Internal Migration, Sectoral Reallocation, and Large Devaluation*

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Abstract

How do internal migration and its frictions affect sectoral labor reallocation after large devaluations? I provide empirical evidence on relative increases in labor reallocation to more export-intensive sectors and in migration inflows to more export-oriented regions following the 1998 South Korean devaluation, which suggests that sectoral labor reallocation and migration could have been interlinked. To quantify effects of migration frictions on transitional dynamics after the devaluation, I build a dynamic spatial model of migration, investment, and trade. I find that higher migration frictions lead to less sectoral labor reallocation, and lower growths in aggregate export intensity and real GDP.

Keywords: devaluation, migration, sectoral reallocation, trade
JEL Codes: F16, F31, R23

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1 Introduction

When hit by sector-specific shocks, any barriers to sectoral reallocation of labor hinder workers from flexibly reallocating across sectors and decrease the aggregate efficiency of an economy.[1] Understanding spatial aspects of these barriers can be important because many sectors tend to be geographically concentrated in a few regions.[2] When sectors are geographically concentrated, workers may have to migrate to other regions to reallocate themselves into different sectors, and any frictions in internal migration can decrease amounts of sectoral reallocation of workers accompanied by such migration.

This paper studies how internal migration and its frictions affect sectoral reallocation of labor after large devaluations. I use South Korean data after that country's 1998 devaluation episode. I make two contributions. First, I provide novel empirical findings on the short-run local labor market adjustment to transitory trade shocks induced by the devaluation: increased reallocation of labor to more export-intensive sectors within regions and increased migration flows to regions whose industrial composition was more export-intensive. Second, motivated by these empirical findings, I build a model to quantify how an economy would have adjusted differently to the same devaluation episode depending on the levels of migration frictions.

Large devaluations are associated with a large depreciation of the real exchange rate that boosts exports by making prices of domestic goods in foreign markets cheaper. After large devaluations, higher efficiency can be achieved if labor can be flexibly reallocated to more export-intensive sectors that experience relatively larger increases in exports. However, when these export-intensive sectors are geographically concentrated, migration frictions may hinder reallocation of labor to these sectors through the migration channel. Migration frictions can work as even bigger barriers in emerging market economies in which large devaluations occur more frequently and migration frictions are known to be higher than those of developed economies.[3]

I document two empirical patterns after the devaluation. First, there were relatively larger increases in exports among more export-intensive sectors. Second, these export-intensive sectors were highly concentrated in a few regions. Due to this geographical concentration, there was substantial cross-sectional variation in regional export intensity, defined as the weighted average of sectoral export intensity, where the weights are given by employment shares in the initial period. I refer to regions with higher regional export intensity as more export-oriented regions.

Exploiting cross-sectional variation in the regional export intensity and event-study specifications, I provide two causal empirical findings which I call sectoral reallocation of labor within regions and spatial reallocation of labor across regions. I find relative increases in reallocation of workers to more

[1] Many economists and policymakers have studied barriers to sectoral reallocation of labor to improve labor market flexibility. See, for example, Heckman and Pages (2000), Wacziarg and Wallack (2004), Kambourov (2009), Helpman et al. (2010), Menezes-Filho and Muendler (2011) Petrin and Sivadasan (2013), and Cosar et al. (2016).

[2] See Ellison and Glaeser (1997) for geographic concentration of manufacturing sectors in the US.

[3] For example, Bryan and Morten (2019) document higher internal migration frictions in Indonesia than in the US. They find that if Indonesia's migration frictions were at the US level, the aggregate labor productivity of Indonesia would increase by 7.1%.

export-intensive sectors in more export-oriented regions after the devaluation (sectoral reallocation within regions). I also find relative increases in migration inflows to more export-oriented regions (spatial reallocation across regions). The documented patterns and the empirical findings suggest that sectoral and spatial reallocation of labor could have been interlinked through migration after the devaluation.

For sectoral reallocation, I regress region-sector employment shares in the top five most export-intensive manufacturing sectors (the top five sectors) on regional export intensity interacted with event-time dummies while controlling for region and year fixed effects. For spatial reallocation, I similarly regress migration inflows at the pair level on the regional export intensity of destination regions interacted with event-time dummies while controlling for origin-year and pair fixed effects. I find that two years after the devaluation, the employment shares in the top five sectors and migration inflows of a region increased by 3.6% and 4.8% more, respectively, relative to another region with one standard deviation lower regional export intensity. For both event specifications, there were no pre-trends, implying that more export-oriented regions did not exhibit differential trends in these employment shares and migration flows in the years leading up to the devaluation.

Second, guided by the two empirical findings, I build a multi-sector, multi-region dynamic trade and spatial general equilibrium model with forward-looking migration and investment. Regions and sectors are interconnected through costly interregional trade and input-output (IO) linkages. South Korea is a small open economy, and the devaluation is modeled in a reduced-form fashion as four exogenous time-varying shocks: productivity, foreign demand, import price, and trade deficit shocks. These four shocks rationalize a big drop in total factor productivity (TFP), an expansion of exports, a collapse in imports, and a rapid decline in trade deficits that are common features of emerging market economies after large devaluation episodes as studied in the previous literature.[4]

There are two agents in the model: workers and landlords. In each period, workers make decisions on which sectors to work in (sectoral labor supply) and where to live (migration). Workers have a continuum of members. Each member receives idiosyncratic labor productivity shocks across different sectors. Given region-sector wages and members' idiosyncratic labor productivity shocks, workers optimally allocate their members across different sectors to maximize the total sum of wages of their members, similar to the Roy model of sector choice (Lagakos and Waugh, 2016; Hsieh et al., 2019). These decisions determine sectoral labor supply within regions conditional on population. The migration decisions are modeled as a dynamic discrete choice (Artuc et al., 2010; Caliendo et al., 2019). When households make location decisions, they consider real income, amenities, option values of being in one region, and migration frictions measured in terms of utility. Landlords are geographically immobile and make forward-looking investment decisions for accumulation of local capital from which they earn capital income (Kleinman et al., 2021).

[4]See Kehoe and Ruhl (2008) and Queralto (2020) for big TFP drops; Alessandria et al. (2010), Gopinath and Neiman (2014) and Blaum (2018) for large changes in imports and exports; and Kehoe and Ruhl (2009) for rapid changes in trade deficits in emerging market economies after different large devaluation episodes.

In the model, aggregate sectoral employment is determined by region-sector employment shares and population distribution across regions. Workers' sectoral labor supply decisions characterize region-sector employment shares governed by the elasticity of region-sector employment shares to region-sector wages. Workers' migration decisions characterize population distribution across regions, governed by the elasticity of migration outflow shares to the discounted lifetime utilities net of migration frictions.

Higher foreign demands due to the devaluation can increase aggregate employment in export-intensive sectors through their influences on both region-sector employment shares and population distribution. Because higher foreign demands relatively increase wages of more export-intensive sectors within regions, workers allocate more members to these export-intensive sectors, consistent with the first empirical finding. Also, because higher foreign demands increase the average real income in more export-oriented regions, more workers migrate to these regions, consistent with the second empirical finding. However, despite higher real income in these regions, if migration frictions are sufficiently high, workers may opt to stay in their initial locations instead of moving.

The model is calibrated to data at the region-sector level. I derive two regression models from the model and estimate the two key structural elasticities related to the two decisions of workers. When estimating these regression models, I use the instrumental variable (IV) strategy. The IVs for both regression models exploit similar identifying variation to the two empirical findings: the cross-sectional variation in the sectoral and regional export intensities of the initial period interacted with a dummy of the post-devaluation periods. The identifying assumptions of these IV strategies are that demand shocks due to the devaluation's expansionary effects on exports are uncorrelated with shocks to other fundamentals conditional on controls.

I calibrate the exogenous shocks by fitting the quantitative model to the observed data. The productivity shocks are identified from region-sector gross output, sectoral producer price indices, and aggregate real gross domestic products (GDP) growth; the foreign demand shocks from sectoral exports; the import price shocks from sectoral import shares; and the exogenous trade deficits directly from the observed trade data.

Using this model, I evaluate how the economy would have adjusted differently, and how its transitional dynamics would have differed, in response to the same calibrated devaluation shocks depending on levels of migration frictions. To do so, I compare the transition paths of the baseline economy, whose migration frictions are consistent with observed migration flows in the data, and with those of the counterfactual economies, in which migration frictions temporarily differ from those of the baseline only up to 2002, four years after the devaluation, and move back to the original level in 2003. I perform the comparison while feeding the same devaluation shocks.

I construct the counterfactual economies by feeding temporary migration friction shocks. I consider hypothetical temporary changes in migration frictions similar to Bryan and Morten (2019) rather than specific policies, but these hypothetical changes can be potential outcomes of migration policies .[5] By focusing on temporary rather than permanent changes, I consider a set of more realistic policy options for policymakers after large devaluations because policies with permanent reductions can be more costly to implement. Also, I can focus on the effects of migration frictions on short-run adjustment and transitional dynamics rather than their long-run consequences.

I indirectly infer migration frictions from the observed migration flows (Head and Ries, 2001) and compute the empirical distribution of reductions in migration frictions between 1996 and 2016. I find that there were 5% reductions at the median of this distribution. As in Monte et al. (2018), I use this distribution to compute empirically-plausible changes in migration frictions. I consider five counterfactual scenarios. In the first scenario, migration is not allowed. In the second and third scenarios, I consider common decreases and increases by the median of the empirical distribution for all migration flows. In the fourth scenario, I consider selective decreases by the median only for migration flows to more export-oriented regions. In the final scenario, I consider reductions in components of migration frictions predicted by a bilateral index of regional conflicts. In all scenarios, migration frictions temporarily differ and return to the original level in 2003.

I quantitatively find that migration frictions affect the adjustment of the economy at regional and aggregate levels to the same devaluation episode. In the baseline, between 1997 and 2000, growths in the aggregate employment shares in the top five sectors, the aggregate export intensity, and real GDP were 1.5, 14.9, and -1.1%, respectively. As the baseline is fitted to the data, these numbers are as reported in the data. However, if migration were temporarily not allowed, two years after the devaluation, when compared with the baseline, fewer workers were reallocated to more export-intensive sectors and growth in the aggregate employment shares in the top five sectors would have been 1.2 percentage points lower, which leads growths in aggregate export intensity and real GDP growth to be lower by 1.5 percentage points and 0.3 percentage point, respectively. These aggregate effects were mostly driven by changes in population distribution due to increased migration inflows to more export-oriented regions rather than by changes in region-sector employment shares.

