Supplementary Appendix
NOT INTENDED FOR PUBLICATION

This supplementary appendix includes the following material: (i) the non-quantitative model, (ii) analytical proofs of the paper, (iii) calibration details and algorithms, (iv) migration costs, (v) a small collection of analytical steady-state results, (vi) additional validation of our estimated migration costs, and (vii) a model of investment in activity-specific skills.

SA The Non-Quantitative Model

Costs. We begin by defining efficiency wages as $w_{j,k} = \pi_{j,k}(s)/s$, i.e., as income per unit of knowledge. When $\beta = 0$, $s_{i,k} = 1$ for all workers, efficiency wages boil down to the standard payments per worker. The cost of a unit of input bundle is $c_{j,kt} = \kappa_\pi w_{j,k}^{1-\gamma_k} r_j^{\gamma_k}$,where $\kappa_\pi \equiv \gamma_k^{\gamma_k}(1-\gamma_k)^{1-\gamma_k}$, and the unit cost of producing a unit of good k in region j is $c_{j,kt}/A_{j,kt}$.

Trade Shares. Utility maximization gives the standard Armington expenditure shares: the share of region j's expenditure in sector k goods produced in region i, $\pi_{ij,kt}$, is given by:

$$\pi_{ij,kt} = \frac{(c_{i,kt}\tau_{ij,kt}/A_{i,kt})^{1-\eta}}{\sum_{i'}(c_{i',kt}\tau_{i'j,kt}/A_{i',kt})^{1-\eta}}.$$

Migration Shares and Labor Supply Turning to migration, the definition of the observable component of welfare (5) together with optimal worker sorting gives the share of workers from i choosing to work in region j and sector k, $\lambda_{ij,kt}$

$$\lambda_{ij,kt} = \frac{W_{ij,kt}^{\kappa}}{\Xi_{i,t}^{\kappa}} \tag{34}$$

where $\Xi_{i,t}^{\kappa} \equiv \sum_j \sum_k [w_{j,kt}s_{i,kt}/(\mu_{ij,kt}P_{j,t})]^{\kappa}$. We define the effective units of labor migrating from i to region j, sector k as

$$E_{ij,kt} \equiv s_{i,kt}\lambda_{ij,kt}L_{i,t-1}. \tag{35}$$

Closing the model. We assume that land rents in a region are rebated to workers who live there, proportionally to their labor income. We also assume there are no deficits. Therefore, total expenditure in region j reflects payments to factors there

$$X_{j,t} = \sum_k w_{j,kt}E_{j,kt} + r_{j,t}H_{j,t},$$

and sectoral expenditure, $X_{j,kt}$ reflects the preferences described above.

Equilibrium Given a geography for $t = 1, \ldots, \infty$ and initial labor allocations in period 0, $\{L_{i,k0}\}_{i,k}$, a competitive equilibrium is a sequence of migration flows, efficient labor allocations, and prices, for each origin i, destination j and good k, $\{L_{ij,kt}, E_{i,kt}, w_{i,kt}, r_{i,t}\}$, that satisfy

1. The market for efficiency units of labor clears in region j and good k:

$$w_{j,kt}E_{j,kt} = (1-\gamma_k)\sum_i \pi_{ji,kt}X_{i,kt}. \tag{36}$$

2. Land markets clear in region j:

$$r_{j,t}H_{j,t} = \sum_k \gamma_k \sum_i \pi_{ji,kt}X_{i,kt}, \tag{37}$$

3. Total immigration determines the effective supply of labor in region j, good k:

$$E_{j,kt} = \sum_i s_{i,kt}\left(L_{i,kt-1}\right)L_{ij,kt}, \tag{38}$$

   where the function $s_{i,kt}$ is defined in equation (6).

4. Migration flows maximize workers utility

$$L_{ij,kt} = \lambda_{ij,kt}L_{i,t-1}. \tag{39}$$

SB The Small Open Economy Limit

We start by studying equilibrium prices when the Home economy is small. To do this, we adapt the procedure in Alvarez and Lucas (2007). We use the following assumptions, for each region in Home: (i) $L_i \to 0$, (ii) $A_{i,k}^{\eta-1}/L_i \to \delta_{i,k}$, where $\delta \in (0,\infty)$, (iii) $H_i/L_i \to h_i$, where $h_i \in (0,\infty)$, and (iv) $L_i/L_{i'} \to \ell_{ii'}$

Assuming that, in the limit $w_{i,k} \in (0,\infty)$ and $r_{i,k} \in (0,\infty)$ — which we verify later — the equilibrium price indexes for each region and sector

$$P_{i,k} = \left(\sum_j \left(c_{i,k}\tau_{ji,k}\right)^{1-\eta} A_{i,k}^{\eta-1}\right)^{1-\eta}$$

and assumptions (i) and (ii), imply that

$$P_{i,k} \to \left(\bar{c}_{F,k}\tau_{jF,k}\right)/A_{F,k}, \forall i,k.$$

where $\bar{c}_{F,k} = w_{F,k}^{\alpha(1-\gamma)} r_F^{\gamma\alpha} P_F^{1-\alpha}$ solves the labor and land market clearing conditions for Foreign

$$w_{F,k} E_{F,k} = (1-\gamma)\,\alpha a_k X_F$$
$$r_F H_F = \alpha\gamma X_F.$$

In what follows, we take $w_{F,k}$, r_F and $\{P_{i,k}\}$ as given.

We now characterize the equilibrium wages and rental rates for each region at Home. Using labor market clearing

$$w_{i,k} \sum_{i'} \frac{(s_{i',k} w_{i,k})^{\kappa} (\mu_{i'i,k} P_i)^{-\kappa}}{\Xi_{i'}^{\kappa}} s_{i',k} L_{i'} = \alpha\,(1-\gamma) \left\{ \sum_{j\in H} \left(\frac{w_{i,k}^{\alpha(1-\gamma)} r_i^{\alpha\gamma} P_i^{1-\alpha} \tau_{ij,k}/A_{i,k}}{P_{j,k}} \right)^{1-\eta} X_{j,k} + \left(\frac{w_{i,k}^{\alpha(1-\gamma)} r_i^{\alpha\gamma} P_i^{1-\alpha} \tau_{ij,k}/A_{i,k}}{P_{F,k}} \right)^{1-\eta} X_{F,k} \right\}, \tag{40}$$

which implies:

$$w_{i,k}^{1+\kappa-(1-\gamma)\alpha(1-\sigma)} \sum_{i'} \frac{s_{i',k}^{\kappa} (\mu_{i'i,k} P_i)^{-\kappa}}{\sum_l \sum_{i''} (s_{i',l} w_{i'',l})^{\kappa} (\mu_{i''i,l} P_{i''})^{-\kappa}} s_{i',k} \ell_{i'i} = \alpha\,(1-\gamma)\,\delta_{i,k} \left[\left(\frac{r_i^{\gamma\alpha} P_i^{1-\alpha} \tau_{ij,k}}{P_{F,k}} \right)^{1-\eta} X_{F,k} \right], \tag{41}$$

where the second line divides through by $L_{i,k}$ and uses assumptions (i) through (iv).

Similarly, land market clearing states

$$r_i H_i = \alpha\,(1-\gamma) \left[\sum_k \sum_{j\in H} \left(\frac{w_{i,k}^{\alpha(1-\gamma)} r_i^{\alpha\gamma} P_i^{1-\alpha} \tau_{ij,k}/A_{i,k}}{P_{j,k}} \right)^{1-\eta} X_{j,k} + \left(\frac{w_{i,k}^{\alpha(1-\gamma)} r_i^{\alpha\gamma} \tau_{ij,k} P_i^{1-\alpha}/A_{i,k}}{P_{F,k}} \right)^{1-\eta} X_{F,k} \right],$$

which implies a

$$r_i^{1+\alpha\gamma(\eta-1)} = \alpha\,(1-\gamma) \sum_k w_{i,k}^{\alpha(1-\gamma)(1-\eta)} \delta_{i,k} h_i^{-1} \left[\left(\frac{\tau_{ij,k} P_i^{1-\alpha}}{P_{F,k}} \right)^{1-\eta} X_{F,k} \right] \tag{42}$$

Taken together, equations (41) and (42) constitute a system of equations for $w_{i,k}$ and r_i jointly for all $i \in H$, which depend only on predetermined constants, parameters, and prices solved above.

SC Proofs for Section 4.3

SC.1 Relative Opportunity Costs and Migration at the Regional Level

In this section we provide proofs for the statements in Section 4.3 of the main body of the paper, which relate specialization, comparative advantage and internal migration. We begin

by showing under which conditions the following inequality holds

$$\frac{P^A_{i,k}}{P^A_{i,k'}} < \frac{P^A_{F,k}}{P^A_{F,k'}}, \tag{43}$$

where $P^A_{i,k}$ is the price index of sector k when region i is in autarky, which in this model the standard "opportunity-cost" definition of comparative advantage introduced by Haberler (see Deardorff (2005) and French (2017)). We discuss below conditions under which this is also sufficient to predict the patterns of trade specialization. To obtain tractable equations, we adopt the following assumptions: (i) same technology across activities k $\alpha_k = \alpha$ and $\gamma_k = \gamma$; (ii) workers are born of type k and can choose where to live, but not what activity to produce.

Note first that under full trade autarky (i.e., when the regions within Brazil cannot trade), the opportunity cost ratio in region i is given by

$$\begin{aligned}\frac{P^A_{i,k}}{P^A_{i,k'}} &= \frac{c_{i,k}/A_{i,k}}{c_{i,k'}/A_{i,k'}} \\ &= \frac{w_{i,k}^{(1-\gamma)\alpha}/A_{i,k}}{w_{i,k'}^{(1-\gamma)\alpha}/A_{i,k'}}.\end{aligned}$$

The inequality thus becomes

$$\left(\frac{w_{i,k}}{w_{i,k'}}\right)^{(1-\gamma)\alpha} \frac{A_{i,k'}}{A_{i,k}} < \left(\frac{w_{F,k}}{w_{F,k'}}\right)^{(1-\gamma)\alpha} \frac{A_{F,k'}}{A_{F,k}}. \tag{44}$$

SC.1.1 Prohibitive migration costs

When migration costs are prohibitive, so $\mu_{ij} \to \infty$ for $i \neq j$, then the labor market clearing condition for region i and sector k is given by:

$$w_{i,k} s_{i,k} L^0_{i,k} = \alpha\,(1-\gamma)\,a_k X_i,$$

which solving for $w_{i,k}$ gives

$$w_{i,k} = \frac{\alpha\,(1-\gamma)\,a_k X_i}{s_{i,k} L^0_{i,k}}.$$

Note that to obtain this expression, we assume region i is in full autarky. Substituting for wages in (44), we show that under prohibitive migration costs, the opportunity-cost definition depends only on productivities and endowments of knowledge and workers.

$$\left(\frac{s_{i,k'} L^0_{i,k'}}{s_{i,k} L^0_{i,k}}\right)^{(1-\gamma)\alpha} \frac{A_{i,k'}}{A_{i,k}} < \left(\frac{s_{F,k'} L^0_{F,k'}}{s_{F,k} L^0_{F,k}}\right)^{(1-\gamma)\alpha} \frac{A_{F,k'}}{A_{F,k}} \tag{45}$$

SC.1.2 Free migration

With free migration, $\mu_{ij} = 1$ for $i \neq j$. Thus labor market in region i, sector k is given by

$$w_{i,k} \sum_{i'} s_{i',k} \lambda_{i',ik} L^0_{i',k} = \alpha (1-\gamma) a_k X_i.$$

