a fall in the price of type-B or an increase price of type-A goods. Formally, this is simply a choice of numeraire. Intuitively, type-B cities can be damaged either by a lower price of their output, or by expanding type-A cities pulling in labour and increasing factor prices. Thus, the financial sector in the City of London has a ‘Dutch disease’ effect on the rest of the UK.

**Initial positions:** Any point in the lozenge is an equilibrium, but analysis so far has been based on starting at the point of no coordination failure. What happens more generally? The initial lozenge in Fig. 5 is divided into zones I, II, III and we discuss each in turn.

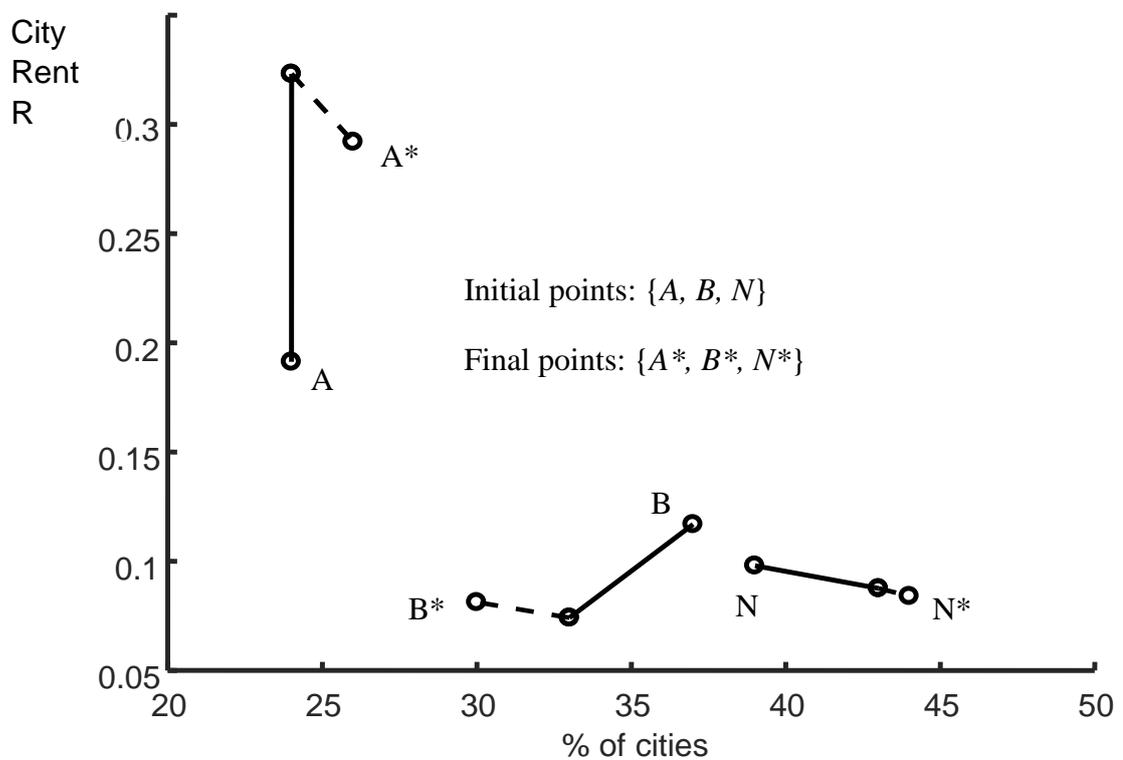
Starting from a point in the upper part of zone I, effects are similar to movement from point S. While initial city sizes are different, the trade shock causes some cities to switch from type-B to type-N and the number of type-A cities is unchanged. However, in the lower part of zone I horizontal movement encounters the bottom vertex of the moving lozenge. A path of continuous change is shown on Fig. 5 by the kinked arrow with origin Y. Initially city specialisations are dragged by the ‘Exit-B’ boundary, switching from type-B to type-N, (horizontal movement on fig. 5), but at some point this movement will coincide with the south-east vertex of the lozenge. Beyond that point the equilibrium is dragged along by the vertex, moving up the dashed line. Some type-B cities switch to become type-N, and others become type-A. Fig. 7 gives the evolution of city numbers and city rents on this path. The initial point is asymmetric, with city numbers and rents labelled A, B, N on Fig. 7; thus, there are few type-A cities but they are large, with high rent. Small reductions in  $p_B / p_A$  cause

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<sup>14</sup> The starting point is a symmetric equilibrium with zero trade and hence no terms of trade effect in the neighbourhood of  $p_B / p_A = 1$ . Moving away from this point the country becomes an exporter of type-A goods and importer of type-B, so further reductions in  $p_B / p_A$  bring terms of trade gains and start to increase aggregate utility.

movements along the solid lines; the number of type-A cities is unchanged (their size and rents increasing), and type-B cities to default to type-N. Beyond the kink (dashed line) type-B firms continue to exit, but most switch to type-A production, and a few to type-N. Essentially, the initial point with few type-A cities has relatively lower skilled wages so, as  $p_B / p_A$  falls it becomes profitable to initiate type-A activity in what was previously a type-B city. However, the story remains one of urban polarisation. The cities that grow are those that were initially large (high rent); non-tradable cities start small, and as their number increases they become smaller and lower rent.