With the temporary reductions by the empirically-plausible level or by components predicted by the regional conflict index, the counterfactual economies had larger amounts of reallocation to more export-intensive sectors, which led to higher growths in aggregate export intensity and real GDP relative to the baseline. Although the counterfactual with the common decreases had higher average migration rates due to lower frictions, the counterfactual with the selective decreases had highest growths in aggregate export intensity and real GDP between 1997 and 2000, which were 1.2 percentage points and 0.2 percentage point higher relative to the baseline. This indicates that both levels and directions of reductions in migration frictions are important to achieve higher aggregate exports and real GDP growth.

My quantitative exercises can be useful for policymakers, given that many real-world policies target observed outcomes, such as aggregate export intensities and real GDP growth, and given

[5] For specific policies, see Tombe and Zhu (2019), Fan (2019), and Hao et al. (2020).

that these exercises are informative on how migration policies with temporary reductions affect these objects of policymakers after large devaluations.[6] My quantitative findings suggest that after large devaluations, migration policies can be one of the policy options for policymakers to stimulate economic growth and exports in emerging market economies.

Related literature This paper contributes to several strands of the literature. First, this paper is related to the literature on labor mobility and shock propagation (see, among many others, Blanchard and Katz, 1992; Fogli et al., 2012; Monras, 2015; Cadena and Kovak, 2016; Caliendo et al., 2018; House et al., 2020; Monras, 2020). My findings resonate with the previous papers that find that migration smooths out various types of different shocks. However, unlike the previous papers, I study how migration affects sectoral reallocation of labor at both aggregate and regional levels when an economy gets hit by large sectoral shocks. By exploring quantitative aspects of migration frictions, this paper is also related to the literature that quantifies the effects of internal migration frictions (see, for example, Morten and Oliveira, 2018; Lagakos et al., 2018; Fan, 2019; Tombe and Zhu, 2019; Hao et al., 2020; Imbert and Papp, 2020; Ma and Tang, 2020; Brinatti and Morales, 2021; Pellegrina and Sotelo, 2021; Nakamura et al., 2022). Unlike previous studies that quantify long-run consequences of migration frictions, I quantify the effects of migration frictions on transitional dynamics using the quantitative dynamic spatial equilibrium model.

Second, I contribute to the large literature on local labor market adjustment to trade shocks (see, among many others, Topalova, 2010; Autor et al., 2013; Kovak, 2013; Adão, 2015; Hakobyan and McLaren, 2016; Dix-Carneiro and Kovak, 2017, 2019; Benguria et al., 2018; Kondo, 2018; Bloom et al., 2019; Greenland et al., 2019; Artuc et al., 2021; Kim and Vogel, 2021; Lake and Liu, 2021; Adão et al., 2022). Unlike previous papers that study more persistent trade shocks such as commodity super-cycles, the China shock, and trade liberalization episodes, I contribute to this literature by providing novel empirical findings on relatively short-run sectoral and spatial adjustment of the local labor market to the transitory trade shocks induced by the devaluation.[7]

Third, I contribute to the literature that studies consequences of large devaluations, surveyed by Burstein and Gopinath (2014) (see, for example, Burstein et al., 2005, 2007; Cravino and Levchenko, 2017; Blanco et al., 2019; Bonadio et al., 2020; Auer et al., 2022). Related to big trade changes after the devaluation, Alessandria et al. (2010) study inventory behavior of importers and trade

[6] Related to the policy objects of policy makers, after the currency crisis occurred, President Kim of South Korea emphasized–in his second televised presidential address in 1998–that exports are only solutions for the current situation: "The crisis is far from over, without easy solutions. Fundamental solutions would be to boost exports and attract foreign direct investments." See Kim (1998).

[7] There is mixed empirical evidence on how internal migration flows respond to trade shocks. For example, Autor et al. (2013) and Adão et al. (2022) find limited evidence of changes in internal migration flows in response to the China shock in the US; Adão (2015) and Benguria et al. (2018), in response to the commodity price shocks in Brazil; and Topalova (2010) and Dix-Carneiro and Kovak (2017), in response to the trade liberalization episodes in India and Brazil. That said, Greenland et al. (2019) find increased migration flows among young or less-educated workers into regions less exposed to the China shock in the US, and Hakobyan and McLaren (2016) find that migration outflows of high school dropouts increased from regions negatively affected by NAFTA.

dumpiness; Gopinath and Neiman (2014) large TFP drops due to collapses of imports; Blaum (2018) joint import and export decisions of large firms; and Alessandria et al. (2020) and Kohn et al. (2020) firm-level export dynamics. Unlike these papers, I examine local labor market adjustment margins to the devaluation.

Structure The structure of this paper is as follows. Section 2 describes the data used for the empirical and quantitative analysis and the background on the 1998 South Korean large devaluation episode. Section 3 presents empirical evidence on sectoral and spatial reallocation of labor after the devaluation. In Section 4, I build a quantitative model to quantify the effects of migration frictions. Section 5 concludes.

2 Data and Background

2.1 Data

The final data set has information on region-sector employment shares, gross output, real capital stock, region-to-region migration flows, regional population, sectoral trade, and other sectoral variables, with the sample period between 1995 and 2002. I aggregate data to 121 regions and 15 sectors. Region-sector gross output, capital stock, and other sectoral variables are used only for the quantitative analysis. See Online Appendix Section A for more details on the construction of the final data set.

Region-sector employment shares I construct region-sector employment shares from the Census on Establishment which covers the universe of formal establishments with one or more employees in South Korea at a finely disaggregated geographic level for all sectors.[8] The data set has information on geographical locations, sectors, and employment of establishments. I compute region-sector employment shares by summing up employment across establishments within region-sectors and dividing the sum by total regional employment.

Region-to-region migration flows and regional population I obtain data sets on the number of internal migrants between regions and on regional population from Statistics Korea. I calculate migration flows as the total number of migrants between origin and destination regions divided by lagged populations of origin regions.

Sectoral trade and Input-Output tables I obtain sectoral import and export data and IO tables between 1995 and 2002 from the WIOD and, before 1995, from the Bank of Korea. I aggregate countries except for South Korea as the rest of the world.

Region-sector gross output and capital stock I construct region-sector gross output by combining the Census of Establishment and the IO tables from the WIOD 2013 release (Timmer et al.,

[8]The Census on Establishment covers the universe of formal establishments with one or more employees except for agriculture, forestry, and fisheries businesses by individual owners and establishments related to national defense, housekeeping service, and international and foreign organizations. On average, approximately 2.9 million establishments are covered by this data set across the sample period.

Table 1: Descriptive Statistics

Variable	Mean	SD	Median
Top five mfg. emp. share	0.17	0.14	0.12
Overall mfg. emp. share	0.25	0.15	0.22
Outflow migration rate	0.12	0.03	0.12

Notes. This table reports the descriptive statistics of the data set. There are 15 sectors and 121 regions. The sample period is between 1995 and 2002.

2015). I allocate sectoral gross output from the WIOD across regions using region-sector employment shares obtained from the Census of Establishment.

I construct region-sector real capital stock by combining the Census of Establishment, the Mining and Manufacturing Survey, the WIOD Socio–Economic Accounts (WIOD-SEA), and the International Monetary Fund (IMF) Investment and Capital Stock Database (IMF-ICSD). I allocate the aggregate real capital stock series from the IMF-ICSD across sectors based on the sectoral nominal capital stock series from the WIOD-SEA. For the manufacturing sectors, I calculate region-sector nominal capital stock by summing fixed assets across establishments within region-sectors, which come from the Mining and Manufacturing Survey.[9] Then I allocate region-sector real capital stock using the calculated region-sector nominal capital stock for manufacturing sectors and the region-sector employment shares for non-manufacturing sectors.

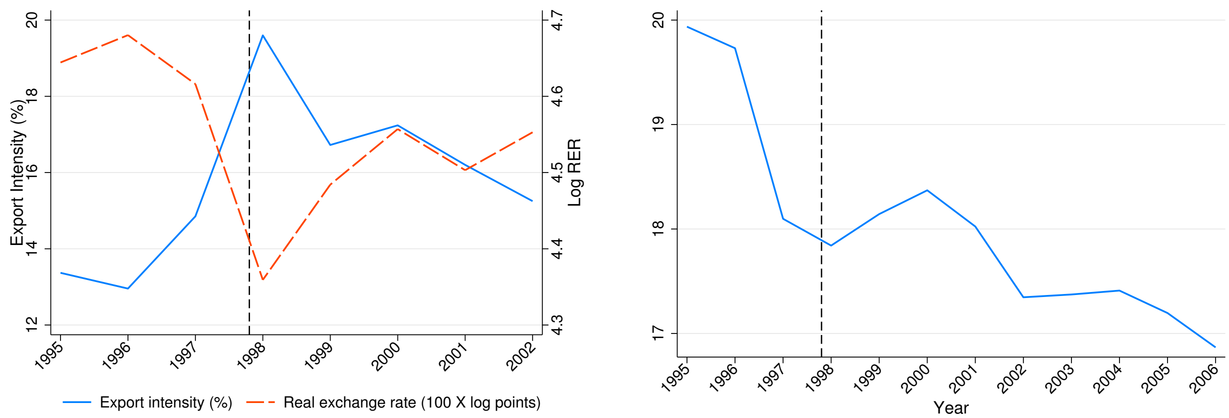
Other sectoral data I obtain sectoral producer price indices (PPI) and real gross output from the OECD STAN database.

Descriptive statistics Table 1 reports the descriptive statistics of the final data set. The average employment shares in the five most export-intensive and overall manufacturing sectors were 17% and 25%, respectively. On average, 12% of people moved to different regions annually. When aggregating 121 regions up to 16 states that are more comparable with the average land size of US counties, the average outflow rate is 7.2%, which is about 1 percentage point higher than the annual inter-county migration rates (Molloy et al., 2011).[10]

[9]The Mining and Manufacturing Survey covers the universe of formal establishments with more than five employees in the mining and manufacturing sectors, which are a subset of the Census of Establishment. However, when compared with the Census of Establishment, the Mining and Manufacturing Sector Survey has more detailed establishment-level variables, such as fixed assets and wage bills.

[10]The median of the geographical size of the spatial unit is 236mi^2 (612km^2), which is 38% of the median of the geographical size of US counties based on the 2000 US census. South Korea is about the same size as Indiana in the US.