Using the migration equations, we obtain

$$w_{i,k} \sum_{i'} \frac{\left(w_{i,k} s_{i',k} P_i^{-1}\right)^\kappa}{\sum_h \left(w_{h,k} s_{i',k} P_h^{-1}\right)^\kappa} s_{i',k} L^0_{i',k} = \alpha (1-\gamma) a_k X_i$$

$$w_{i,k}^{1+\kappa} P_i^{-\kappa} \frac{\mathcal{S}_{H,k}}{\sum_h \left(w_{h,k} P_h^{-1}\right)^\kappa} = \alpha (1-\gamma) a_k X_i$$

and solving for wages, we get

$$w_{i,k}^{1+\kappa} = P_i^\kappa \alpha (1-\gamma) a_k X_i \sum_h \left(w_{h,k} P_h^{-1}\right)^\kappa \mathcal{S}_{H,k}^{-1}. \tag{46}$$

It will be useful to solve for $w_{i,k}$ here, i.e., eliminate $w_{h,k}$:

$$\frac{w_{i,k}}{w_{h,k}} = \left(\frac{P_i^\kappa}{P_h^\kappa} \frac{X_i}{X_h}\right)^{\frac{1}{1+\kappa}} \Rightarrow w_{h,k} = w_{i,k} \left(\frac{P_h^\kappa}{P_i^\kappa} \frac{X_h}{X_i}\right)^{\frac{1}{1+\kappa}},$$

which we use again in (46) to obtain

$$w_{i,k} = P_i^{\kappa/(1+\kappa)} \alpha (1-\gamma) a_k X_i^{\frac{1}{1+\kappa}} \mathcal{S}_{H,k}^{-1} \sum_h \left(X_h / P_h\right)^{\kappa/(1+\kappa)}$$

Substituting this expression in (44), we obtain

$$\left(\frac{\mathcal{S}_{H,k'}}{\mathcal{S}_{H,k}}\right)^{(1-\gamma)\alpha} \frac{A_{i,k'}}{A_{i,k}} < \left(\frac{\mathcal{S}_{F,k'}}{\mathcal{S}_{F,k}}\right)^{(1-\gamma)\alpha} \frac{A_{F,k'}}{A_{F,k}}. \tag{47}$$

SC.2 Regional Comparative Advantage

In this section, we study how migration relates to region i's export specialization in sector k (relative to sector k' and region F). In particular, we study how migration shapes the inequality

$$\frac{X_{iF,k}}{X_{iF,k'}} > \frac{X_{FF,k}}{X_{FF,k'}}. \tag{48}$$

We then show how the relative opportunity costs in autarky give a sufficient condition for this to hold.

Under the assumptions laid out in the paper, expression (48) is equivalent to

$$\left(\frac{w_{i,k}}{w_{i,k'}}\right)^{(1-\gamma)(1-\eta)\alpha}\left(\frac{A_{i,k'}}{A_{i,k}}\right)^{1-\eta}\left(\frac{\tau_{iF,k}}{\tau_{iF,k'}}\right)^{1-\eta} > \left(\frac{w_{F,k}}{w_{F,k'}}\right)^{(1-\gamma)(1-\eta)\alpha}\left(\frac{A_{F,k'}}{A_{F,k}}\right)^{1-\eta} \tag{49}$$

To obtain conditions relating to exogenous forces in the model, we now solve for wages using labor market clearing. To focus on the sources of comparative advantage related to costs of production, and not of trade, we set $\tau_{iF,k} = \tau_{iF,k'} = 1$, and simplify equation (49) to obtain:

$$\left(\frac{w_{i,k}}{w_{i,k'}}\right)^{(1-\gamma)(1-\eta)\alpha}\left(\frac{A_{i,k'}}{A_{i,k}}\right)^{1-\eta} > \left(\frac{w_{F,k}}{w_{F,k'}}\right)^{(1-\gamma)(1-\eta)\alpha}\left(\frac{A_{F,k'}}{A_{F,k}}\right)^{1-\eta} \tag{50}$$

SC.2.1 Prohibitive migration costs

When migration costs are prohibitive, so $\mu_{ij} \to \infty$ for $i \neq j$, then the labor market clearing condition is

$$w_{i,k}s_{i,k}L^0_{i,k} = \alpha\left(1-\gamma\right)\sum_j \left(w_{i,k}^{\alpha(1-\gamma)}r_i^{\alpha\gamma}P_i^{1-\alpha}/A_{i,k}\right)^{1-\eta} P_{j,k}^{\eta-1}X_{j,k}$$

where $X_{j,k}$ is expenditure of region j on goods from k. Solving for $w_{i,k}$ gives

$$w_{i,k} = \left(\alpha\left(1-\gamma\right)\frac{\left(r_i^{\alpha\gamma}P_i^{1-\alpha}\right)^{1-\eta}}{A_{i,k}^{1-\eta}s_{i,k}L^0_{i,k}}\sum_j \frac{X_{j,k}}{P_{j,k}^{1-\eta}}\right)^{\frac{1}{1+\alpha(1-\gamma)(\eta-1)}}. \tag{51}$$

Substituting equation (51) into (50), we get

$$\left(\frac{\left(s_{i,k}L^0_{i,k}\right)^{\alpha(1-\gamma)}A_{i,k}}{\left(s_{i,k'}L^0_{i,k'}\right)^{\alpha(1-\gamma)}A_{i,k'}}\right)^{\frac{\eta-1}{1+\alpha(1-\gamma)(\eta-1)}} > \left(\frac{\left(s_{F,k}L^0_{F,k}\right)^{\alpha(1-\gamma)}A_{F,k}}{\left(s_{F,k'}L^0_{F,k'}\right)^{\alpha(1-\gamma)}A_{F,k'}}\right)^{\frac{\eta-1}{1+\alpha(1-\gamma)(\eta-1)}}. \tag{52}$$

SC.2.2 Free migration

As will be come clear later, in this section we need to introduce assumptions on land markets. We assume that either land is not a factor of production, so $\gamma = 0$, or that land supply is perfectly elastic, so $r_i = \bar{r}_i$.

With free migration, $\mu_{ij} = 1$ for $i \neq j$, and labor market clearing is given by

$$\sum_{i'} w_{i,k}\frac{\left(w_{i,k}s_{i',k}P_i^{-1}\right)^{\kappa}}{\sum_h\left(w_{h,k}s_{i',k}P_h^{-1}\right)^{\kappa}}s_{i',k}L^0_{i',k} = \alpha\left(1-\gamma\right)\sum_j\left(w_{i,k}^{\alpha(1-\gamma)}r_i^{\alpha\gamma}P_i^{1-\alpha}/A_{i,k}\right)^{1-\eta}P_{j,k}^{\eta-1}X_{j,k},$$

which we can use to solve for wages in region i and sector k:

$$w_{i,k} = \left(\frac{\alpha (1-\gamma) \left(r_i^{\alpha\gamma} P_i^{1-\alpha} \right)^{1-\eta}}{A_{i,k}^{1-\eta} \mathcal{S}_{H,k}} \right)^{\frac{1}{1+\kappa+\alpha(1-\gamma)(\eta-1)}} \left(\left[\sum_h w_{h,k}^{\kappa} \right] \sum_j \frac{X_{j,k}}{P_{j,k}^{1-\eta}} \right)^{\frac{1}{1+\kappa+\alpha(1-\gamma)(\eta-1)}} . \quad (53)$$

Use equation (53), to express wages in i as a function of wages in h, both for sector k:

$$w_{h,k} = w_{i,k} \left(\frac{A_{h,k}^{\eta-1} \left(r_h^{\alpha\gamma} P_h^{1-\alpha} \right)^{1-\eta}}{A_{i,k}^{\eta-1} \left(r_i^{\alpha\gamma} P_i^{1-\alpha} \right)^{1-\eta}} \right)^{\frac{1}{1+\kappa+\alpha(1-\gamma)(\eta-1)}}$$

Under the assumptions of free trade and $\gamma = 0$, this simplifies to

$$w_{h,k} = w_{i,k} \left(\frac{A_{h,k}}{A_{i,k}} \right)^{\frac{\eta-1}{1+\kappa+\alpha(\eta-1)}}$$

and the substitute back into (53) to obtain expression for equilibrium wage

$$w_{i,k} = \left(\frac{\alpha \left(P_i^{1-\alpha} \right)^{1-\eta}}{A_{i,k}^{1-\eta} \mathcal{S}_{H,k}} \right)^{\frac{1}{1+\kappa+\alpha(\eta-1)}} \left(\left[\sum_h w_{i,k}^{\kappa} \left(\frac{A_{h,k}}{A_{i,k}} \right)^{\frac{\kappa(\eta-1)}{1+\kappa+\alpha(\eta-1)}} \right] \sum_j \frac{X_{j,k}}{P_{j,k}^{1-\eta}} \right)^{\frac{1}{1+\kappa+\alpha(\eta-1)}} \Rightarrow$$

$$w_{i,k} = \left\{ \frac{\alpha \left(P_i^{1-\alpha} \right)^{1-\eta}}{A_{i,k}^{1-\eta} \mathcal{S}_{H,k} \mathcal{A}_{i,k}} \sum_j \frac{X_{j,k}}{P_{j,k}^{1-\eta}} \right\}^{\frac{1}{1+\alpha(\eta-1)}} \quad (54)$$

where we define $\mathcal{A}_{i,k} \equiv A_{i,k}^{\kappa \frac{\eta-1}{1+\kappa+\alpha(\eta-1)}} / \sum_h A_{h,k}^{\kappa \frac{\eta-1}{1+\kappa+\alpha(\eta-1)}}$.

Substitute the expression above into (50) to obtain

$$\left[\left(\frac{\mathcal{S}_{H,k} \mathcal{A}_{i,k}}{\mathcal{S}_{H,k'} \mathcal{A}_{i,k'}} \right)^{\alpha} \left(\frac{A_{i,k}}{A_{i,k'}} \right) \right]^{\frac{\eta-1}{1+\alpha(\eta-1)}} > \left[\left(\frac{\mathcal{S}_{H,k} \mathcal{A}_{F,k}}{\mathcal{S}_{H,k'} \mathcal{A}_{F,k'}} \right)^{\alpha} \left(\frac{A_{F,k}}{A_{F,k'}} \right) \right]^{\frac{\eta-1}{1+\alpha(\eta-1)}} \quad (55)$$

With this, we complete the proof for regional comparative advantage.

SC.2.3 Relation to the opportunity cost definition of CA

For the case in which migration costs are prohibitive, direct comparison of expressions (45) and (52) shows that the opportunity-cost formulation is equivalent to free-trade specialization. For the case of free internal migration, comparison of (47) and (55) gives two results. First, relative opportunity costs in autarky cannot be translated with a constant elasticity into free-trade specialization. Second, in fact, the predictions for specialization coming from relative opportunity costs in autarky can be overturned under free migration. Since the term $\mathcal{A}_{i,k}$ captures the degree of competition for workers and how they are apportioned to i relative

to the rest of the economy, in the economy as a whole (as measured by $\sum_h A_{h,k}^{\kappa\frac{(1-\eta)}{1+\kappa+\alpha(\eta-1)}}$), the lack of workers will increase marginal costs under free migration, as to overturn the patterns of specialization.