**Figure 7: Globalisation and city specialisation: initial equilibrium at Y**



In zone II the effect of the price change is (initially) to cause type-N cities to switch to type-A, i.e. there is vertical movement as the entry-A barrier shifts the equilibrium. The reason follows from our assumed factor intensity of different activities. The initial situation has very few type-A cities so has relatively low skilled wages. The increase in the price of  $p_A$  relative to  $p_B$  (and also to  $p_N$ ) makes the switch profitable. Notice that if the initial point is near the south-east vertex then upwards movement becomes, at some point, movement along the dashed line with type-A activity replacing a combination of type-B and type-N.

Finally, zone III. If the initial position is in this area then, for the 20% relative price change

on which Fig. 5 is based, no city changes specialisation; points in zone III are in both the initial and the final lozenge. City sizes do change, and in this region the story is one of convergence. There are relatively many type-A cities which are relatively small, but grow as price  $p_A$  increases relative to  $p_B$ .

#### **4. Conclusions and implications**

The spatial economy is replete with market failures that make adjustment to change difficult while, in contrast, much international economics has put naive faith in adjustment occurring because ‘everywhere has a comparative advantage’. The latter statement is true, but irrelevant in an integrated economy. It becomes positively misleading if there are barriers to starting activities in new places, such as those created by localisation economies and coordination failure. This paper makes a small step towards setting up a framework where spatial and international economics combine in a way that recognises the inability of markets to secure satisfactory adjustment to some of the economic shocks witnessed in recent years. As recent political events have made clear, research needs to take many further steps down this path.

The core of the economic problem is that the market mechanism does not create sufficient incentives to start new tradable activities (or more generally, new activities that can achieve high productivity through agglomeration economies and increasing returns to scale) in places that have lost historic specialisms. What can start such activities?

One possibility is based on innovation. If the economy is creating new activities, not linked to existing agglomerations, then it is possible that they start up in relatively low cost ‘type-N’ places. This route is emphasised in Moretti (2013), and exemplified by Seattle. In the 1970s Seattle was a city with a declining port and manufacturing sector, unemployment twice the US national average, losing population and famous for the 1971 billboard saying ‘will the last person leaving Seattle turn out the lights’. It has been transformed by the arrival of Microsoft and an associated cluster of firms. Of course, the arrival of Microsoft from its initial base in Albuquerque was due to the fortuitous circumstance that both Bill Gates and Paul Allen had grown up in Seattle. While the innovation route has been successful in transforming some cities, it is most unlikely that there are enough distinct new innovative clusters to populate the number of cities that have lost previous sectoral specialisms.

A second route is to try and address the coordination failure by policy that targets particular places for economic development, possibly in specific sectors. The simple economic theory suggests that ‘large developers’ may be able to internalise the externalities created by agglomeration, overcoming coordination failure by launching development at scale. Public policy to support this may take the form of city plans and the location of infrastructure (e.g.

placement of transport hubs). Special economic zones offer regulatory, fiscal, and infrastructure benefits, concentrated in one place with the hope of creating cluster benefits. Developing countries offer some successful example, such as Shenzhen, Dhaka, and Penang; however, there are many more failures.<sup>15</sup> Developed countries have used fiscal incentives in the form of regional investment or employment subsidies and subsidies to influence plant location decisions. A review of the success of these policies is beyond the scope of this paper, but existing reviews tend to the conclusion that, even if policies have had some impact, they have generally failed to jump-start new economic activities and trigger the development of self-sustaining private sector clusters (see e.g. Neumark and Simpson 2015, Moretti 2013). Perhaps one reason for this is that such policies may succeed in attracting non-tradable activities, moving public services or securing investments in warehousing or customer service centres (and may even be targeted at these sectors). But this is simply to accelerate the unsatisfactory adjustment process described in this paper, dragging down incomes in all other non-tradable cities.

A further option is to be willing to let towns and cities contract. In a simple framework – such as that presented in this paper – this could be welfare improving, providing that booming cities are enabled to expand by constructing infrastructure and housing to mitigate effects on commuting costs, land prices and rents. However, there are many further costs to such a policy, beyond those captured in such a simple model. These are the costs of economic and social dislocation borne largely by those unable to move and trapped in a declining community.

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<sup>15</sup> See Duranton and Venables (2017) for analysis of place-based policies developing economies.

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## Appendix

Section 2 parameter values:  $L = 100$ ,  $M = 100$ ,  $\theta = 1/2$ ,  $b = 0.3$ ,  $q(L_T) = 1 + 0.15L_T$ .

Section 3 parameter values:  $L = 50$ ,  $K = 50$ ,  $M = 100$ ,  $\theta_A = \theta_B = \theta_N = 1/3$ ,  $b = 0.25$ ,

$\lambda_A = 0.25$ ,  $\lambda_N = 0.5$ ,  $\lambda_B = 0.75$ ,  $q(x_i) = 1 + 0.1x_i$ ,  $i = A, B$ .

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