Table 2: Aggregate Export Intensity and Employment Shares around the Devaluation



A. Aggregate export intensity (%) B. Aggregate top five mfg. share (%)

Notes. Panels A and B plot the aggregate export intensity and the aggregate employment shares in the top five most export-intensive sectors. The vertical dashed line plots the year of the devaluation. The red dotted line is the log real exchange rate.

2.2 Export Patterns after the 1998 South Korean Large Devaluation Episode

The large devaluation occurred in South Korea in December 1997. The real exchange rate depreciated by 26%. The devaluation was contractionary, which led annual real GDP growth of South Korea to decrease from 5.2% to negative 5.8% in one year. However, despite this sharp drop in real GDP, because of the depreciated exchange rate, the aggregate export intensity increased from 15% in 1997 to 19% in 1998 and remained around 2 percentage points higher several years after the occurrence (Panel A of Figure 2).

Consistent with the sharp rise in export intensity, there was modestly increased reallocation of labor to more export-intensive sectors at the aggregate level. Panel B plots the aggregate employment shares in the top five most export-intensive sectors. Despite decreasing trends in manufacturing employment shares due to structural change, two years after the devaluation occurred, the aggregate employment shares in the top five manufacturing sectors increased by 1.5%. I later show that these aggregate outcomes mask large regional heterogeneity and spatial linkages across regions through migration and play a quantitatively important role in shaping these aggregate outcomes.

3 Empirical Evidence on Sectoral and Spatial Reallocation of Labor

In this section, I provide two causal empirical findings on sectoral and spatial local labor market adjustment to the devaluation: relative increases in reallocation of workers to more export-intensive sectors in more export-oriented regions (sectoral reallocation of labor within regions) and relative increases in migration inflows to more export-oriented regions after the devaluation (spatial reallocation of labor across regions). These two findings imply that sectoral and spatial reallocation of labor could have been interlinked.

Sectoral and regional heterogeneity Before conducting a formal empirical analysis, I begin by documenting two empirical facts: larger increases in exports among more export-intensive sectors and the geographical concentration of these sectors. Panel A of Figure 1 displays sectoral export intensity and shares of exports to total exports in 1993. This figure shows substantial variation in the export intensity across sectors, and manufacturing sectors were more export-intensive. Panel B plots changes in export intensities of the top five most export-intensive manufacturing sectors and the other remaining sectors around the devaluation.[11] For ease of comparison, I normalize the export intensities by the median between 1995 and 1997. The top five export intensity increased by 4.9 (2.2) percentage points more than the intensity of the other sectors in 1998 (in 2000) relative to 1997.[12]

The export-intensive sectors were geographically concentrated in a few regions. Panel C illustrates regional export intensity defined as the weighted average of the sectoral export intensities in Panel A, where the weights are given by employment shares in 1994[13]:

$$\mathrm{RegEX}_{nt_0} = \frac{\sum_j \mathrm{Emp}_{njt_0} \times \mathrm{SecEX}_{jt_0}}{\sum_j \mathrm{Emp}_{njt_0}}. \tag{3.1}$$

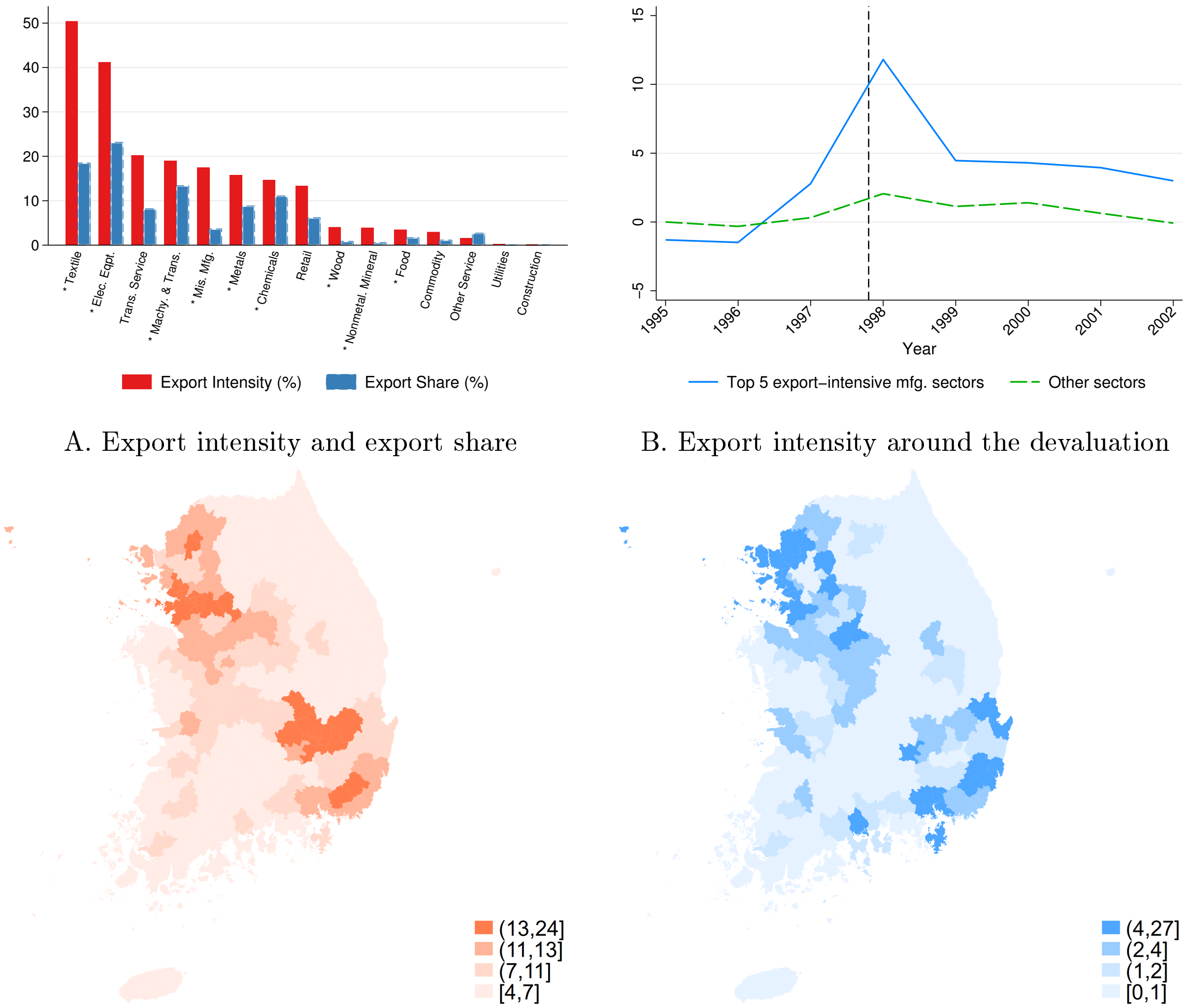
SecEX_{jt_0} is the sectoral export intensity, and Emp_{njt_0} is sector j's employment in region n. Regional differences in employment shares generate regional variation in RegEX_{nt_0}. The figure illustrates the substantial variation in the regional export intensity across regions and the geographical concentration of export-intensive sectors in the northwestern and southeastern regions. Also, Panel D illustrates that more export-oriented regions coincide with regions with higher top five employment shares. Together with the asymmetric expansionary effects on exports across sectors, this geographical concentration implies that the expansionary effects had differential effects across regions.

Sectoral reallocation of labor The differential expansionary effects on exports across sectors could have induced workers to reallocate to more export-intensive sectors. To formally show this reallocation, I exploit cross-sectional variation in the regional export intensity. I run the following

[11] I define the top five most export-intensive manufacturing sectors based on the export intensity plotted in Panel A, which includes textiles, electrical equipment, machinery and transportation equipment, metals, and chemicals. Although the miscellaneous manufacturing sector had higher export intensity than the machinery and transportation equipment, metal, and chemicals sectors, I did not include it as one of the top five sectors, because its export shares were low and its classification was ambiguous.

[12] Consistent with the increased export intensity, the aggregate value-added and gross output shares in the top five sectors increased from 22.8 to 25.7% and 35.3% to 39.5%, respectively, between 1997 and 2000. See Online Appendix Figure B9.

[13] The sectoral export intensity and region-sector employment shares are measured in different initial years because IO tables are reported in only 1993 and 1995, and the Census of Establishment begins in 1994.



A. Export intensity and export share

B. Export intensity around the devaluation

C. Regional export intensity

D. Top five mfg. emp share

Figure 1. Sectoral and Regional Heterogeneity in Export Intensity

Note. Panel A plots the sectoral export intensity and export shares in 1993. An asterisk * denotes manufacturing sectors. Panel B plots changes in the export intensities around the devaluation. The blue solid and green dashed lines are the export intensities of the top five most export-intensive manufacturing and the other remaining sectors, respectively. The export intensities are normalized by the median between 1995 and 1997 for both groups. Panels C and D plot the regional export intensity (Equation (3.1)) and the top five employment shares in 1994, respectively. Regions are colored based on the quartiles and colored darker with higher values.

event-study specification:

$$y_{nt} = \sum_{\tau=-3}^{7} \beta_\tau (D_t^\tau \times \text{RegEX}_{nt_0}) + \mathbf{X}_{nt}'\boldsymbol{\gamma} + \delta_n + \delta_t + \epsilon_{nt}, \tag{3.2}$$

where RegEX_{nt_0} is the standardized regional export intensity in the initial year and D_t^τ are event-time dummies: $D_t^\tau \equiv \mathbb{1}[\tau = t - 1998]$. y_{nt} The dependent variables, y_{nt}, are log of employment shares in the top five and the overall manufacturing sectors. δ_n and δ_t are region and year fixed effects, respectively. $\mathbf{X}_{nt}$ are regional time-varying observables in which I control for the interaction terms between the log of total employment in 1994 and year fixed effects. ϵ_{nt} is the error term. I normalize β_0 to be zero.

The aforementioned specification is based on a shift-share research design where the shares are the initial employment shares and the shifts are the interaction term between SecEX_{jt_0} and the event-time dummies that capture the larger export expansionary effects for more export-intensive sectors. Given that the expansionary effects were concentrated among a few sets of sectors and there are only 15 sectors in the data, my research design exploits differential exposure to the export shocks and the identifying assumption comes from the exogeneity of the initial shares to the changes in outcomes, the setting studied in Goldsmith-Pinkham et al. (2020).[14] Note that the identification comes from the interaction term between the event dummies and RegEX_{nt_0} rather than from the level differences in RegEX_{nt_0} that are absorbed out by region fixed effects.