SC.3 Aggregate Comparative Advantage

In this section, we study how migration relates to country H's export specialization in sector k (relative to sector k' and region F). In particular, we study how migration shapes the inequality

$$\frac{X_{HF,k}}{X_{HF,k'}} > \frac{X_{FF,k}}{X_{FF,k'}}. \tag{56}$$

In this section, we focus directly on the case in which land is not a factor of production, or $\gamma = 0$. Together with the assumptions laid out in the paper, (56) is equivalent to

$$\frac{\sum_i \left(w_{i,k}^{\alpha}/A_{i,k}\right)^{1-\eta}}{\sum_i \left(w_{i,k'}^{\alpha}/A_{i,k'}\right)^{1-\eta}} > \frac{w_{F,k}^{\alpha(1-\eta)} A_{F,k}^{\eta-1}}{w_{F,k'}^{\alpha(1-\eta)} A_{F,k'}^{\eta-1}} \tag{57}$$

where we use again the assumption $\tau_{iF,k} = \tau_{iF,k'} = 1$

SC.3.1 Prohibitive migration costs

If we substitute equation (51) into the (57), we get

$$\frac{\sum_i \left(s_{i,k} L_{i,k}^0\right)^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{i,k}^{\frac{\eta-1}{1+\alpha(\eta-1)}}}{\sum_i \left(s_{i,k'} L_{i,k'}^0\right)^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{i,k'}^{\frac{\eta-1}{1+\alpha(\eta-1)}}} > \frac{\left(s_{F,k} L_{F,k}^0\right)^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{F,k}^{\frac{\eta-1}{1+\alpha(\eta-1)}}}{\left(s_{F,k'} L_{F,k'}^0\right)^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{F,k'}^{\frac{\eta-1}{1+\alpha(\eta-1)}}} \tag{58}$$

Expression (58) restates inequality (57) in terms of exogenous forces in the model.

SC.3.2 Free migration.

Consider now the case of free labor mobility. In particular, if we substitute equation (54) into the (57), we obtain:

$$\left(\frac{S_{H,k}}{S_{H,k'}}\right)^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} \frac{\sum_i \mathcal{A}_{i,k}^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{i,k}^{\frac{\eta-1}{1+\alpha(\eta-1)}}}{\sum_i \mathcal{A}_{i,k'}^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{i,k'}^{\frac{\eta-1}{1+\alpha(\eta-1)}}} > \frac{\mathcal{S}_{F,k}^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{F,k}^{\frac{\eta-1}{1+\alpha(\eta-1)}}}{\mathcal{S}_{F,k'}^{\frac{\alpha(\eta-1)}{1+\alpha(\eta-1)}} A_{F,k'}^{\frac{\eta-1}{1+\alpha(\eta-1)}}}.$$

A Sufficient Statistic for the Impact of Migration

In this Section we provide a proof for the propositions in Section 4.4 of the paper.

SD Proof of Proposition 1

We seek to understand the impact of changes in migration costs on the direction of trade

$$\frac{X_{iF,k}/X_{iF,l}}{X_{FF,k}/X_{FF,l}}.$$

Using our model, changes in the direction of trade respond to changes in wages

$$\frac{\widehat{X_{iF,k}/X_{iF,l}}}{X_{FF,k}/X_{FF,l}} = \frac{\hat{w}_{i,k}^{(1-\eta)(1-\gamma)\alpha}/\hat{w}_{i,l}^{(1-\eta)(1-\gamma)\alpha}}{\hat{w}_{F,k}^{(1-\eta)(1-\gamma)\alpha}/\hat{w}_{F,l}^{(1-\eta)(1-\gamma)\alpha}}.$$

Applying hat algebra to equation (41) we obtain:

$$\begin{aligned}
\widehat{w_{i,k}}^{1+\kappa-(1-\gamma)\alpha(1-\eta)} &\left[\mathcal{E}_{ii,k}\frac{s_{i,k}^{\kappa}\widehat{P_i^{-\kappa}}}{\sum_l\sum_{i''}\left(s_{i,l}w_{i'',l}\right)^{\kappa}\left(\mu_{ii'',l}P_{i''}\right)^{-\kappa}}s_{i,k}\ell_{ii}\right]+ \\
\widehat{w_{i,k}}^{1+\kappa-(1-\gamma)\alpha(1-\eta)} &\left[\sum_j\mathcal{E}_{ji,k}\frac{s_{j,k}^{\kappa}P_i^{-\kappa}\widehat{\mu_{ji,k}^{-\kappa}}}{\sum_l\sum_{i''}\left(s_{j,l}w_{i'',l}\right)^{\kappa}\left(\mu_{ji'',l}P_{i''}\right)^{-\kappa}}s_{j,k}\ell_{ji}\right]= \\
&\alpha\left(1-\gamma\right)\delta_{i,k}\left[\left(\frac{\widehat{r_i^{\gamma\alpha}P_i^{1-\alpha}}\tau_{ij,k}}{P_{F,k}}\right)^{1-\eta}X_{F,k}\right]
\end{aligned}$$

and evaluated at $\mu_{ij,k}\to\infty$ for $i\neq j$, yields

$$\widehat{w_{i,k}} = \left\{\hat{r}_i^{\alpha\gamma(1-\eta)}\left[\mathcal{E}_{ii,k}\frac{\widehat{1}}{\sum_l\sum_{i''}\left(s_{i,l}w_{i'',l}\right)^{\kappa}\left(\mu_{ii'',l}P_{i''}\right)^{-\kappa}}\right]^{-1}\right\}^{\frac{1}{1+\kappa+\alpha(1-\gamma)(\eta-1)}}. \tag{59}$$

Thus, the change in export specialization is given by

$$\frac{\widehat{X_{iF,k}/X_{iF,l}}}{X_{FF,k}/X_{FF,l}} = \left(\mathcal{E}_{ii,k}/\mathcal{E}_{ii,l}\right)^{\frac{\alpha(1-\eta)(1-\gamma)}{1+\kappa+\alpha(1-\gamma)(\eta-1)}}.$$

SD.1 The impact on the aggregate direction of trade

The change in the aggregate direction of trade is, when $\gamma=0$:

$$\frac{\widehat{X_{HF,k}/X_{HF,l}}}{X_{FF,k}/X_{FF,l}} = \frac{\sum_{i\in H}S_{i,k}\hat{w}_{i,k}^{(1-\eta)\alpha}}{\sum_{i\in H}S_{i,k}\hat{w}_{i,l}^{(1-\eta)\alpha}}\times\frac{\hat{w}_{F,l}^{(1-\eta)\alpha}}{\hat{w}_{F,k}^{(1-\eta)\alpha}}$$

where $S_{i,k}$ is region $i's$ share in country $H's$ total exports of sector k to country F, in the baseline scenario.

Start by computing changes in welfare as $\mu_{ij,k} \to \infty$:

$$\hat{\Xi}_i^{\kappa} = \left(\sum_k \tilde{\mathcal{E}}_{ii,k} \widehat{w_{i,k}^{\kappa}} \right),$$

where $\tilde{\mathcal{E}}_{ii,k'} = \lambda_{ij,k} / \sum_{k'} \lambda_{ii,k'}$. Substituting $\hat{\Xi}_i$ in equation (59) we obtain

$$\hat{w}_{i,k} = \left\{ \mathcal{E}_{ii,k}^{-1} \left(\sum_k \tilde{\mathcal{E}}_{ii,k} \widehat{w_{i,k}^{\kappa}} \right) \right\}^{\frac{1}{1+\kappa+\alpha(\eta-1)}}.$$

Noting that

$$\frac{\hat{w}_{i,k}}{\hat{w}_{i,l}} = \left\{ \frac{\mathcal{E}_{ii,l}}{\mathcal{E}_{ii,k}} \right\}^{\frac{1}{1+\kappa+\alpha(1-\gamma)(\eta-1)}},$$

We can rewrite the changes in wages of sector k region i as

$$\hat{w}_{i,k} = \left\{ \widehat{w_{i,k}^{\kappa}} \frac{\tilde{\mathcal{E}}_{ii,k} + \sum_{l \neq k} \tilde{\mathcal{E}}_{ii,l} \hat{w}_{i,l}^{\kappa} / \hat{w}_{i,k}^{\kappa}}{\mathcal{E}_{ii,k}} \right\}^{\frac{1}{1+\kappa+\alpha(\eta-1)}}$$

$$\hat{w}_{i,k}^{\frac{1+\alpha(\eta-1)}{1+\kappa+\alpha(\eta-1)}} = \left\{ \frac{\tilde{\mathcal{E}}_{ii,k}}{\mathcal{E}_{ii,k}} + \sum_{l \neq k} \frac{\tilde{\mathcal{E}}_{ii,l}}{\mathcal{E}_{ii,k}} \left\{ \frac{\mathcal{E}_{ii,l}}{\mathcal{E}_{ii,k}} \right\}^{\frac{\kappa}{1+\kappa+\alpha(1-\gamma)(\eta-1)}} \right\}^{\frac{1}{1+\kappa+\alpha(\eta-1)}}$$

Finally, if we assume that there are no within region distortions to the allocation of labor, nor heterogeneity across workers, this becomes:

$$\hat{w}_{i,k} = \left(\frac{\tilde{\mathcal{E}}_{ii}}{\mathcal{E}_{ii}} \right)^{\frac{1}{1+\kappa+\alpha(\eta-1)}}.$$

Evaluating it in the aggregate bilateral specialization:

$$\frac{\widehat{X_{HF,k}/X_{HF,l}}}{X_{FF,k}/X_{FF,l}} = \frac{\sum_{i \in H} S_{i,k} \left(\frac{\tilde{\mathcal{E}}_{ii}}{\mathcal{E}_{ii}} \right)^{\frac{1-\eta}{1+\kappa+\alpha(\eta-1)}}}{\sum_{i \in H} S_{i,k} \left(\frac{\tilde{\mathcal{E}}_{ii}}{\mathcal{E}_{ii}} \right)^{\frac{1-\eta}{1+\kappa+\alpha(\eta-1)}}}$$

SE Proposition 1, with Capital as a productive factor

We seek to understand the impact of changes in migration costs on the direction of trade

$$\frac{X_{iF,k}/X_{iF,l}}{X_{FF,k}/X_{FF,l}}.$$

In addition to labor, land, and intermediate inputs, let capital be a factor of production. let the shares by α for VA, γ for land and ν for capital. Then the cost function is

$$c_{i,k} = \left(w_{i,k}^{(1-\gamma-\nu)} r_i^{\gamma} R_i^{\nu}\right)^{\alpha} P_i^{1-\alpha},$$

where R_i is the rental rate of capital. Changes in the direction of trade respond to changes in marginal costs

$$\frac{\widehat{X_{iF,k}/X_{iF,l}}}{X_{FF,k}/X_{FF,l}} = \frac{\hat{w}_{i,k}^{(1-\eta)(1-\gamma-\nu)\alpha}/\hat{w}_{i,l}^{(1-\eta-\nu)(1-\gamma)\alpha}}{\hat{w}_{F,k}^{(1-\eta)(1-\gamma-\nu)\alpha}/\hat{w}_{F,l}^{(1-\eta-\nu)(1-\gamma)\alpha}}.$$

Rewriting the analog to equation (41) in proportional changes, we obtain:

$$\widehat{w_{i,k}}^{1+\kappa-(1-\gamma-\nu)\alpha(1-\eta)} \left[\mathcal{E}_{ii,k} \frac{s_{i,k}^{\kappa} \widehat{P_i^{-\kappa}}}{\sum_l \sum_{i''} \left(s_{i,l} w_{i'',l}\right)^{\kappa} \left(\mu_{ii'',l} P_{i''}\right)^{-\kappa}} s_{i,k} \ell_{ii}\right] +$$
$$\widehat{w_{i,k}}^{1+\kappa-(1-\gamma-\nu)\alpha(1-\eta)} \left[\sum_j \mathcal{E}_{ji,k} \frac{s_{j,k}^{\kappa} P_i^{-\kappa} \widehat{\mu_{ji,k}^{-\kappa}}}{\sum_l \sum_{i''} \left(s_{j,l} w_{i'',l}\right)^{\kappa} \left(\mu_{ji'',l} P_{i''}\right)^{-\kappa}} s_{j,k} \ell_{ji}\right] =$$
$$\alpha\left(1-\gamma\right)\delta_{i,k}\left[\left(\frac{r_i^{\gamma\alpha} \widehat{R_i^{\nu\alpha}} P_i^{1-\alpha} \tau_{ij,k}}{P_{F,k}}\right)^{1-\eta} X_{F,k}\right]$$

and evaluated at $\mu_{ij,k} \to \infty$ for $i \neq j$, yields

$$w_{i,k} = \left\{\hat{r}_i^{\alpha\gamma(1-\eta)} \hat{R}_i^{\nu\alpha(1-\eta)} \left[\mathcal{E}_{ii,k} \frac{\widehat{1}}{\sum_l \sum_{i''} \left(s_{i,l} w_{i'',l}\right)^{\kappa} \left(\mu_{ii'',l} P_{i''}\right)^{-\kappa}}\right]^{-1}\right\}^{\frac{1}{1+\kappa-(1-\gamma-\nu)\alpha(1-\eta)}}. \quad (60)$$

Thus, the change in export specialization is given by

$$\frac{\widehat{X_{iF,k}/X_{iF,l}}}{X_{FF,k}/X_{FF,l}} = \left(\mathcal{E}_{ii,k}/\mathcal{E}_{ii,l}\right)^{\frac{\alpha(1-\eta)(1-\gamma-\nu)}{1+\kappa+(1-\gamma-\nu)\alpha(\eta-1)}}.$$

Note that when $\nu = 0$ we go back to our main specification. What are the comparative statics on ν? Since the exponent is decreasing in ν, including capital works as an additional buffer on marginal costs, which diminishes the impact of migration on comparative advantage.

