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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, c

competitiveness.[4] 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 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 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.[5] 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

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

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

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

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

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

7KH µXUEDQ FRVWV¶ RI D SDUWLFXODU ZRUNHU DUH GLYL land rent according to her residential location relative to the centre of the city.[8] 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 $R_i = bL_i^2/2$.

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 $w_T \quad p_T q(L_T)$.[10] 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.

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 WKH FRXQWU\¶V FRPSDUDWLYH DGYDQWDJH LQ VRPH RI L type-T cities. Coordination failure means that these cities cannot easily switch to a new T-sec

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

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

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[12]

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

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

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

$$(M - M_A - M_B) p_N x_N = \gamma [M_A p_A x_A + M_B p_B x_B + (M - M_A - M_B) p_N x_N]. \tag{8}$$

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

The composite good is made up both types of tradable and the non-tradables, according to $P = p_N^{\gamma} p_A^{\gamma_A} p_B^{\gamma_B}$, with .

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

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

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

Factor market clearing equations are

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

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

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[12] 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 $bL \quad K^2 P/2$, and rents , so that real rents are $R_i \quad bL_i \quad K_i^2/2$, i = A, B, N. Total utility in a city of type i is

$$U_i \quad u_i^L L_i \quad u_i^K K_i \quad R_i, \qquad i = A, B, N \tag{11}$$

3.2: Equilibria:

As in section 2, localisation economies and coordination failure create a set of equilibria. This is the set of city combinations, $\{M_A, M_B, M_N \quad M \quad M_A \quad M_B\}$ 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:

$$p_N \quad c_N(N) \; d \hat{c}_N(A), c_N(B) \grave{}, \qquad p_A \quad c_A(A)/q_A(x_A) \; d \hat{c}_A(B)/q_A(0), c_A(N)/q_A(0) \grave{},$$

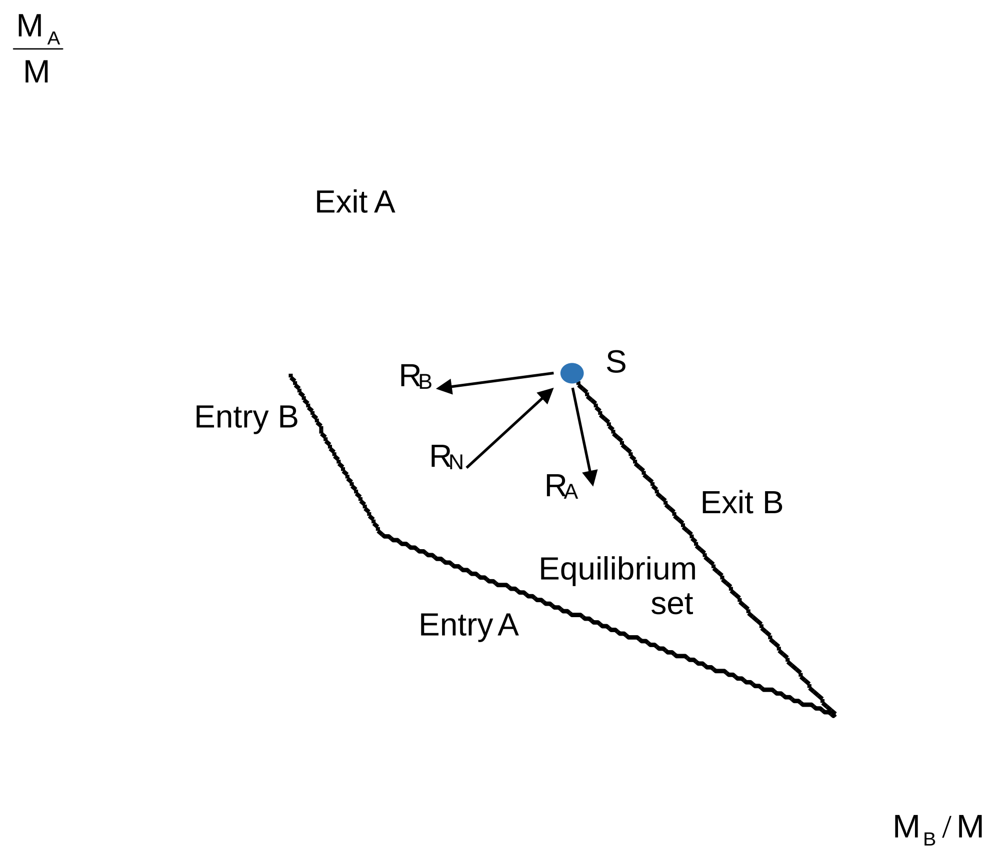
$$. \tag{12}$$

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 $M_N \quad M \quad M_A \quad M_B$). The figure is constructed for a symmetric example in which consumption shares for the 3 types of goods are the same $T \quad T_A \quad T_B \quad 1/3$, 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 $Q_A \quad 0.25$, $Q_N \quad 0.5$, $Q_B \quad 0.75$, i.e. sector A is the most skill intensive, followed by non-tradables with sector B least skill intensive. Prices of tradables are $p_A \quad p_B \quad 1$. The lozenge shaped area is the equilibrium set, i.e. the set of values

$\{M_A, M_B, M_N\}$ that satisfy inequalities (12).[13] 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, $M_A \quad M_B$, 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:

x East boundary: exit type-B: $p_B \quad c_B(B)/q_B(x_B)$, $p_N \quad c_N(B)$.

x West boundary: entry type-B: $p_N \quad c_N(N)$, $p_B \quad c_B(N)/q_B(0)$.

x North boundary: exit type-A: $p_A \quad c_A(A)/q_A(x_A)$, $p_N \quad c_N(A)$.

x South boundary: entry type-A: $p_N \quad c_N(N)$, $p_A \quad c_A(N)/q_A(0)$.

[13] The formal definition of a lozenge is a rhombus with acute angles of less than 45°. 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 KHQFH WKH-%¶ODE2HQWμKH[LZHVW ERXQGDU\ IDF 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 ODEHOB ¶1 HQWU\ 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° 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° 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, Q_A, Q_B, leave points on 45° 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° 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 $p_B / p_A \quad 1$ to $p_B / p_A \quad 0.8$) 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^, 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

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^). 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^, this driven largely by a terms of trade improvement.[14]

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
LQFUHDVLQJ IDFWRU SULFHV 7KXV WKH ILQDQFLDO VHF urc
GLVHDVH¶ HIIHFW RQ WKH UHVW RI WKH 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 dra JJHG E\ WKH µERXQGDU\ as 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 an 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 on which Fig. 5 is based, no city changes specialisation; points in zone III are in both the initial and the final lozenge.

placement of transport hubs). Special economic zones

References:

Autor, D.H. ' 'RUQ DQG * + +DQVRQ µ7KH