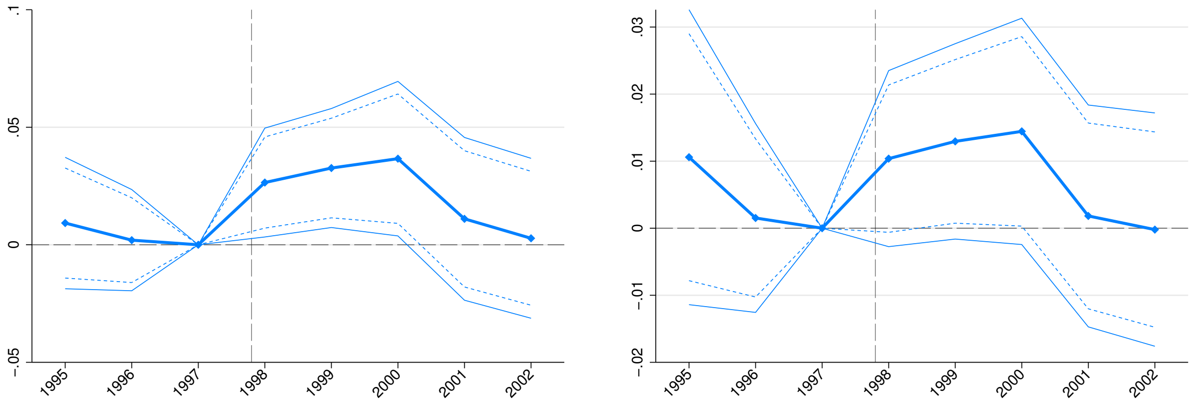
Figure 2 reports the results. Two years after the devaluation, the top five and overall manufacturing employment shares increased by 3.6% and 1.4% more in one region, respectively, relative to another region whose regional export intensity was one standard deviation lower. Also, more export-oriented regions did not exhibit pre-trends in these manufacturing shares, giving credence to the identifying assumption.

I also consider first-difference specifications for changes in outcomes between 1997 and 2000[15]:

$$\triangle y_{nt} = \beta \text{RegEX}_{nt} + \mathbf{X}_{nt}'\boldsymbol{\gamma} + \triangle \epsilon_{nt}. \tag{3.3}$$

[14] Goldsmith-Pinkham et al. (2020) show numerical equivalence between the two-stage least squares estimators using the Bartik-type instrument and a generalized method of moments estimators with the local shares as instruments and a weight matrix constructed from the national-level shocks. Instead of using the shift-share regressor as the IV, I use it in the reduced-form but the moment conditions are the same. Unlike Goldsmith-Pinkham et al. (2020), whose identifying assumption is achieved by the exogeneity of shares, Borusyak et al. (2022) study the identifying assumption where shocks are as-good-as-randomly assigned. The setting of Borusyak et al. (2022) requires a large number of sectors, which is not the case with my data. Adão et al. (2019) study issues in inference in the setup of Borusyak et al. (2022).

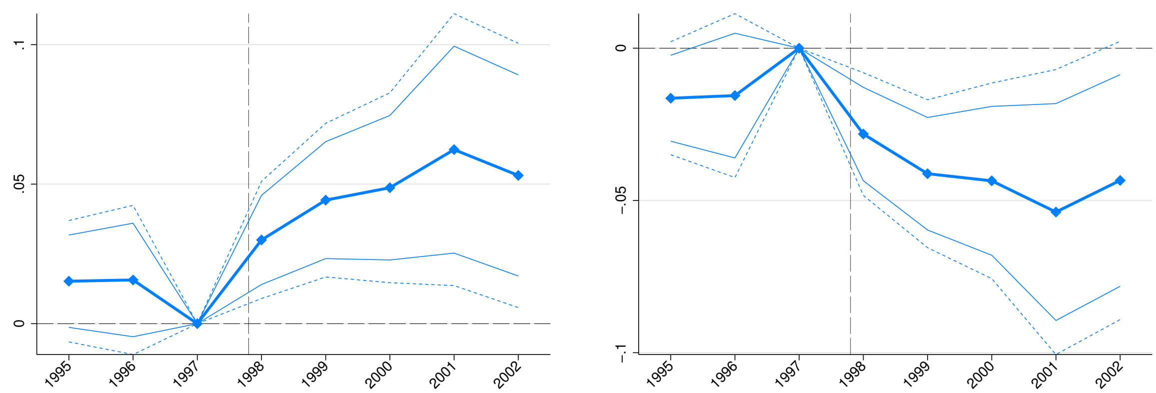
[15] As in the event study specification, I make it explicit that this first-difference specification captures differential exposure to the devaluation depending on RegEX_{nt_0} rather than the level differences. The specification is equivalent to estimating the following fixed effect specifications for years in 1997 and 2000: $y_{nt} = \beta \text{RegEX}_{nt} \times \mathbb{1}[t \geq 1998] + \tilde{\mathbf{X}}_{nt}'\boldsymbol{\gamma} + \delta_n + \delta_t + \epsilon_{nt}$. The identification comes from the interaction between RegEX_{nt} and the post-devaluation dummy, $\mathbb{1}[t \geq 1998]$, and the level differences are absorbed out by region fixed effects.



A. Top five mfg., RegEX$_{nt_0}$ B. Overall mfg., RegEX$_{nt_0}$

Figure 2. Event Study. Sectoral Reallocation of Labor. Increased Reallocation of Labor to More Export-Intensive Sectors within Regions

Note. This figure illustrates the estimated β_τ in Equation (3.2). In Panels A and B, the dependent variables are the log of the employment shares in the top five and all manufacturing sectors, respectively. RegEX is the regional export intensity defined in Equation (3.1). The black dashed line indicates the year of the devaluation. The figure reports 90% and 95% confidence intervals based on standard errors clustered at the regional level.



A. Migration inflows, Dest. RegEX$_{mt_0}$ B. Migration outflows, Origin RegEX$_{nt_0}$

Figure 3. Event Study. Spatial Reallocation of Labor. Increased Migration Flows to More Export-Oriented Regions

Note. This figure illustrates the estimated β_τ in Equation (3.4). The dependent variables are the log of migration flows between origin and destination regions. In Panels A and B, the estimated coefficients for RegEX$_{nt_0}$ of destination and origin are plotted, where RegEX is the regional export intensity defined in Equation (3.1). I estimate Equation (3.4) using Poisson pseudo-maximum likelihood to deal with statistical zeros. The black dashed line indicates the year of the devaluation. The figure reports 90 and 95 percent confidence intervals based on standard errors that are two-way clustered at the origin and destination levels.

Table 3: OLS First-Difference. Sectoral Reallocation of Labor. Increased Reallocation of Labor to More Export-Intensive Sectors within Regions

Dep.	△ Top five mfg., 1997-2000				△ Overall mfg., 1997-2000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RegEX_{nt_0}	0.03*	0.04**	0.03**	0.04**	0.01*	0.01*	0.02**	0.02**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial emp.		−0.02*		−0.02		−0.00		−0.00
		(0.01)		(0.01)		(0.01)		(0.01)
Labor demand			−0.98	−0.87			−0.50	−0.50
			(1.08)	(1.09)			(0.46)	(0.47)
Adj. R^2	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.01
# Cluster	121	121	121	121	121	121	121	121
N	121	121	121	121	121	121	121	121

Note. This table reports the OLS estimates of Equation (3.3). In columns (1)-(4) and (5)-(8), dependent variables are changes in log of the top five most export-intensive and overall manufacturing sectors, respectively, between 1997 and 2000. RegEX is the regional export intensity defined in Equation (3.1). Controls include initial log employment and the constructed labor demand shocks. Standard errors, reported in parentheses, are two-way clustered at the regional levels. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

To isolate variation in differential exposure to export shocks from other sources of shocks, I additionally control for local labor demand shocks, which take the form of the standard leave-one-out shift share regressor constructed based on the initial employment shares and the leave-one-out national-level sector-specific employment growth.[16] This national-level employment growth can be interpreted as sector-specific productivity shocks, and the labor demand shocks as the weighted average of these sector-specific shocks (e.g., Adão et al., 2019). For example, financial frictions or balance sheet effects can be sources of negative productivity shocks in the setting of the devaluation.[17] Although I am agnostic about the drivers of these differential productivity shocks caused by the devaluation, the labor demand shock variable can capture differential exposure to these shocks.

Table 3 reports the results of the first-difference model. Across specifications with different controls, the estimates are stable and stay within a standard error of the event-study estimates of 2000. The fact that the labor demand shocks are statistically insignificant bolsters that the event-study results were driven by the export shocks rather than other sources of shocks.

[16] Formally, the labor demand shocks are constructed as $\frac{\sum_{j\in\mathcal{J}} Emp_{njt_0} \times g_{(-n)jt}}{\sum_{j\in\mathcal{J}} Emp_{njt_0}}$ where $g_{(-n)jt}$ is growth of national-level sector j employment excluding region n's employment between 1997 and 2000.

[17] See, e.g., Aguiar (2005), Kim et al. (2015), and Queralto (2020).

Spatial reallocation of labor Because relatively more export-intensive manufacturing sectors were geographically concentrated, workers could have to move to more export-oriented regions to reallocate themselves to these more export-intensive sectors. To examine this spatial reallocation of labor, I consider the following event-study specification at the pair level:

$$\ln \mu_{nmt} = \sum_{\tau=-3}^{7} \beta_\tau (D_t^\tau \times \text{RegEX}_{mt_0}) + \mathbf{X}'_{mt}\boldsymbol{\gamma} + \delta_{nm} + \delta_{nt} + \epsilon_{nmt} \tag{3.4}$$

The dependent variables are the log of migration flows μ_{nmt} from region n to m. RegEX_{mt_0} is the standardized regional export intensity of destination region m. δ_{nm} and δ_{nt} are pair and origin-year fixed effects, respectively. For time-varying observables $\mathbf{X}_{mt}$ of destination region m, I use the same set of controls with Equation (4.17). ϵ_{nmt} is the error term. I normalize β_τ to be zero. To deal with statistical zeros, I estimate Equation (3.4) using Poisson pseudo-maximum likelihood (Silva and Tenreyro, 2006).