SF The Gains from Trade – Proofs

This Section contains the proofs to the Propositions in Section 7 of the paper. In what follows, we set $\gamma_k = 0$, $\forall k$. Proof of Proposition 2

Let W_i denote the real wage in region i, $W_i = w_i/P_i$. Inverting the domestic trade share,

we obtain:

$$W_i = \pi_{ii}^{\frac{1}{\alpha(1-\eta)}} A_i^{\frac{1}{\alpha}},$$

which implies the following changes in real wages in response in changes to fundamentals:

$$\hat{W}_i = (\hat{\pi}_{ii})^{\frac{1}{\alpha(1-\eta)}} \hat{A}_i^{\frac{1}{\alpha}}. \tag{61}$$

Likewise, the implied changes to expected welfare are

$$\hat{\Xi}_i = \left[\sum_j \lambda_{ij} \left(\hat{W}_j \hat{s}_i \hat{\mu}_{ij}^{-1} \right)^{\kappa} \right]^{1/\kappa}, \tag{62}$$

where λ_{ij} are observed migration shares.

We introduce the following notation to indicate four scenarios: (i) B is our baseline with observed trade costs and migration costs, (ii) B,A is the scenario in which, starting from B, we take region i to full trade autarky, (iii) N is the scenario in which, starting from B, we take region i to full migration autarky, and (iv) N, A corresponds to the scenario in which, starting from N, we take region i to full trade autarky.

SF.1 Proof of Proposition 2

Observing that $\hat{\pi}_{ii}^{B \to B,A} = \pi_{ii}^{-1}$, i.e., the inverse of the observed trade shares, direct substitution of (61) in (62) yields

$$\hat{\Xi}_i^{B \to B,A} = \left[\sum_j \lambda_{ij} \pi_{ii}^{\frac{\kappa}{\alpha(1-\eta)}} \right]^{1/\kappa}, \tag{63}$$

which completes the proof.

SF.2 Proof of Proposition 3

Start by noting that we can write the welfare change from going to autarky, starting from no migration, $N \to N, A$ as

$$\begin{aligned} \hat{\Xi}_i^{N \to N,A} &= \frac{\Xi_i^{N,A}}{\Xi_i^N} \\ &= \frac{\Xi_i^{N,A}}{\Xi_i^B} \left(\frac{\Xi_i^N}{\Xi_i^B} \right)^{-1}. \end{aligned} \tag{64}$$

We obtain expressions for each of the terms in the last equation.

Applying the same reasoning that led to equation (63), we obtain

$$\left(\frac{\Xi_i^N}{\Xi_i^B} \right)^{-1} = \left(\lambda_{ii} \left(\frac{\pi_{ii}^N}{\pi_{ii}^B} \right)^{\frac{1}{\alpha(1-\eta)}} \right)^{-1},$$

noting that π_{ii}^N is not observed and that π_{ii}^B is simply data. Likewise, we obtain:

$$\frac{\Xi_i^{N,A}}{\Xi_i^B} = \lambda_{ii} \left(\frac{\pi_{ii}^{N,A}}{\pi_{ii}^B} \right)^{\frac{1}{\alpha(1-\sigma)}} = \lambda_{ii} \left(\pi_{ii}^B \right)^{\frac{1}{\alpha(\sigma-1)}} .$$

Substituting the last two expressions in equation (64) we obtain

$$\begin{aligned} \hat{\Xi}_i^{N\to N,A} &= \left(\frac{1}{\pi_{ii}^B} \right)^{\frac{1}{\alpha(1-\sigma)}} \left(\frac{\pi_{ii}^B}{\pi_{ii}^N} \right)^{\frac{1}{\alpha(1-\sigma)}} \\ &= \left(\frac{1}{\pi_{ii}^B} \right)^{\frac{1}{\alpha(1-\sigma)}} T_i, \end{aligned} \tag{65}$$

where the last line defines $T_i = \left(\pi_{ii}^B / \pi_{ii}^N \right)^{1/\alpha(1-\sigma)}$.

To obtain the result, rewrite equation (63)

$$\hat{\Xi}_i^{B\to B,A} = \left[\lambda_{ij} \left(\pi_{ii}^B \right)^{\frac{\kappa}{\alpha(\sigma-1)}} + \sum_{j\neq i} \lambda_{ij} \left(\pi_{jj}^B \right)^{\frac{\kappa}{\alpha(\sigma-1)}} \right]^{1/\kappa}$$

and use (65) to substitute for π_{ii}^B

$$\hat{\Xi}_i^{B\to B,A} = \left[\lambda_{ii} T^{-\kappa} \left(\hat{\Xi}_i^{N\to N,A} \right)^{\kappa} + \sum_{j\neq i} \lambda_{ij} \left(\pi_{jj}^B \right)^{\frac{\kappa}{\alpha(\sigma-1)}} \right]^{1/\kappa} . \tag{66}$$

SG Gains from Trade in a Multisector Model

The key difficulty in the multi-sector case is that changes trade shares are no longer sufficient statistics for changes in real wages induced by changes in trade costs. Nevertheless, with CES preferences across activities and an elasticity of substitution different from one, one can use changes in observed expenditure shares to proceed.

SG.1 Gains from Trade

Note first that we can rewrite trade shares as a function of real wages and expenditure shares

$$\pi_{ii,k} = \left(\frac{w_{i,k}^{\alpha_k} P_i^{1-\alpha_k} / A_{i,k}}{P_{i,k}} \right)^{1-\eta}$$
$$\pi_{ij,k} = \left(\frac{W_{i,k}^{\alpha_k}}{A_{i,k}} \frac{P_i}{P_{i,g}} \frac{P_{i,g}}{P_{i,k}} \right)^{1-\eta}$$
$$\pi_{ii,k} = \left(\frac{W_{i,k}^{\alpha_k}}{A_{i,k}} \left(\frac{S_{i,k}}{a_{i,k}} \right)^{\frac{1}{\sigma_g - 1}} \left(\frac{S_{i,g}}{b_g} \right)^{\frac{1}{\sigma - 1}} \right)^{1-\eta},$$

where we use

$$S_{i,k} = a_{ik} \left(\frac{P_{j,k}}{P_{j,g}} \right)^{1-\sigma_g}$$
$$S_{i,g} = b_g \left(\frac{P_{i,g}}{P_i} \right)^{1-\sigma}$$

We begin by computing the GFT starting from the baseline and going to full trade autarky. Noting that

$$W_{i,k} = \pi_{ii,k}^{\frac{1}{\alpha_k(1-\eta)}} A_{i,k}^{\frac{1}{\alpha_k}} (S_{i,k})^{\frac{1}{\alpha_k(1-\sigma_g)}} (S_{i,g})^{\frac{1}{\alpha_k(1-\sigma)}},$$

we can compute changes in real wages, $\hat{W}_{i,k}$, and substitute them into the change in expected welfare $\hat{\Xi}_i^{B \to B,A}$:

$$\hat{\Xi}_i^{B \to B,A} = \left[\sum_j \sum_k \lambda_{ij,k} \left(\pi_{ii,k}^{\frac{1}{\alpha_k(\eta-1)}} \hat{S}_{i,k}^{\frac{1}{\alpha_k(1-\sigma_g)}} \hat{S}_{i,g}^{\frac{1}{\alpha_k(1-\sigma)}} \right)^{\kappa} \right]^{1/\kappa}$$

SG.2 GFT Comparison to the Migration Autarky Scenario

Our goal now is to compare the gains from trade in our baseline scenario to one in which there is no migration. Unfortunately, an exact decomposition such as the one in Proposition 3 is not available. However, we will show that one can cleanly separate the gains arising from migration opportunities, as before.

First, we will see show how real wage changes determine the welfare change going to autarky in a no migration scenario. As before, note that we can decompose the welfare change as

$$\hat{\Xi}_i^{N \to N,A} = \frac{\Xi_i^{N,A}}{\Xi_i^B} \left(\frac{\Xi_i^N}{\Xi_i^B} \right)^{-1}.$$

The first and second terms are given by:

$$\frac{\Xi_i^{N,A}}{\Xi_i^B} = \left(\sum_k \lambda_{ii,k} \left(\frac{s_{i,k}^{N,A}}{s_{i,k}^B} \right)^{\kappa} \left(\frac{1}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^{N,A}}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^{N,A}}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}} \right)^{1/\kappa}$$

and

$$\left(\frac{\Xi_i^N}{\Xi_i^B} \right)^{-1} = \left(\sum_k \lambda_{ij,k} \left(\frac{s_{i,k}^N}{s_{i,k}^B} \right)^{\kappa} \left(\frac{\pi_{ii,k}^N}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^N}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^N}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}} \right)^{-1/\kappa}.$$

Putting them together, we obtain

$$\hat{\Xi}_i^{N\to N,A} = \left[\frac{\sum_k \lambda_{ii,k} \left(\frac{1}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^{N,A}}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^{N,A}}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}{\sum_k \lambda_{ii,k} \left(\frac{\pi_{ii,k}^N}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^N}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^N}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}} \right]^{1/\kappa}.$$

Letting

$$\rho_{i,k} = \frac{\lambda_{ii,k} \left(\frac{\pi_{ii,k}^N}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^N}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^N}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}{\sum_l \lambda_{ii,l} \left(\frac{\pi_{ii,k}^N}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^N}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^N}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}$$

and

$$\xi_{i,k} = \frac{\left(\frac{1}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^{N,A}}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^{N,A}}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}{\left(\frac{\pi_{ii,k}^N}{\pi_{ii,k}^B} \right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{i,Sk}^N}{S_{i,Sk}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{i,S}^N}{S_{i,S}^B} \right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}$$

we can rewrite the welfare change as

$$\hat{\Xi}_i^{N\to N,A} = \left[\sum_k \rho_{i,k} \xi_{i,k} \right]^{1/\kappa}.$$

Thus $\{\rho_{i,k}, \xi_{i,k}\}$ and κ fully determine $\hat{\Xi}_i^{N\to N,A}$.

Note that we can write the baseline domestic trade share as

$$\left(\pi_{ii,k}^B \right)^{\frac{\kappa}{\alpha_k(\eta-1)}} = \frac{\xi_{i,k}}{\rho_{i,k}} T_{i,k}.$$

Finally, we can rewrite $\hat{\Xi}_i^{B\to B,A}$ to separate migration opportunities from the components that determine $\hat{\Xi}_i^{N\to N,A}$.

Now we compute $\hat{\Xi}_i^{B\to B,A}$ so

$$\begin{aligned}\hat{\Xi}_i^{B\to B,A} &= \left[\sum_j \sum_k \lambda_{ij,k} \left(\frac{1}{\pi_{jj}^B}\right)^{\frac{\kappa}{\alpha_k(1-\eta)}} \left(\frac{S_{j,Sk}^{B,A}}{S_{j,Sk}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{j,S}^{B,A}}{S_{j,S}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}\right]^{1/\kappa} \\ &= \Bigg[\sum_k \lambda_{ii,k} \frac{\xi_{i,k}}{\rho_{i,k}} T_{i,k} \left(\frac{S_{j,Sk}^{B,A}}{S_{j,Sk}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{j,S}^{B,A}}{S_{j,S}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma)}} \\ &\quad + \underbrace{\sum_{j\neq i} \sum_k \lambda_{ij,k} \left(\frac{1}{\pi_{jj}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma)}} \left(\frac{S_{j,Sk}^{B,A}}{S_{j,Sk}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma_A)}} \left(\frac{S_{j,S}^{B,A}}{S_{j,S}^B}\right)^{\frac{\kappa}{\alpha_k(1-\sigma)}}}_{\text{contribution of migration opportunities}}\Bigg]^{1/\kappa}. \end{aligned} \tag{67}$$

Note that this decomposition is analogous to 66, which forms the basis of Proposition 3.

In calculating the contribution of migration opportunities to the GFT in the multi-sector model, we rely on equation 67.

SH Calibration Details

This section describes the algorithm that we set up for the calibration of the model. The algorithm can be divided in two steps. In the first step, we calibrate the exogenous parameters related to the goods market equilibrium using data on gross output by sector and region, total exports and imports of Brazil to the rest of the world, and the share of domestic trade of states in Brazil. In the second step, we calibrate the exogenous parameters related to workers' migration using data on migration flows between states and activities and the share of workers living in their region of birth. To simplify notation, we drop time indexes whenever unnecessary for our exposition. In what follows, we denote Brazil as Home and the rest of the world as Foreign.

SH.1 Parameters in the calibration algorithm

We begin by discussing a few aspects of the identification of the parameters in our calibration procedure that are important for understanding the algorithm.

Migration costs. We parameterize our matrix of migration costs using a hub-spoke structure (see Ramondo et al. (2016)). In particular, for all regions within a state, workers have to pass through a common location to migrate to other states. This structure allows us aggregate our regional level migration flows to estimate the symmetric component of our migration costs using equation 18 at the aggregate level of states. To see this, write migration cost as $\mu_{ij,k} = \mu_{ss}\mu_i\mu_j\mu_{ss',k}$. With this assumption, migration flows become:

$$L_{ij,k} = \frac{\left(w_{j,k}s_{i,k}/P_j\mu_{ss}\mu_i\mu_j\mu_{ss',k}\right)^{\kappa}}{\Xi_i^{\kappa}} L_i.$$

Let $L_{ss',k} \equiv \sum_{i\in s}\sum_{j\in s'} L_{ij,k}$ be the aggregate flow of workers from state s to state and activity s' and k. Summing the expression above over origins in state s and destinations in state s' gives

$$L_{ss',k} = \sum_{i\in s}\sum_{j\in s'} \frac{(w_{j,k}s_{i,k}/P_i\mu_{ss}\mu_i\mu_j\mu_{ss',k})^{\kappa}}{\Xi_i^{\kappa}} L_i.$$

Straightforward manipulations give

$$\log L_{ss',k} = \alpha_{s,k} + \alpha_{s',k} - \kappa \log \mu_{ss'} - \kappa \log \mu_{ss',k},$$

where $\alpha_{s,k} \equiv \sum_{i\in s} \frac{(s_{i,k}/\mu_i)^{\kappa}}{\Xi_i^{\kappa}}$ and $\alpha_{s',k} \equiv \sum_{j\in s'} (w_{j,k}/P_j\mu_j)^{\kappa}$.

Prices and natural advantages. We calibrate natural advantages ($A_{j,k}$) using data on gross output per region and activity. The intuition for the calibration of natural advantages is the same as the one described in detail in Allen and Arkolakis (2014): if two regions have the same distance to other markets, but the model predicts that one region sells more than the other in a given activity, this difference is attributed to differences in natural advantages. In practice, we first search for prices $p_{j,k}$, which has a direct relationship with natural advantages ($A_{j,k}$) given that $p_{j,k} = c_{j,k}/A_{j,k}$, where $c_{j,k}$ is the unit cost of production and $A_{j,k}$ is the absolute advantage. With calibrated values for $p_{j,k}$, in the end of our algorithm, we can construct $c_{j,k}$ using model-implied values of $w_{j,k}$, r_i and P_i and recover $A_{j,k}$.

Trade costs and international trade. We calibrate trade costs τ_k and relative productivities between Home and Foreign as to exactly match trade shares between Home and Foreign in the absence of trade deficits. We illustrate this point using a simple 2 by 2 case (without internal geography). The system of equations defining trade shares is given by

$$\begin{aligned}
\frac{X_{HH,k}}{X_{H,k}} &= \frac{(p_{H,k})^{1-\sigma}}{(p_{H,k})^{1-\sigma} + (\tau_k p_{F,k})^{1-\sigma}} \\
\frac{X_{HF,k}}{X_{H,k}} &= \frac{(\tau_k p_{H,k})^{1-\sigma}}{(p_{H,k})^{1-\sigma} + (\tau_k p_{F,k})^{1-\sigma}} \\
\frac{X_{FF,k}}{X_{F,k}} &= \frac{(p_{H,k})^{1-\sigma}}{(p_{H,k})^{1-\sigma} + (\tau_k p_{F,k})^{1-\sigma}} \\
\frac{X_{HH,k}}{X_{H,k}} &= \frac{(p_{H,k})^{1-\sigma}}{(p_{H,k})^{1-\sigma} + (\tau_k p_{F,k})^{1-\sigma}}
\end{aligned}$$

where $X_{jj',k}$ is the trade flow of country j to j' and $X_{j,k}$ is the total consumption of country j. We have four equations and three variables ($p_{H,k}$, $p_{F,k}$ and τ_k). Two of these equations are dependent and, therefore, satisfying 2 out of the four equations of this system provides a perfect match of the model with the data. We therefore use such equations to recover trade costs τ_k and relative prices $p_{H,k}/p_{F,k}$. Noticed that we do not have any degree of freedom left to calibrate an asymmetric trade cost in the example given above. Alternatively, we

could assume that prices are the same across countries $p_{H,k} = p_{F,k}$, but that trade costs are asymmetric.

SH.2 Calibration algorithm

Our algorithm calibrates preference shifters ($a_{H,kt}$ and $a_{F,kt}$), productivities ($A_{j,kt}$ and $b_{j,kt}$), migration costs (μ_t^0, $\mu_{ss',kt}$), trade costs (δ_t^0, δ_t^1 and $\delta_{ij,kt}$), taking the following parameters as given: preference parameters (σ and σ_S), production technology parameters (α_k, γ_k, ρ and ς), worker heterogeneity (β and κ), the elasticity of migration cost with respect to distance (μ^1) and the symmetric component of migration costs between states ($\mu_{ss,t}$). As described below, our algorithm consists of three major. In what follows, we drop index t to save on notation unless necessary.

Step 1: Trade equilibrium. In the first step of our calibration, we search for values of prices ($p_{j,k}$), preference shifters ($a_{H,kt}$ and $a_{F,kt}$), international trade costs (δ_k), the level of domestic trade costs (δ^0) and the elasticity of trade cost with respect to distance (δ^1) such that different moments of the data, detailed below, are consistent with a goods market equilibrium in the model. Our calibration requires measures of expenditure X_j by region, which we construct by summing the gross output across activities and distributing Brazil's trade deficit across regions proportionally to X_j.[61]

We define $p_{j,k} \equiv \tilde{p}_{j,k} p_{H,k}$, where $p_{H,k}$ is the average price of goods in Home and $\sum_{j \in H} \tilde{p}_{j,k} = 1$, use superscripts g for guessed values and let $\widehat{x}$ be model-implied value for observed value x. Using these definitions, the algorithm consists of the following steps:

1. Guess values for $(\delta^0)^g$ and $(\delta^1)^g$
2. Guess values for $(\tilde{p}_{j,k})^g$, $(b_{j,k})^g$, $(a_{H,k})^g$ and $(a_{F,k})^g$
3. Guess values for $(\delta_k)^g$ and $(p_{H,k})^g$
4. Compute τ_{ijk} using the guesses of $(\delta^0)^g$, $(\delta^1)^g$ and $(\delta_k)^g$
5. Compute prices $p_{j,k}$, $P_{j,k}$, $P_{j,s}$ and P_j
6. Compute model-implied trade flows $\widehat{X}_{HF,k}$ and $\widehat{X}_{FH,k}$, revenues $\widehat{Y}_{F,k}$, $\widehat{Y}_{H,k}$, and $\widehat{Y}_{j,k}$ and share of trade between states within Home $\sum_k \sum_s \widehat{X}_{ss,k} / \sum_k \widehat{X}_{HH,k}$
7. Compute the differences between model-implied trade flows $\widehat{X}_{HF,k}$ and $\widehat{X}_{FH,k}$ with data $X_{HF,k}$ and $X_{FH,k}$. If the differences are smaller than a tolerance level, move to next step, otherwise, generate new values for $(\delta_k)^g$ and $(p_{H,k})^g$ with an updating rule and return to step 3

[61] In the exercises in which we study the gains from trade, we move the economy to autarky. To avoid endogeneizing the deficits or keeping them constant when there is no trade (or more generally, taking a stance on how they change in our counterfactual exercises), we set deficits to zero in all simulations of our model.

8. Compute the differences between model-implied revenues $\widehat{Y}_{F,k}$, $\widehat{Y}_{H,k}$ and $\widehat{Y}_{j,k}$ with data $Y_{F,k}$, $Y_{H,k}$ and $Y_{j,k}$. If the differences are smaller than a tolerance level, move to the next step, otherwise, generate new values for $(\tilde{p}_{j,k})^g$, $(b_{j,k})^g$ and $(a_{j,k})^g$ using an updating rule and return to step 3.

9. Compute the difference between model-implied $\sum_k \sum_s \frac{\widehat{X}_{ss,k}}{\sum_k \widehat{X}_{HH,k}}$ and data $\sum_k \sum_s \frac{X_{ss,k}}{\sum_k X_{HH,k}}$, as well as the difference between the model-implied elasticity of trade with respect to distance and the corresponding elasticity in the data. If the differences are smaller than a tolerance level, finish the calibration. Otherwise, generate new values for $(\delta^0)^g$ and $(\delta^1)^g$ using an updating rule and return to step 1

Step 2: Migration equilibrium In the second step of our calibration, we search for values of migration costs (μ_0), migration shocks ($\tilde{\mu}_{ss',k}$), land intensity γ_k such that different moments of the data are consistent with workers migration choices in the model. We use the price index of every region generated in the previous calibration step and construct the supply of efficiency labor in every origin region $E_{j,k}$ using $s_{i,kt} = L^{\beta}_{i,kt-1}$ if $L_{i,kt-1} > 0$ and $s_{i,kt} = \min\{L^{\beta}_{i,kt-1}\}$ if $L_{i,kt-1} = 0$.

The steps for the calibration of migration costs are as follows:

1. Guess values for $(\mu_0)^g$ and $(\tilde{\mu}_{ss',k})^g$

2. Compute $\mu_{ss,k}$ using the guesses of $(\mu_0)^g$ and $(\tilde{\mu}_{ss',k})^g$

3. Guess values of $(\gamma_k)^g$

4. Guess values of $(w_{j,k})^g$ and $(r_j)^g$

5. Compute real income in each region using $w^0_{j,k}$ and P_j

6. Compute model-implied migration $\widehat{L}_{ss',k}$ and $\widehat{L}_{ii}$, efficiency labor $\widehat{E}_{j,k}$, land use $\widehat{H}_j$ and cost share of labor in Home

7. Compute predicted demand for efficiency labor $\widehat{E}_{j,k}$ and for land $\widehat{H}_j$

8. Compute the differences between model-implied $\widehat{E}_{j,k}$ and $\widehat{H}_j$ and $E_{j,k}$ and H_j. If the differences are smaller than a tolerance level, move to the next step, otherwise, generate new values for $(w_{j,k})^g$ and $(r_j)^g$ using an updating rule and return to step 5.