The identifying assumption of the regression model just described is similar to that of Equation (3.2): employment shares of origin are orthogonal to the error term conditional on controls and fixed effects. Also, because the regression model is at the bilateral pair level, the regression model incorporates the bilateral nature of location choices and does not suffer from the omitted variable bias problem due to this bilateral nature studied in (Borusyak et al., 2022).

Panel A of Figure 3 reports the results of the event-study specification. Two years after the devaluation, migration inflows to a destination increased 6% more than other migration flows whose destination region had one standard deviation lower regional export intensity. There is no evidence of pre-trends in migration inflows. In Panel B, I consider migration outflows instead of inflows and run an event-study specification analogous to Equation (3.4), in which the variable of interest is the regional export intensity of origins interacted with the event-time dummies and destination-year fixed effects are controlled for. Two years after the devaluation, I find migration outflows decreased by 4% of one region compared with other migration outflows with one standard deviation lower regional export intensity of origins. Migration outflows had slight pre-trends in 1995 at the 10% level but in the opposite direction. If such pre-trends existed, then it would lead to upward-bias to my estimates, underestimating the effects of the regional export-intensity.

I also consider the analogous first-difference specification for changes in migration inflows between 1997 and 2000:

$$\triangle \ln \mu_{nmt} = \beta \text{RegEX}_{mt_0} + \mathbf{X}'_{mt}\boldsymbol{\gamma} + \delta_n + \triangle\epsilon_{nmt}. \tag{3.5}$$

I also control for initial log employment and the labor demand shocks, as in Equation (3.3). When dependent variables are migration outflows, the regressors vary across origin regions and I control for destination fixed effects.

Table 3 reports the results of this first-difference model. Because zero-values are dropped, as I

Table 4: OLS First-Difference. Spatial Reallocation of Labor. Increased Migration Flows to More Export-Oriented Regions

Dep.	△ Migration inflows, 1997-2000				△ Migration outflows, 1997-2000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RegEX_{nt_0}	0.06***	0.06***	0.06***	0.06***	−0.05***	−0.04***	−0.05***	−0.04***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial emp.		0.00		0.00		−0.03***		−0.03***
		(0.01)		(0.01)		(0.01)		(0.01)
Labor demand			−0.07	−0.11			−0.11	0.13
			(0.60)	(0.62)			(0.59)	(0.59)
Origin FE	✓	✓	✓	✓				
Dest. FE					✓	✓	✓	✓
Adj. R^2	0.04	0.04	0.04	0.04	0.07	0.08	0.07	0.08
# Cluster 1	121	121	121	121	121	121	121	121
# Cluster 2	121	121	121	121	121	121	121	121
N	13336	13336	13336	13336	13336	13336	13336	13336

Note. This table reports the OLS estimates of Equation (3.5). In columns (1)-(4) and (5)-(8), dependent variables are changes in log migration inflow and outflow shares between 1997 and 2000, respectively. RegEX is the regional export intensity defined in Equation (3.1). Controls include initial log employment and the constructed labor demand shocks. Standard errors are reported in parentheses, two-way clustered at the origin and destination levels. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

estimate Equation (3.5) via OLS, the sample decreased from 14,641 to 13,336, and the estimates can be subject to the well-known issues related to zero-values. However, despite these issues, the estimates stay within a standard error of the event-study estimates of 2000 and are stable across specifications with different controls.

Additional checks and alternative measure I conduct the diagnostics proposed by Goldsmith-Pinkham et al. (2020). They show that the shift-share estimator can be decomposed as a weighted sum of just-identified IV estimators based on each share and the Rotemberg weights. These weights are informative on which shares are driving the estimated coefficients and sensitivity of each share to misspecification or endogeneity issues. Online Appendix Tables B2 and B3 report the summary and the values of these weights and exactly just-identified estimators of the first-difference specifications. The weights are highly skewed. The top five most export-intensive sectors explain more than 96% of the positive weights of the estimator. Although these large weights indicate that the estimates can be sensitive to other confounding factors that affect regions with larger employment shares in the top five sectors, no evidence of pre-trends alleviates this concern. Also, although 47% of the weights take negative values, which affects LATE-like interpretation of the estimates and suggests that they need not be robust to heterogeneous effects, the magnitude of their weighted sums is only about 20% of that of the positive weights across specifications, which alleviates this concern.

Because of the depreciation of the real exchange rate, the devaluation could have negatively affected sectors that imported intermediate inputs more intensively from foreign countries. Following Campa and Goldberg (1995), I construct an alternative regional exposure measure:

$$\mathrm{RegEXIM}_{nt_0} = \frac{\sum_j \mathrm{Emp}_{njt_0} \times (\mathrm{SecEX}_{jt_0} - \mathrm{SecIM}_{jt_0})}{\sum_j \mathrm{Emp}_{njt_0}}, \tag{3.6}$$

where SecIM_{jt_0} is the share of imported inputs to the total costs of production. The differences between SecEX_{jt_0} and SecIM_{jt_0} capture the sectoral net exposures to the real exchange rate changes. Using this alternative measure, I run the same event study specifications in Equations (3.2) and (3.4). Online Appendix Figures B7 and B8 and Tables B4 and B5 report the results. The estimated coefficients are similar to the baseline results.

Summary and discussion To summarize, my empirical findings on sectoral and spatial reallocation of labor come from comparing regions with different industry compositions. After the devaluation, more export-oriented regions had larger growth in employment in more export-intensive sectors because of larger increases in employment shares in these sectors and migration inflows. These empirical findings suggest that sectoral and spatial reallocation of labor could have been interlinked at both regional and aggregate levels.

The empirical strategies identify only the relative changes and cannot speak to the aggregate implications and the general equilibrium effects of migration frictions. The magnitude of the interlink between migration and sectoral reallocation and its aggregate implications are the quantitative questions that require the structural model, which I present in the next section. Using the same data set and the IV strategies that exploit the similar identifying variation, I later estimate specifications driven from the structural model and recover two key elasticities of the model, each related to these two findings.

4 Quantitative Framework

4.1 Model

In this section, motivated by the empirical evidence, I develop a dynamic spatial general equilibrium model to quantify how the economy would have adjusted differently to the devaluation with different levels of migration frictions. Given the focus is the adjustment of the economy to transitory trade shocks induced by the devaluation, understanding transitional dynamics is important.

4.1.1 Environment

The world is divided into Home and Foreign, corresponding to South Korea and the rest of the world. Home is a small open economy that takes the world import price as given but faces downward-sloping demands for its products in the international market. There are $N+1$ regions. Home is composed of N regions, indexed by $n, m \in \mathcal{N} = \{1, \ldots, N\}$. There are J sectors, indexed by $j, k \in \mathcal{J} = \{1, \ldots, J\}$. Each region has different natural productivity across different sectors and is spatially linked through costly trade and migration. Internal and international trade are subject to iceberg trade costs. For a unit of any sector j variety good shipped from n to m for $n, m \in \mathcal{N} \cup \{F\}$ where F denotes Foreign, $d^j_{nm} \geq 1$ units have to be shipped. I normalize $d^j_{nn} = 1$, $\forall n \in \mathcal{N}$.

There are two types of infinitely-lived agents: workers and landlords. Both agents are forward-looking with perfect foresight. Each worker has a continuum of members who supply labor inelastically. Each member has different amounts of labor efficiency units across sectors. Workers optimally allocate their members across different sectors based on sectoral wages and members' labor efficiency units. The total labor income earned by each worker is the sum of wages earned by the worker's members. Workers also make migration decisions subject to migration frictions. Workers live hand-to-mouth, so they spend all of their income on consumption each period.

Landlords are geographically immobile and own capital stock in each region. They make forward-looking consumption and investment decisions in local capital stock that depreciates at a rate δ. Labor and capital markets are segmented across regions and capital is freely mobile across sectors within regions. Population and capital (L_{nt}, K_{nt}) are state variables of the model, which are derived from the optimal forward-looking migration decisions of workers and investment decisions of landlords, respectively. I normalize the total population to one: $L_t \equiv \sum_{n \in \mathcal{N}} L_{nt} = 1$.

4.1.2 Production

Intermediate goods producer Each region n produces a unique sector j intermediate good variety. A representative intermediate goods producer of each region-sector produces a variety using labor, capital, and material inputs with input-output linkages. The output is produced using Cobb-Douglas technology:

$$q_{njt} = A_{njt} H_{njt}^{\gamma_j^H} K_{njt}^{\gamma_j^K} \prod_{k=1}^{J} (M_{njt}^k)^{\gamma_j^k}, \qquad \gamma_j^H + \gamma_j^K + \sum_k \gamma_j^k = 1, \tag{4.1}$$

where A_{njt} is region-sector productivity, H_{njt} is labor input, K_{njt} is capital input, M^k_{njt} is the material input of sector k used by sector j, γ_j^H and γ_j^K are labor and capital shares, and γ_j^k is the share of sector j goods spent on intermediate input from sector k. The value-added shares are the sum of the labor and capital shares: $\gamma_j^V \equiv \gamma_j^H + \gamma_j^K$. Under cost minimization, the unit cost of production is

$$c_{njt} = \frac{1}{A_{njt}} \left(\frac{W_{njt}}{\gamma_j^H} \right)^{\gamma_j^H} \left(\frac{r_{nt}}{\gamma_j^K} \right)^{\gamma_j^K} \prod_{k=1}^{J} \left(\frac{P_{nkt}}{\gamma_j^k} \right)^{\gamma_j^k}, \tag{4.2}$$

where W_{njt} is region-sector wage, R_{nt} is a rental rate of local capital, and P_{njt} is the price of intermediate inputs.

Final goods producer Final goods are non-tradable and can be used as material inputs or final consumption goods. Final goods are the constant elasticity of substitution aggregate of sector j intermediate goods of domestic regions, q_{njt}, and Foreign, q_{Fjt}:

$$Q_{njt} = \left(\sum_{m \in \mathcal{N}} q_{mjt}^{\frac{\sigma-1}{\sigma}} + q_{Fjt}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{4.3}$$

where σ is the elasticity of substitution. The final goods market is perfectly competitive and free entry ensures zero profits. The associated price index is

$$P_{njt}^{1-\sigma} = \sum_{m \in \mathcal{N}} (d_{mn}^j c_{mjt})^{1-\sigma} + (d_{Fn}^j P_{jt}^F)^{1-\sigma}, \tag{4.4}$$

where P_{jt}^F are import prices exogenous to the Home regions.

Trade Region n's sector j expenditure shares on intermediate goods from region m and Foreign are given by

$$\pi_{mnt}^j = \frac{(d_{mnt}^j c_{mjt})^{1-\sigma}}{\sum_{m' \in \mathcal{N}} (d_{m'n}^j c_{m'jt})^{1-\sigma} + (d_{Fn}^j P_{jt}^F)^{1-\sigma}} \text{ and } \pi_{Fnt}^j = \frac{(d_{Fn}^j P_{jt}^F)^{1-\sigma}}{\sum_{m \in \mathcal{N}} (d_{mn}^j c_{mjt})^{1-\sigma} + (d_{Fn}^j P_{jt}^F)^{1-\sigma}}. \tag{4.5}$$

Total sector j export values of region n are

$$\text{EX}_{njt} = (d_{nF}^j c_{njt})^{1-\sigma} D_{jt}^F, \tag{4.6}$$

where D_{jt}^F are the Foreign market demands exogenous to Home.[18]

4.1.3 Workers

Preference Workers' preferences are Cobb-Douglas with expenditure shares α_j:

$$U(C_{nt}) = \ln C_{nt}, \qquad C_{nt} = \prod_{j \in \mathcal{J}} (C_{njt})^{\alpha_j}$$

[18] Gopinath and Neiman (2014), Blaum (2018), and Blaum et al. (2018) similarly model large changes in exports or imports after currency devaluations as exogenous shocks to foreign demands or import price.

where C_{nt} is region n workers' consumption at time t. The ideal price index is $P_{nt} = \prod_{j \in \mathcal{J}} (P_{njt}/\alpha_j)^{\alpha_j}$. The budget constraint is $P_{nt}C_{nt} = I_{nt}$, where I_{nt} is income earned by workers.

Sectoral labor supply Each worker is made up of a continuum of members with measure one, $i \in [0, 1]$. Sectoral labor supply is determined by workers' allocation of their members across sectors within regions. Each member is ex-ante identical, but ex-post heterogeneous due to different ability draws across sectors. Members receive new draws every period after workers make migration decisions. Each member is characterized by ability vector $\boldsymbol{\epsilon}_t^i \equiv (\epsilon_{n1t}^i, \dots, \epsilon_{nJt}^i)$, where ϵ_{njt}^i is amounts of efficiency units of labor of member i that can be supplied to sector j.

I assume that the skills of each member in region n are independently and identically drawn from a multivariate Fréchet distribution across regions and time: $F_{nt}(\boldsymbol{\epsilon}_t) = \exp(-\sum_{j \in \mathcal{J}} E_{njt}\epsilon_{njt}^{-\theta})$ with $\theta > 1$ (Eaton and Kortum, 2002; Lagakos and Waugh, 2016; Hsieh et al., 2019). θ is the shape parameter of the Fréchet distribution that governs the dispersion of skills across members, with the higher value of θ corresponding to smaller dispersion. E_{njt} is the location parameter that varies at the region-sector-time level.

E_{njt} can be interpreted as time-varying region-sector labor productivity. I introduce this labor productivity to account for decreasing trends in manufacturing employment shares but increases in manufacturing GDP shares during the sample period, which can be rationalized by decreases in labor productivity but increases in the overall productivity of manufacturing sectors.[19] If I do not incorporate such decreasing trends, quantitative results may overstate the effects of migration frictions on labor reallocation to export-intensive manufacturing sectors because, without labor productivity shocks, gross output and employment shares are isomorphic in the model and increases in gross output always lead employment shares to increase proportionally.

Given sectoral wages, workers allocate their available members across sectors to maximize the total sum of wages earned by their members. Workers allocate member i to sector j only if sector j generates the highest labor income over other sectors: $\epsilon_{njt}^i \in \Omega_{njt}$, where $\Omega_{njt} = \{\boldsymbol{\epsilon}_t | W_{njt}\epsilon_{njt} \geq W_{nkt}\epsilon_{nkt}, \forall k \in \mathcal{J}\}$. Each worker's shares of members allocated to sector j are expressed as

$$\lambda_{njt} = \int_0^1 \left[\int_{\Omega_{njt}} dF_{njt}(\boldsymbol{\epsilon}_t^i) \right] di = \frac{E_{njt}W_{njt}^{\theta}}{\sum_{j'} E_{nj't}W_{nj't}^{\theta}}, \tag{4.7}$$

which is equal to the share of members whose earnings are the highest in sector j. The labor supply of sector j in the unit of effective labor in region n is expressed as follows:[20]

$$H_{njt} = L_{nt} \int_0^1 \left[\int_{\Omega_{njt}} \epsilon_{njt}^i dF(\boldsymbol{\epsilon}_t^i) \right] di = \Gamma^1 \lambda_{njt}^{\frac{\theta-1}{\theta}} L_{nt}.$$

[19] Between 1995 and 2006, employment shares in the top five sectors decreased from 20 to% 17% (Panel B of Figure 2), but their GDP and gross output shares increased from 23% to 25% and 36% to 42%, respectively. Similar results also hold for the overall manufacturing sectors.

[20] Γ^1 is a constant defined as $\Gamma^1 \equiv \Gamma(1 - \frac{1}{\theta})$ where $\Gamma(\cdot)$ is the Gamma function.

Labor supply curves are upward sloping and increase in W_{njt}. The total labor income of each worker in region n is the sum of wages across the worker's members:

$$W_{nt} = \int_0^1 \max_{j\in\mathcal{J}}\{W_{njt}\epsilon^i_{njt}\}di = \Gamma^1\Big(\sum_{j\in\mathcal{J}} E_{njt}W^{\theta}_{njt}\Big)^{\frac{1}{\theta}}. \tag{4.8}$$

Migration At the end of each period, workers can migrate to another location where they work in the next period after they earn labor income and make consumption decisions in the current location. Migration frictions are measured in terms of utility. These costs are origin-destination specific and can be time-varying, represented by the bilateral cost matrix τ_{nmt}. Workers are forward-looking and discount the future with discount factor $\beta \in (0,1)$. Workers choose a region that gives the highest utility net of migration frictions. Workers have idiosyncratic preference shocks η_{nt} for each location, independently and identically distributed across workers, regions, and time.

The dynamic problem of workers is

$$\mathrm{v}_{nt} = \ln C_{nt} + \max_{m\in\mathcal{N}}\{\beta\mathbb{E}[\mathrm{v}_{m,t+1}] + B_{mt} - \tau_{nmt} + \eta_{mt}\},$$

where v_{nt} is the lifetime utility of a household in region n and $\mathbb{E}[\mathrm{v}_{m,t+1}]$ is the future lifetime utility where the expectation is taken over the realization of all future shocks. B_{mt} are amenities that capture features that make regions more or less desirable to live in. When workers choose to live in region m in the next period, they enjoy region m's amenities at the end of each period t.[21]

I assume that η_{mt} is distributed Type-1 Extreme Value with zero means with the parameter ν.[22] Let $V_{nt} = \mathbb{E}_{\eta}[\mathrm{v}_{nt}]$, where the expectation is taken over the idiosyncratic preference shocks, which is the lifetime expected utility before realization of the preference shocks. Under the distributional assumption, V_{nt} is expressed as:

$$V_{nt} = \ln C_{nt} + \nu \ln \sum_{m\in\mathcal{N}} \exp(\beta V_{m,t+1} + B_{mt} - \tau_{nmt})^{\frac{1}{\nu}}. \tag{4.9}$$

Equation (4.9) implies that the value of being in region n is the sum of the current utility and the option value of moving into other regions.

The fraction of workers who migrate from region n to m at the end of time t admits the following closed form:

$$\mu_{nmt} = \frac{\exp(\beta V_{m,t+1} + B_{mt} - \tau_{nmt})^{\frac{1}{\nu}}}{\sum_{m'\in\mathcal{N}} \exp(\beta V_{m',t+1} + B_{m't} - \tau_{nm't})^{\frac{1}{\nu}}}. \tag{4.10}$$

The previous expression indicates that, all things being equal, workers migrate more into regions

[21] I follow Balboni (2021) for modeling amenities into this dynamic framework and the timing amenities enter the utility function.

[22] η_{mt} follows the Gumbel distribution with parameters, $(-\gamma\nu, \nu)$, where γ is Euler's constant.

with higher expected lifetime utility net of migration frictions, with the migration elasticity $1/\nu$. The migration elasticity governs how sensitive migration flows are to changes in expected lifetime utilities and migration frictions, with the lower value corresponding to more persistent location choices. With the distribution of population, region n's population in the next period evolves as

$$L_{n,t+1} = \sum_{m\in\mathcal{N}} \mu_{mnt} L_{mt}. \tag{4.11}$$

I allow for trade imbalances by incorporating exogenous trade deficits and introducing an exogenous tax common across workers, ι_t, which rationalizes trade deficits observed in the data.[23] ι_t makes the ratio of per capita expenditure to per capita income vary exogenously over time:

$$\iota_t \equiv \frac{\sum_{n\in\mathcal{N}} \sum_{j\in\mathcal{J}} (\mathrm{IM}_{njt} - \mathrm{EX}_{njt})}{\sum_{n\in\mathcal{N}} W_{nt} L_{nt}},$$

where IM_{njt} is sector j import values of region n. With exogenous trade deficits, workers' income is given as $I_{nt} = (1+\iota_t) W_{nt}$.

4.1.4 Capital Accumulation

Landlords in each region can produce one unit of capital using one unit of final goods. They choose their consumption and investment to maximize their intertemporal utility:

$$\nu^k_{nt} = \mathbb{E}_t \sum_{s=t_0}^{\infty} \beta^{t+s} \frac{(C^k_{n,t+s})^{1-1/\psi}}{1-1/\psi}, \tag{4.12}$$

subject to the budget constraint $r_{nt}K_{nt} = P_{nt}(C^k_{nt} + K_{n,t+1} - (1-\delta)K_{nt})$, where r_{nt} is the rental rate of capital. $r_{nt}K_{nt}$ is the total income from the existing capital stock, $P_{nt}C^k_{nt}$ is the total value of their consumption, and $P_{nt}(K_{n,t+1} - (1-\delta)K_{nt})$ is the total value of their investment.