9. Compute the difference between model-implied aggregate cost share of labor in Home and the difference with the data. If the difference is smaller than a tolerance level, move to the next step, otherwise, generate new values for $(\gamma_k)^g$ using an updating rule and return to step 3.

10. Compute the differences between $\widehat{L}_{ss',k}$ and the average of $\widehat{L}_{ii}$ in Home and their corresponding values in the data. If the differences are smaller than a tolerance level, move to the next step, otherwise, generate new values for $(\mu_0)^g$ and $(\tilde{\mu}_{ss',k})^g$ using an updating rule and return to step 1

Step 3: Natural advantages and land supply productivity

Once with values for model-implied wages ($w_{j,k}$), land rents (r_j) and price indexes (P_i), we can construct the unit cost of production $c_{j,kt}$ and recover the natural advantage of a region from $A_{j,k} = c_{j,k}/A_{j,k}$. For the land supply, we recover land productivity using $b_{j,t} = (\varsigma P_{j,t}/r_{j,t})^{1/\varsigma} (H_{j,t})^{(\varsigma-1)/\varsigma}$.

SI Steady State

SI.1 Steady State Equilibrium.

Given a constant geography for $t = 1, \ldots, \infty$, a steady state equilibrium is a competitive equilibrium in which migration flows, labor allocations, and prices, are unchanged: $L_{ij,kt} = \bar{L}_{ij,k}$, $w_{i,kt} = \bar{w}_{i,k}$, $r_{i,t} = \bar{r}_i$, and $E_{i,kt} = \bar{E}_{i,k}$, $\forall t = 1, \ldots, \infty$. Equilibrium conditions

$$
\begin{aligned}
w_{j,k}E_{j,k} &= (1-\gamma_k)\sum_i \pi_{ji,k}X_{i,k} \\
r_jH_j &= \sum_k \gamma_k \sum_i \pi_{ji,k}X_{i,k} \\
E_{j,k} &= \sum_i L_{i,k}^{\beta} L_{ij,k}, \\
L_{ij,k} &= \lambda_{ij,k}L_i. \\
L_j &= \sum_i L_i \left[\sum_k \lambda_{ij,k}\right]
\end{aligned}
$$

In the supplementary appendix, we focus on a model with two sectors to draw sharp conclusions about how migration and the knowledge externality shape the steady state equilibrium.

SI.2 Closed economy without internal geography

To draw sharp conclusions about how migration and the knowledge externality shape the steady state equilibrium, we focus on a model with two sectors, denoted k and k'. Letting $\omega = w_k/w_{k'}$, we can boil down our equilibrium to a labor market clearing equation

$$
\omega = \left(\frac{\lambda_{kt}}{(1-\lambda_{kt})}\frac{\lambda_{kt-1}^{\beta}}{1-\lambda_{kt-1}^{\beta}}\right)^{1/\sigma}
$$

and a migration equation

$$
\frac{\lambda_{kt}}{1-\lambda_{kt}} = \left(\frac{\lambda_{kt-1}^{\beta}}{\omega\,(1-\lambda_{kt-1})^{\beta}}\right)^{\kappa}.
$$

To study the dynamics of the system, we substitute for ω in the migration equation to obtain

$$
\tilde{\lambda}_t = \tilde{\lambda}_{t-1}^{\beta\kappa\frac{\sigma-1}{\kappa+\sigma}},
$$

where $\tilde{\lambda}_t = \lambda_{k,t}/\lambda_{k',t}$. We distinguish the following cases. First, if $\sigma < 1$, so sectors are complementary, the unique equilibrium features symmetric labor allocations, $\tilde{\lambda} = 1$. Second, when $\sigma > 1$, there are multiple equilibria: one symmetric, $\tilde{\lambda} = 1$, and two featuring full specialization, $\tilde{\lambda} = 0$ and $\tilde{\lambda}^{-1} = 0$.

The properties of the equilibrium are shaped by the interaction of agglomeration and dispersion forces. First, the idiosyncratic draws are a force towards populating all region-crop cells. The strength of this force is governed by the dispersion in preference shocks κ: as κ decreases, individuals have stronger idiosyncratic tastes for working in different regions and activities. Second, the external sector has a downward sloping demand for the goods in Brazil; this acts as a force against full agglomeration in a given crop, within regions. The strength of this force is governed by η_k: as η_k grows, terms of trade turn against Brazil faster as output in a given crop increases. Third, our assumptions on technology yield high marginal values of labor when $L_{i,kt} = 0$, which provides an incentive for workers to be employed in each region-crop combination.

The opposing, agglomeration force is given by the spatial allocation of knowledge: if there is a large number of workers populating a region-crop cell, workers want to locate there because their productivity is larger. The strength of the agglomeration force is governed by β. Note that this force only operates in steady state, since in each period past allocations are taken as given. In other words, at any given time, conditional on past labor allocations, ours is a standard model of migration and trade in which there are no agglomeration forces. Related, there is a dynamic externality in the way we model knowledge diffusion, since workers do not internalize their impact on the productivity of the next generations.

SI.3 Small open economy

We now turn to the steady state in the case of a small open economy, as described in detail in Appendix Section SB. For simplicity, set $\gamma = 0$, so labor and intermediate inputs are the only factors of production. From equation (40), which describes labor market clearing for region i and activity k, it is apparent that corners with zeros are not possible if at least one other region i' produced k in the previous period, so that $s_{i',k} > 0$. To see this, note that $L_{i,k} = 0$ only when $w_{i,k} = 0$. If that is the case, the left-hand side of equation (40) equals zero. This is inconsistent with the right-hand side of the same equation, which approaches infinity as $w_{i,k} \to 0$. Therefore, in a small open economy, zero employment is only possible in the trivial case in which $A_{i,k} = 0$.

SJ Investment in Activity-Specific Skills

In this model, the young born at $t-1$ face an investment choice. The are endowed with $\bar{e}$ units of time, which they can invest to obtain activity-specific knowledge that they will be able to use at time t, $s^e_{i,kt}$, according to the following production function

$$s^e_{i,kt} = e^{\varphi_1}_{i,kt-1} L^{\varphi_2}_{i,kt-1} \tag{68}$$

In equation (68) , $e_{i,kt-1}$ is the amount of time destined to learning activity k, and $L_{i,kt-1}$ captures any cost-reducing spillovers that result from exposure to region i's specialization in activity k. The parameters φ_1, φ_2 control the importance of these two forces.

We assume that young workers do not observe their preference shocks when choosing their investment. Therefore, their maximization problem is given by

$$\max_{e_{i,kt-1}} \left[\sum_k \sum_j \left(\frac{w_{j,kt} s_{i,kt}}{\mu_{ij,kt} P_{j,t}} \right) \right]^{\frac{1}{\kappa}}$$

subject to

$$\sum_k e_{i,kt-1} = \bar{e}$$

$$s_{i,kt} = s_{i,t} s^e_{i,kt}$$

and equation (68).

To solve this problem, substitute $s_{i,kt}$ into the maximization problem and set up the following Lagrangian

$$\mathcal{L} = \left[\sum_k \sum_j \left(\frac{w_{j,kt} e^{\varphi_1}_{i,kt-1} L^{\varphi_2}_{i,kt-1}}{\mu_{ij,kt} P_{j,t}} \right)^{\kappa} \right]^{\frac{1}{\kappa}} - \lambda \left(\sum_k e_{i,kt-1} - \mathcal{E} \right).$$

The first order conditions gives

$$\frac{1}{\kappa} \left[\sum_k \sum_j \left(\frac{w_{j,kt} e^{\varphi_1}_{i,kt-1} L^{\varphi_2}_{i,kt-1}}{\mu_{ij,kt} P_{j,t}} \right)^{\kappa} \right]^{\frac{1}{\kappa}-1} \sum_j \left(\frac{w_{j,k't}}{\mu_{ij,k't} P_{j,t}} \right)^{\kappa} \times \kappa \varphi_1 e^{\varphi_1 \kappa - 1}_{i,kt-1} L^{\varphi_2 \kappa}_{i,kt-1} = \lambda, \forall k$$

Letting

$$\Xi^{\kappa}_{i,kt} = \sum_j \left(\frac{w_{j,k't}}{\mu_{ij,k't} P_{j,t}} \right)^{\kappa},$$

and taking the ratio of the FOC for k and k', we obtain:

$$\frac{\Xi^{\kappa}_{i,kt} e^{\varphi_1 \kappa - 1}_{i,kt-1} L^{\varphi_2 \kappa}_{i,kt-1}}{\Xi^{\kappa}_{i,k't} e^{\varphi_1 \kappa - 1}_{i,k't-1} L^{\varphi_2 \kappa}_{i,k't-1}} = 1$$

$$\frac{\Xi^{\kappa}_{i,kt} L^{\varphi_2 \kappa}_{i,kt-1}}{\Xi^{\kappa}_{i,k't} L^{\varphi_2 \kappa}_{i,k't-1}} = \frac{e^{1-\varphi_1 \kappa}_{i,kt-1}}{e^{1-\varphi_1 \kappa}_{i,k't-1}}$$

$$\frac{e_{i,kt-1}}{e_{i,k't-1}} = \frac{L^{\varphi_2 \kappa/(1-\kappa\varphi_1)}_{i,kt-1}}{L^{\varphi_2 \kappa/(1-\kappa\varphi_1)}_{i,k't-1}} \frac{\Xi^{\kappa/(1-\kappa\varphi_1)}_{i,kt}}{\Xi^{\kappa/(1-\kappa\varphi_1)}_{i,k't}}.$$

Substitute into the time constraint

$$e_{i,kt-1} + \sum_{k' \in K \setminus k} e_{i,kt-1} \frac{L_{i,k't-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,k't}^{\kappa/(1-\kappa\varphi_1)}}{L_{i,kt-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,kt}^{\kappa/(1-\kappa\varphi_1)}} = \bar{e}.$$

Isolating $e_{i,kt-1}$, we obtain

$$e_{i,kt-1} = \bar{e} \frac{L_{i,kt-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,kt}^{\kappa/(1-\kappa\varphi_1)}}{\sum_{k'} L_{i,kt-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,k't}^{\kappa/(1-\kappa\varphi_1)}}.$$

Using the expression above, the knowledge obtained through learning investments can thus be written as

$$\begin{aligned} s_{i,kt} &= s_{i,t} s_{i,kt}^{e} \\ &= s_{i,t} e_{i,kt-1}^{\varphi_1} L_{i,kt-1}^{\varphi_2} \\ &= s_{i,t} \bar{e}^{\varphi_1} \left[\sum_{k'} L_{i,kt-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,k't}^{\kappa/(1-\kappa\varphi_1)} \right]^{-\varphi_1} \Xi_{i,kt}^{\varphi_1 \kappa/(1-\kappa\varphi_1)} L_{i,kt-1}^{\varphi_2 \varphi_1 \kappa/(1-\kappa\varphi_1)} L_{i,kt-1}^{\varphi_2} \end{aligned}$$

After some tedious algebra, we can write knowledge as

$$s_{i,kt} = \tilde{s}_i L_{i,kt-1}^{\tilde{\beta}} \Xi_{i,kt}^{\tilde{\varphi}}$$

where $\tilde{s}_i \equiv s_i \left(\mathcal{E} / \sum_{k'} L_{i,kt-1}^{\varphi_2 \kappa/(1-\kappa\varphi_1)} \Xi_{i,k't}^{\kappa/(1-\kappa\varphi_1)} \right)^{\varphi_1}$, $\tilde{\beta} \equiv \varphi_2/(1-\kappa\varphi_1)$ and $\tilde{\varphi} \equiv \varphi_1 \kappa/(1-\kappa\varphi_1)$.