Their optimal investment decisions are characterized by the following law of motion for capital:

$$K_{n,t+1} = (1-\zeta_{nt}) R_{nt} K_{nt}, \tag{4.13}$$

where $R_{nt} \equiv 1 - \delta + r_{nt}/P_{nt}$ is the gross return on capital and ζ_{nt} is recursively defined as

$$\zeta_{nt}^{-1} = 1 + \beta^{\psi} \left(R_{n,t+1}^{\frac{\psi-1}{\psi}} \zeta_{nt}^{-\frac{1}{\psi}} \right)^{\psi}.$$

[23] Given that my focus is the adjustment of an economy to large devaluations rather than explaining sources of changes in trade environments around large devaluations, I treat trade deficits as exogenous as is standard in the trade literature. See Reyes-Heroles (2016) and Dix-Carneiro et al. (2021) for endogenous trade imbalances. Also, if region-sector trade data are available, ι_t can be varying across regions as in Caliendo et al. (2018) by fitting regional trade imbalances.

Landlords save the fraction of $(1-\zeta_{nt})$ out of current-period wealth $R_{nt}K_{nt}$. The optimal consumption of region n's landlords satisfies $C^k_{nt} = \zeta_{nt}R_{nt}K_{nt}$.

Labor is a mobile factor, whereas capital is regionally fixed. Any positive shocks attract labor inflows to regions, but because capital is locally fixed in a given period, these positive shocks increase the price for capital more than wages, generating decreasing returns. These decreasing returns attenuate the direct effects of the positive shocks and the opposite for negative shocks. However, accumulation of local capital may alleviate the effects of the decreasing returns over time.

4.1.5 General Equilibrium

Market clearing Goods market clearing of final goods requires that

$$\mathrm{GO}_{njt} = \sum_{m\in\mathcal{N}} \pi^j_{mnt}\left[\left(\sum_{k=1}^{J}\gamma^j_k \mathrm{GO}_{mkt}\right) + \alpha_j((1+\iota_t)W_{mt}L_{mt} + r_{mt}K_{mt})\right] + \mathrm{EX}_{njt}, \tag{4.14}$$

where GO_{njt} is region n's total sales of sector j intermediate goods. The term inside the brackets is region m's total expenditures on sector j goods. The labor market clearing condition is

$$W_{njt}H_{njt} = \gamma^H_j \mathrm{GO}_{njt}. \tag{4.15}$$

Capital market clearing requires that landlords' capital income equal rental payments for its use. Cost-minimization of intermediate goods producers and the zero profit condition imply that the capital market clearing condition is

$$r_{nt} = \frac{\sum_{j\in\mathcal{J}}(\gamma^K_j/\gamma^H_j)W_{njt}H_{njt}}{K_{nt}}. \tag{4.16}$$

Shocks There are six time-varying exogenous shocks to the fundamentals, $\boldsymbol{\Psi}_t \equiv \{A_{njt}, P^F_{jt}, D^F_{jt}, \iota_t, E_{njt}, B_{nt}\}^{N,J}_{n=1,j=1}$, and shocks to migration frictions, $\boldsymbol{\tau}_t \equiv \{\tau_{nmt}\}^N_{n,m=1}$. Shocks in one region-sector transmit to other region-sectors through interregional trade and migration linkages.

Equilibrium Given the state variables $\{L_{nt}, K_{nt}\}^N_{n=1}$ and $\boldsymbol{\Psi}_t$, allocation in each period is determined as in a static trade and spatial model. The population and capital stock evolve according to the optimal migration and investment decisions of workers and landlords. I formally define the equilibrium as follows:

Definition 1. *Given the parameters of the model, $\{\boldsymbol{\Psi}_t\}^\infty_{t=t_0}$, $\{\boldsymbol{\tau}_t\}^\infty_{t=t_0}$, and initial allocations of the state variables $\{L_{nt_0}, K_{nt_0}\}^N_{n=1}$, the competitive equilibrium of the model is the set of population, sectoral allocation of members, wages, expected lifetime utilities, rental rate of capital, and capital stock $\{L_{nt}, \lambda_{njt}, W_{njt}, V_{nt}, r_{nt}, K_{n,t+1}\}^{N,J,\infty}_{n=1,j=1,t=t_0}$ that satisfies the following condition for each region n, each sector j, and all periods t: (i) Given $\{W_{njt}\}^{N,J}_{n=1,j=1}$, workers optimally allocate their members* *across different sectors (Equation (4.7)); (ii) $\{V_{nt}\}_{n=1}^{N}$ satisfies Equation (4.9); (iii) $\{L_{nt}\}_{n=1}^{N}$ evolves according to Equation (4.11); (iv) $\{K_{n,t+1}\}_{n=1}^{N}$ evolves according to Equation (4.13); and (v) goods, labor, and capital market clearing conditions are satisfied (Equations (4.14), (4.15), and (4.16)).*

4.1.6 Taking Stock: Devaluation and Sectoral Reallocation

I model the devaluation as four time-varying exogenous shocks to fundamentals in a reduced-form fashion that captures common features of emerging market economies after large devaluations. Lower A_{njt} rationalizes large TFP drops; higher D_{jt}^F, large increases in exports; higher P_{jt}^F, collapses of imports; and ι_t, a rapid decline in trade deficits. I call these four exogenous shocks the devaluation shocks: $\mathbf{\Psi}_t^{dev} \equiv \{A_{njt},\ D_{jt}^F,\ P_{jt}^F,\ \iota_t\}_{n=1,j=1}^{N,J} \subset \mathbf{\Psi}_t$. And I denote the other remaining two shocks as the non-devaluation shocks: $\mathbf{\Psi}_t^{ndev} \equiv \mathbf{\Psi}_t / \mathbf{\Psi}_t^{dev}$. These two shocks capture long-run trends in manufacturing employment shares and preferences for particular regions.

These four devaluation shocks affect workers' sectoral labor supply and migration decisions and, therefore, sectoral reallocation of labor at both the regional and aggregate levels. The total amounts of members working in sector j in region n are given by

$$L_{njt} = \underbrace{\lambda_{njt}}_{\substack{\theta\,:\,\text{Sectoral reallocation} \\ \text{within regions}}} \times \underbrace{\sum_{m \in \mathcal{N}} \mu_{nm,t-1} L_{m,t-1}}_{\substack{1/\nu\,:\,\text{Spatial reallocation} \\ \text{across regions}}} . \tag{4.17}$$

Both θ and $1/\nu$ govern two conceptually distinct decisions of workers on which sector to work in (sectoral labor supply) and where to live (migration), respectively.[24] θ governs changes in region-sector employment shares conditional on regional population in time t, related to the first empirical finding. $1/\nu$ governs the evolution of regional population through migration flows, related to the second empirical finding.

4.2 Counterfactual

I examine how amounts of sectoral reallocation and the transition path of the economy would have differed if migration frictions were at different levels. To perform counterfactuals and solve for transition paths, I use a dynamic hat algebra developed by Caliendo et al. (2019) and extended by Kleinman et al. (2021) to incorporate forward-looking investment. For any variable x, I denote time differences as $\hat{x}_{t+1} = x_{t+1}/x_t$. To perform counterfactuals, I require information on the initial allocation in 1997, six exogenous shocks to the fundamentals, structural parameters, and counterfactual

[24] Alternatively, I can model workers to make migration decisions from one region-sector to other region-sectors similar to Caliendo et al. (2019). Such modeling requires data on transitions between region-sectors and frictions of reallocating across different sectors can be inferred from the observed sector-to-sector transition flows combined with the model. However, because of unavailability of sector-to-sector transition flows in my setting, I made workers have two decisions that are governed by the two distinct elasticities, whereas in the model of Caliendo et al. (2019), workers' decisions are governed by a single elasticity. The additional elasticity, θ, stands in for potential sectoral reallocation costs that lead to sluggishness of changes in employment shares in response to shocks. Also, see Dix-Carneiro (2014) and Traiberman (2019) for costs of sectoral reallocation under the dynamic setting.

migration friction shocks that are required to construct the transition paths of the counterfactual economies.

For the baseline economy, I assume there are no changes in migration frictions and feed in a sequence of the exogenous shocks $\{\hat{\mathbf{\Psi}}_t\}_{t=98}^{\infty}$ to the initial allocation and compute the transition path. For the counterfactuals, I consider policies that temporarily reduce migration frictions for only up to three years and move back to the original level four years after the devaluation. To do so, I feed in transitory migration friction shocks jointly with $\{\hat{\mathbf{\Psi}}_t\}_{t=98}^{\infty}$ and compute the transition paths of the counterfactual economies. More precisely, one year before the devaluation in 1997, these unexpected transitory migration friction shocks occur before workers make migration decisions, while they expect the devaluation to happen in 1998, as in the baseline: $\hat{m}^c_{mn,97} = \exp(\tau^c_{nm} - \tau_{nm,96})$, where τ^c_{nm} is the counterfactual friction level. These frictions are held constant between 1998 and 2001 and set back to the original level in 2002: $\hat{m}^c_{nmt} = 1$, $\forall n, m \in \mathcal{N}$, $t \in \{98, 99, 00, 01\}$ and $\hat{m}^c_{nm,02} = 1/\hat{m}^c_{nm,97}$, $\forall n, m \in \mathcal{N}$.

4.3 Taking the Model to the Data

This section discusses the calibration procedure for the structural parameters, the initial allocation, the exogenous shocks to the fundamentals, and the counterfactual migration friction shocks. I aggregate 121 regions up to 54 regions for the quantitative analysis, based on their electoral district and industrial composition, so that each region has positive employment shares for all 15 sectors and region-to-region migration flows are positive. Table 5 reports a summary of the calibration procedure. See Online Appendix Section D for more details.

4.3.1 Initial Allocation

I need the initial allocation of $\{\mathrm{GO}_{njt_0},\ \lambda_{njt_0},\ \mu_{nm.t_0-1},\ L_{nt_0},\ K_{nt_0},\ K_{n,t_0+1},\ \mathrm{EX}_{njt_0},\ \pi^j_{nmt_0},\ \pi^j_{Fnt_0}\}_{n,m=1,j=1}^{N,J}$ to apply the dynamic hat algebra. I obtain region-sector gross output, employment shares, and real capital stock, regional population, and region-to-region migration flows, $\{\mathrm{GO}_{njt_0},\ \lambda_{njt_0},\ K_{nt_0},\ K_{n,t_0+1},\ L_{nt_0},\ \mu_{nj,t_0-1}\}_{n=1,j=1}^{N,J}$, from the data, but region-sector export and import shares and region-to-region trade flows, $\{\mathrm{EX}_{njt_0},\ \pi^j_{Fnt_0},\ \pi^j_{nmt_0}\}_{n,m=1,j=1}^{N,J}$, are not directly observable. Therefore, I indirectly infer these variables from sectoral exports and imports, region-sector gross output, and the gravity structure of trade. Under the gravity structure, there exists a unique set of trade shares that rationalize observed region-sector gross output and sectoral exports and imports (Allen et al., 2020). Therefore, I can obtain these variables by solving the gravity structure given the data.[25]

[25] Gervais and Jensen (2019) and Eckert (2019) also indirectly infer trade flows using region-sector gross output (or value-added) and the gravity structure of trade.