Suppose $\varphi_2 = 0$. Then

$$s_{i,kt} = \tilde{s}_i \Xi_{i,kt}^{\tilde{\varphi}}$$

where

$$\Xi_{i,kt}^{\kappa} = \sum_{j} \left(\frac{w_{j,k't}}{\mu_{ij,k't} P_{j,t}} \right)^{\kappa}$$

$$\tilde{s}_i = \mathcal{E} \frac{1}{\sum_{k'} \Xi_{i,k't}^{\kappa/(1-\kappa\varphi_1)}}$$

Workers in the origin would relate to $L_{i,kt-1}$ via $w_{i,kt}$.

SK Additional analysis of migration costs

To validate our migration costs, we proceed with two exercises. First, we compare the migration costs estimated in our regressions to a common approach used by the literature, which is based on the Head and Ries index. Specifically, to quantify migration costs between the west and the east in our model, we estimated equation 18 and recovered $\mu_{ss',t}$ from the fixed costs. An alternative approach is to disregard the sector dimension of the data,

aggregate up all the migration fluxes to the state level, and compute the Head and Ries index given by:

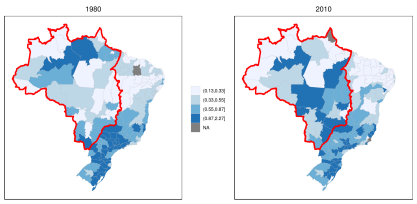
$$HR_{ss',t} = \left(\frac{L_{ss',t}}{L_{ss,t}} \times \frac{L_{s's,t}}{L_{s's',t}} \right)^{-\frac{1}{2\kappa}}.$$

Unreported results show that migration costs between regions based on the formula above give results that are extremely close to the ones obtained from the fixed effect approach that we adopted, with a correlation of 0.98. It shows that the results that we obtain are similar to the ones that would be obtained using a common approach used in the literature. Figure compares (S.7) the migration costs estimated with our regression approach with the Head and Ries index.

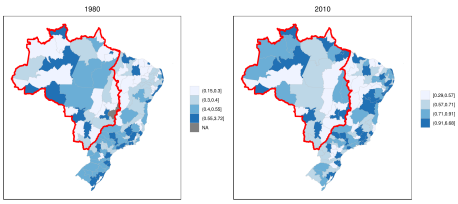
SL Supplementary Appendix Figures and Tables

Figure S.1: Calibrated Wedges: Productivities Relative to Foreign

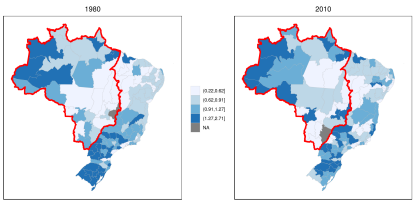
(a) Services



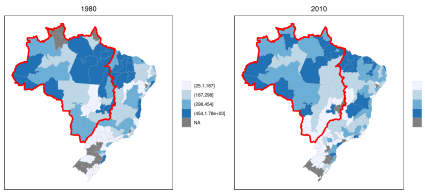
(b) Manufacturing



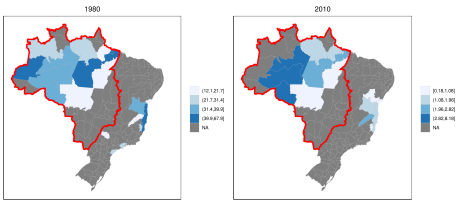
(c) Rest of Agriculture



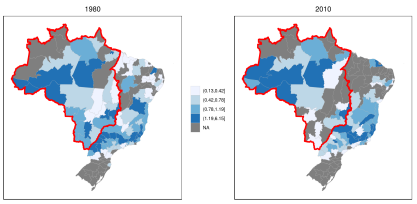
(d) Banana



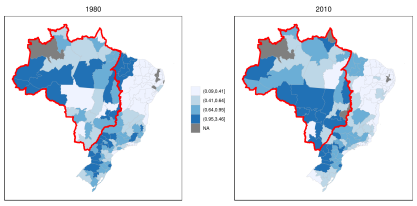
(e) Cacao



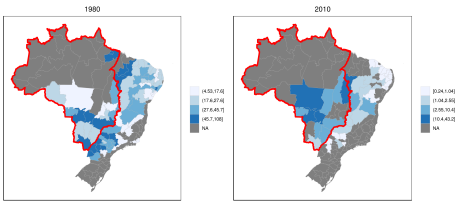
(f) Coffee



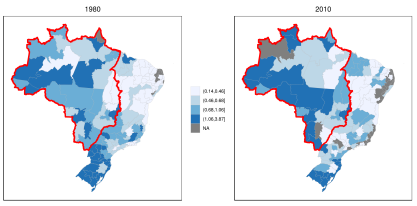
(g) Corn



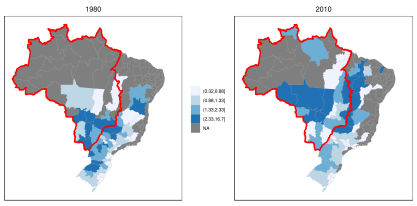
(h) Cotton



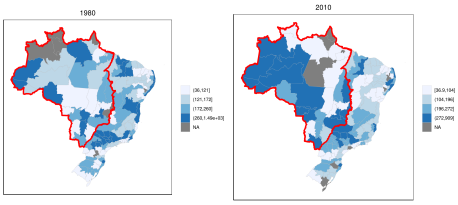
(i) Rice



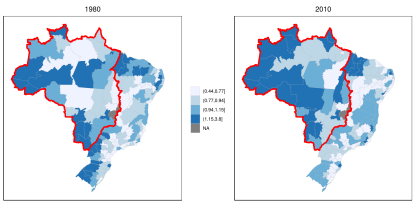
(j) Soy



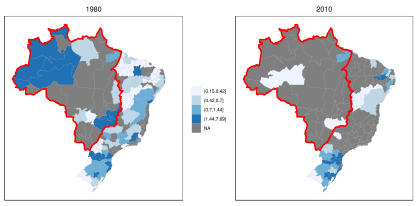
(k) Sugarcane



(l) Beef



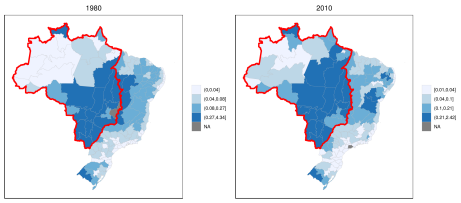
(m) Tobacco



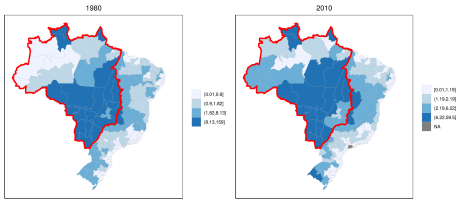
Notes: The figure plots calibrated values of exogenous productivity, $A_{i,k}$, in each region relative to that of Foreign, in a given year.

Figure S.2: Calibrated Wedges: Land Production

(a) Land Production Productivity relative to Foreign



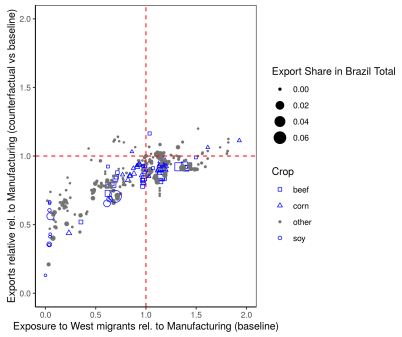
(b) Land to Labor relative to Foreign



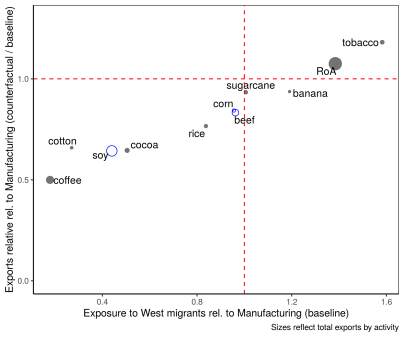
Notes: Panel (a) plots calibrated values of exogenous land production productivity, g_i, in each region relative to that of Foreign, in a given year. Panel (b) plots the observed land to labor ratio in each region relative to that of Foreign.

Figure S.3: Counterfactual Changes for 1980

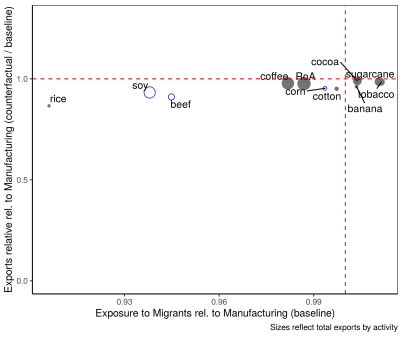
(a) Regional, 1980



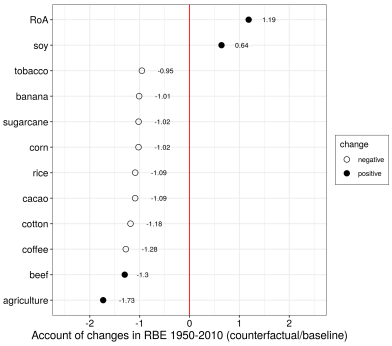
(b) West, 1980



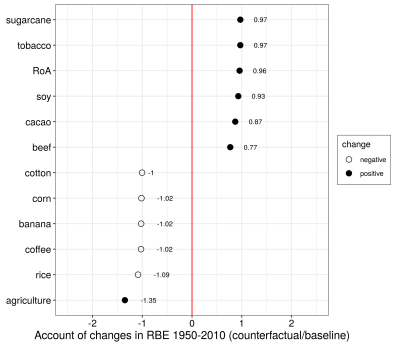
(c) Brazil, 1980



(d) West, 1980



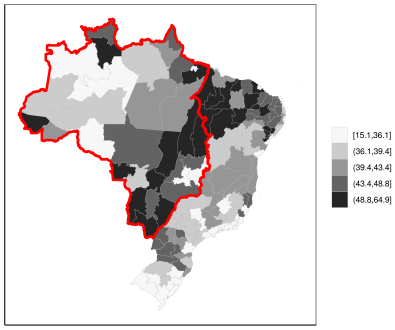
(e) Brazil, 1980



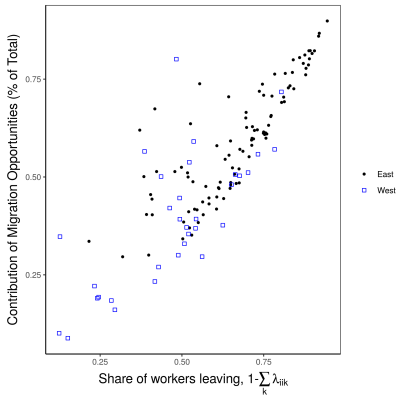
Notes: See the notes of Figures 5, 6, and 7.

Figure S.4: Comparative Advantage, Migration, and the Losses from Autarky, 1980

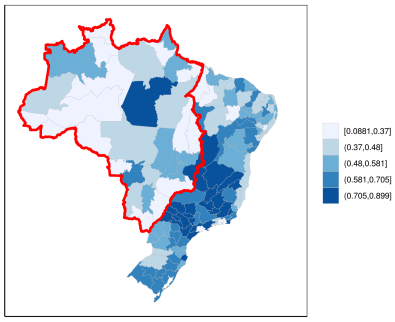
(a) The Losses from Autarky



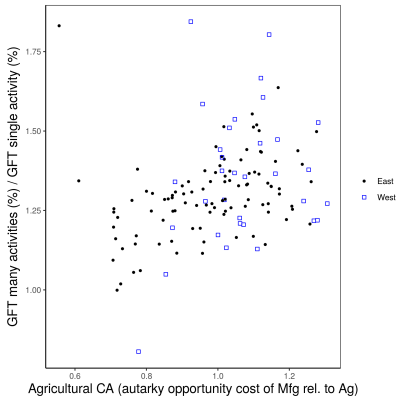
(b) The Contribution of Migration Opportunities



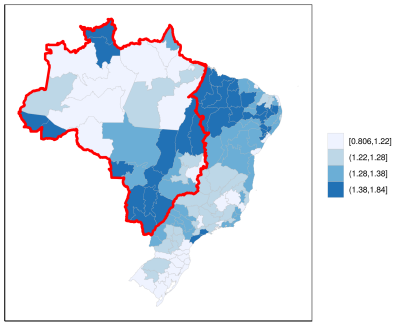
(c) The Contribution of Migration Opportunities



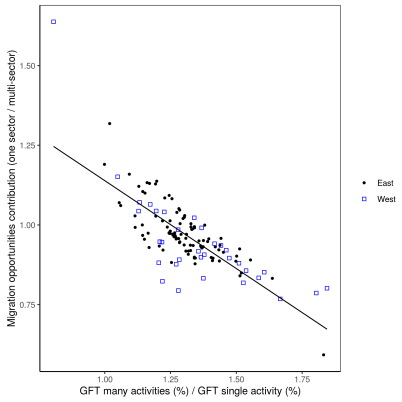
(d) The Contribution of Comparative Advantage



(e) Mapping the Contribution of Comparative Advantage



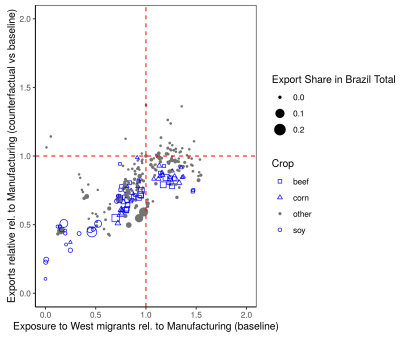
(f) Mapping the Contribution of Comparative Advantage



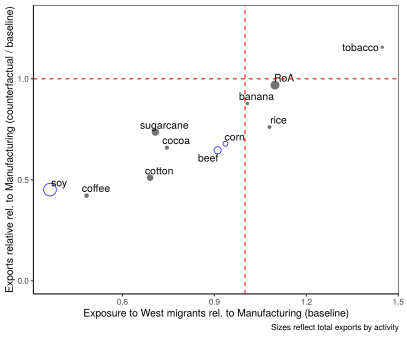
Notes: All simulations are for 1980 and each observation is a region. Panel (a) shows the welfare losses from letting each region go to full trade autarky. Panel (b): The horizontal axis the fraction of workers leaving that region in the baseline simulation. The vertical axis measures the ratio of the welfare cost that results solely from migration opportunities (i.e. setting the domestic contribution to zero) to the total costs. Panel (c): See description for Panel (b). Panel (d): The vertical axis plots the ratio of the losses from autarky in a single-sector version of our model to those in our multi-sector model, showing how the losses increase due to intersectoral heterogeneity. The horizontal axis shows the autarky opportunity cost of manufacturing relative to agriculture. Panel (e) shows the horizontal axis in Panel (d). Panel (f): The vertical axis is the same as in in Panel (d). The horizontal axis shows the change in the contribution of migration opportunities in going from a one-sector to a multi-sector version of our model.

Figure S.5: Knowledge as a function of Employment Shares

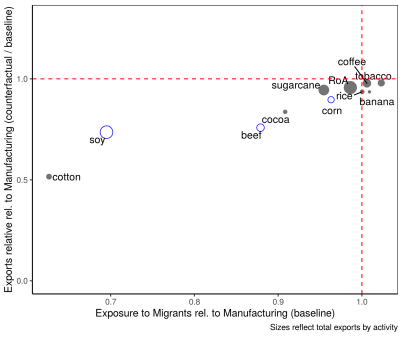
(a) Regional, 2010



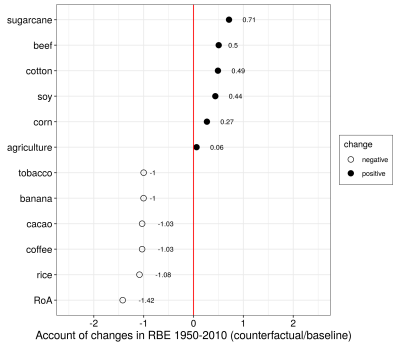
(b) West, 2010



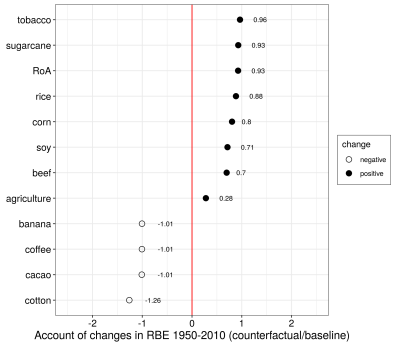
(c) Brazil, 2010



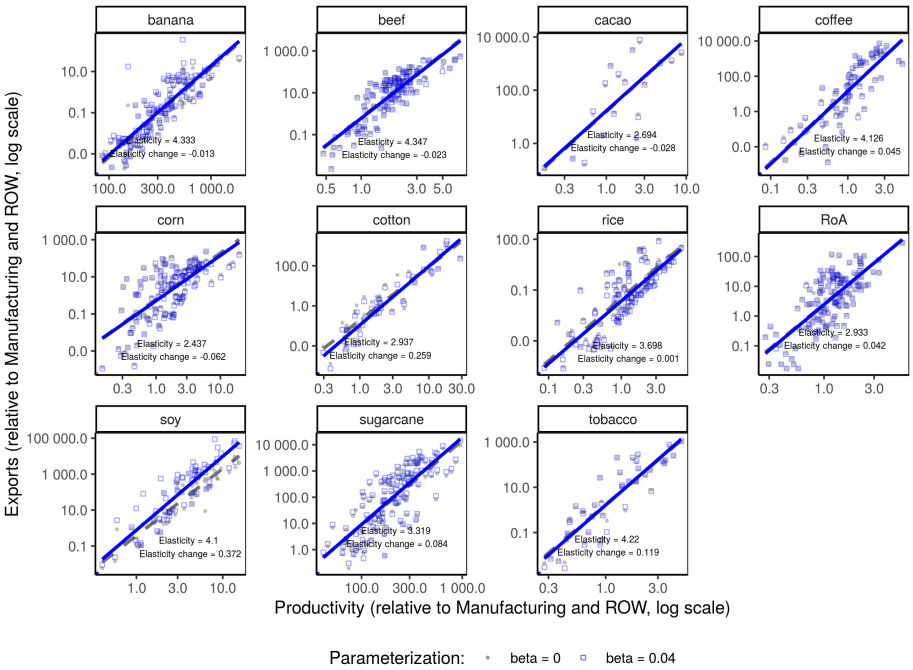
(d) West, 2010



(e) Brazil, 2010

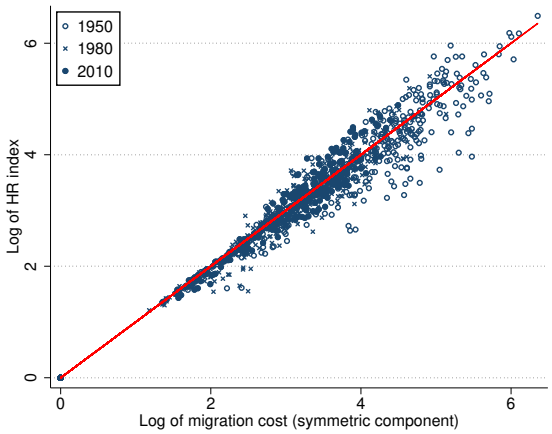


(f) Steady State



Notes: The figures present our main results in a calibration where $s_{i,k} = \bar{s}\left(L_{i,kt-1}/L_{iAg,t-1}\right)^{\beta}$

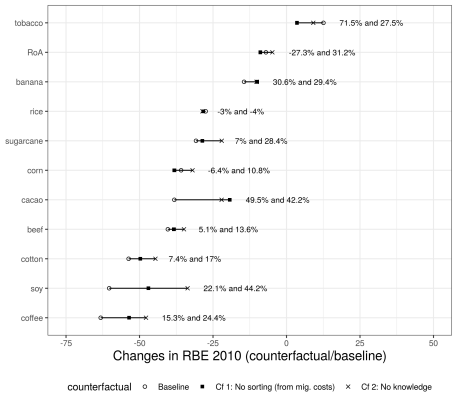
Figure S.7: Comparing Migration Costs Estimated from Fixed Effect Regressions with Head and Ries



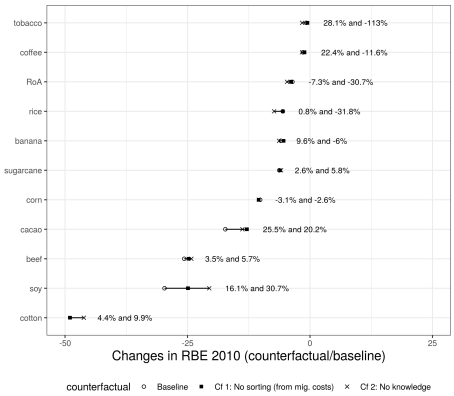
Notes. We estimate migration costs in our model based on origin-destination fixed effects in gravity regressions in which we have origin-destination-activities flows. Here, we compare the results from our estimates with the Head and Ries estimates of migration costs if we aggregate the data at the origin-destination level. The figure shows that both methods generate quite similar values.

Figure S.6: Measuring the Contribution of Knowledge (2010) - $\beta = 0.08$

(a) In the West



(b) In Brazil



Notes: Each row is an activity aggregate. The hollow circle presents the counterfactual change in export specialization in our baseline calibration, which targets state-state-employment flows. The cross presents the counterfactual change in specialization in a calibration that targets state-state migration and state-activty employment, separately. The square corresponds to a calibration in which, additionally, $\beta = 0$. For each activity we present the drop in each calibration relative to the baseline, as a percentage. Panel (a) presents results for the West; Panel (b), for the Brazil as a whole.

Table S.1: Evolution of Revealed Comparative Advantage

	Brazil			East	West
	1950	1980	2010	2010	2010
	(1)	(2)	(3)	(4)	(5)
banana	1.92	1.29	0.36	0.43	0.00
cacao	17.08	14.98	1.26	1.51	0.01
coffee	35.42	17.58	15.34	18.33	0.29
corn	1.53	0.34	6.70	2.23	29.22
cotton	2.96	0.50	5.72	3.93	14.76
beef	2.43	3.17	9.53	5.95	27.59
rice	0.59	0.27	1.35	1.59	0.15
soy	0.00	15.33	22.56	15.14	59.96
sugarcane	3.35	6.08	29.03	33.21	7.97
tobacco	1.48	4.07	6.37	7.63	0.00
rest of agriculture	0.71	1.66	1.69	1.77	1.30
agriculture	3.37	3.71	4.47	4.06	6.55
manufacturing	0.27	0.63	0.73	0.76	0.57

Notes: This table shows the evolution of revealed comparative advantage as measured by the Balassa index:

$$RCA_{i,k} = \frac{X_{i,k}/\sum_k X_{i,k}}{\sum_i X_{i,k}/\sum_i \sum_k X_{i,k}},$$

where $X_{i,k}$ are exports from country i in activity k.