Table 5: Summary of Calibration

Parameters	Value	Description	Target
Elasticities			
$1/\nu$	0.7	Migration elasticity	IV estimates, Equation (4.18)
θ	1.3	Sectoral labor supply elasticity	IV estimates, Equation (4.20)
σ	6	Trade elasticity	Costinot and Rodríguez-Clare (2014)
ψ	1	Intertemporal elasticity of substitution	Literature
Geographic frictions			
$\{\xi_j\}$	0.26, 0.4	Trade costs	Monte et al. (2018), Eckert (2019)
Shocks			
$\{A_{njt}\}$		Productivity shocks	Gross output, PPI
$\{D_{jt}^F\}$		Foreign demand shocks	Aggregate exports
$\{P_{jt}^F\}$		Import price shocks	Aggregate imports
$\{\iota_t\}$		Trade deficits	Aggregate exports/imports
$\{B_{nt}\}$		Amenity shocks	Pop. distribution
$\{E_{njt}\}$		Labor productivity shocks	Region-sector emp. shares
Preference			
β	0.96	Discount factor	Literature
$\{\alpha_j\}$		Final consumption shares	IO table
Production			
$\{\gamma_j^k\}$		IO coefficients	IO table
$\{\gamma_j^V\}$		Value-added shares	IO table
$\{\gamma_j^H/\gamma_j^V\}$	0.66	Value-added labor shares	Literature
δ	0.05	Depreciation rate	Literature

Notes. This table summarizes the calibration results.

4.3.2 Structural Parameters

Sectoral labor supply elasticity I estimate the sectoral labor supply elasticity, θ, from the following estimable regression model that can be derived from Equation (4.7):

$$\ln \lambda_{njt} = \theta \ln W_{njt} + \delta_{nj} + \delta_{nt} + \delta_{jt} + \tilde{e}_{njt}. \tag{4.18}$$

$\tilde{e}_{njt}$ is the structural error term that is a function of labor productivity, E_{njt}. δ_{nj}, δ_{nt}, and δ_{nj} are region-sector, region-year, and sector-year fixed effects, respectively. δ_{nt} absorbs the average wage of region n, W_{nt}. I cluster standard errors at the region-sector level. To use the data more efficiently, I estimate the model using overlapping three-year long-differences: 1996-1999 and 1997-2000.

To run the aforementioned regression, I need data on nominal wages across region-sectors. I obtain this information from the Mining and Manufacturing Survey, which has information on wage bills, employment, and geographic locations for establishments in the mining and manufacturing sectors. I compute region-sector nominal wages by taking the weighted average of wage bills divided by the employment of each establishment within region-sectors, where the weights are given by establishment-level value-added. Because this survey covers only the mining and manufacturing sectors, I run the regression for those sectors.

The regression model suffers from the endogeneity problem because wages can be correlated with labor productivity shocks in the structural error term. Therefore, I estimate the equation using the following IV:

$$\mathrm{RegEX}_{nt_0} \times \mathrm{SecEX}_{jt_0} \times \mathbb{1}[t \geq 1998]. \tag{4.19}$$

The IV exploits positive demand shocks for more export-intensive sectors (higher SecEX_{jt_0}) in more export-oriented regions (higher RegEX_{nt_0}) due to increased exports after the devaluation ($\mathbb{1}[t \geq 1998]$), supported by the first empirical evidence (Panel A of Figure 2). The identifying assumption is that these differential demand shocks across region-sectors due to the devaluation are uncorrelated with time-varying region-sector labor productivity conditional on controls.

The estimated coefficient is 1.34 and statistically significant at the 5% level. The first-stage F-statistic is 9.4, below the rule-of-thumb value of 10. Therefore, I also conduct inference based on the Anderson-Rubin (AR) statistic that is robust to weak instruments following the recommendation of Andrews et al. (2019). The AR statistic also rejects the null at the 1% level, and its 95% confidence interval covers the estimated value of 1.34, which in line with the previous estimates in the literature. Burstein et al. (2019) report values of 1.26–1.81; Hsieh et al. (2019), 1.5–2.6; Lee (2020), 1.05–1.47; and Galle et al. (2022), 2. My estimate is in the lower range of these existing estimates, which may reflect the fact that I estimate θ using shorter-run variation than these papers that use decade-long variation.

Migration elasticity I estimate the migration elasticity, $1/\nu$, from the following estimable regression model that can be derived from the model (Artuc et al., 2010):

$$\ln \frac{\mu_{nmt}}{\mu_{nnt}} = \frac{\beta}{\nu} \ln \frac{I_{m,t+1}/P_{m,t+1}}{I_{n,t+1}/P_{n,t+1}} + \beta \ln \frac{\mu_{nm,t+1}}{\mu_{mm,t+1}} + \delta_{nm} + \delta_t + \tilde{\epsilon}_{nmt}. \tag{4.20}$$

δ_{nm} and δ_t are pair and year fixed effects, respectively.[26] $\tilde{\epsilon}_{nmt}$ is the structural error term that is a function of amenity and migration friction shocks.

To run the above regression model, I need data on I_{nt} and P_{nt}. After imposing constant labor shares of 0.66 across region-sectors, I calculate I_{nt} by dividing the labor share of the total sum of the

[26] The expression captures that current migration flows reflect the future values of expected real income and the option values, where the future migration flows are the sufficient statistics for the option values. Conditioning on the option values, variation in real income differences across regions identifies the migration elasticity. See Online Appendix Section D.2 for more details on the derivation of the regression model from the theoretical framework.

value-added across sectors in region n by the total number of the employed multiplied by observed $(1+\iota_t)$ that rationalizes trade deficits.[27] Regional price levels, P_{nt}, are obtained from the regional consumer price Iidex (CPI) data.[28] The Korean statistical agency only reports CPI data of the selected regions, so following Moretti (2017), I impute CPI data for regions with missing information using housing price data that are available for all regions. Out of 54 regions, the regional CPI data is available for 32 regions and CPIs of the remaining 22 regions are imputed. See Online Appendix Section D.2 for more detail.

Because differences in real income can be correlated with shocks to amenities and migration frictions, this regression model also suffers from the endogeneity problem. Therefore, I estimate the regression model using the following IV:

$$(\text{RegEX}_{mt_0} - \text{RegEX}_{nt_0}) \times \mathbb{1}[t \geq 1998]. \tag{4.21}$$

The identifying assumption of the IV holds when amenity and migration friction shocks are uncorrelated with the differences in regional demand shocks due to increased exports after the devaluation. I estimate Equation (4.20) in first-differences for the sample period between 1997 and 2000. The estimated coefficient is 0.69 and is statistically significant at the 1% level. With the assumed value of the discount factor, this estimate implies $1/\nu$ is around 0.7 in line with the estimates from the previous papers. Caliendo et al. (2021) report a value of 0.5 at the annual frequency, and Caliendo et al. (2019) report one of 0.2 at the quarterly frequency. My estimate is slightly higher than those estimates, which may reflect the fact that the geographic size of my spatial unit of analysis is more granular than that of those two papers.

Trade costs I parametrize internal trade costs as a function of physical distance: $d^j_{nm} = (dist_{nm})^{\xi_j}$ where $dist_{nm}$ is distance between regions and ξ_j are parameters that potentially vary across sectors. I set $(\sigma-1)\xi_j$ to be 1.29 for commodity and manufacturing sectors and 2 for service sectors based on the estimates from Monte et al. (2018) and Eckert (2019). I parametrize international trade costs as $d^j_{Fn} = (pdist_n)^{\xi_j}$, where $pdist_n$ is the minimum distance to port of region n. International trade costs that are common across regions are not separately identifiable from P^F_{jt} and D^F_{jt}, so d^j_{Fn} capture the costs relative to those of regions with ports.[29]

Remaining parameters I set the trade elasticity to be $\sigma - 1 = 6$ (Costinot and Rodríguez-Clare, 2014). I set the intertemporal elasticity of substitution to be one, the conventional value in the

[27]Specifically, $I_{nt} = 0.66 \times (1+\iota_t) \times \sum_{j\in\mathcal{J}} \text{VA}_{njt}$, where VA_{njt} is the value-added of region-sector nj. Because 0.66 and $(1+\iota_t)$ are common across regions, they are absorbed out by fixed effects.

[28]One concern with using the CPI in this regression is that it is comparable across times within regions but not cross-sectionally across regions, because the CPI is normalized to be one in 1992, the base year. However, controlling for δ_{nm} makes the cross-sectional comparisons available by absorbing out differences in unobservable price levels of the base year, $\ln P_{m,92}/P_{n,92}$, under the log utility function.

[29]I consider the top five largest ports in terms of export values, which are located in Busan, Gwangyang, Incheon, Masan, and Ulsan.

literature. Although I do not directly target the evolution of capital accumulation, the model does a decent job of capturing capital accumulation patterns in the data, which can be considered the non-targeted moment of the model (Online Appendix Figure D10).[30]

I obtain value-added shares, input-output coefficients, and final consumption good shares from the WIOD. I set the shares of labor in value-added to be 0.66. I set the one-year discount factor β and depreciation rate to the conventional values, 0.96 and 0.05, respectively.

4.3.3 Shocks to the Fundamentals

Shock process I assume that the model reaches the steady state for a sufficiently large period T. Practically, I set $T = 75$. After 2002, I set the four devaluation shocks, $\hat{\mathbf{\Psi}}_t^{dev}$, to start converging to their original level in 2003 and reach the original level 30 years after the devaluation, while the two remaining shocks, $\hat{\mathbf{\Psi}}_t^{ndev}$, remain constant throughout time. More specifically, for $t \in \{98, \ldots, 02\}$, $\{\hat{\mathbf{\Psi}}_t^{dev}\}_{t=98}^{02}$ and $\{\hat{\mathbf{\Psi}}_t^{ndev}\}_{t=98}^{02}$ are calibrated to fit the data between 1997 and 2002. After 2002, the devaluation shocks have the process

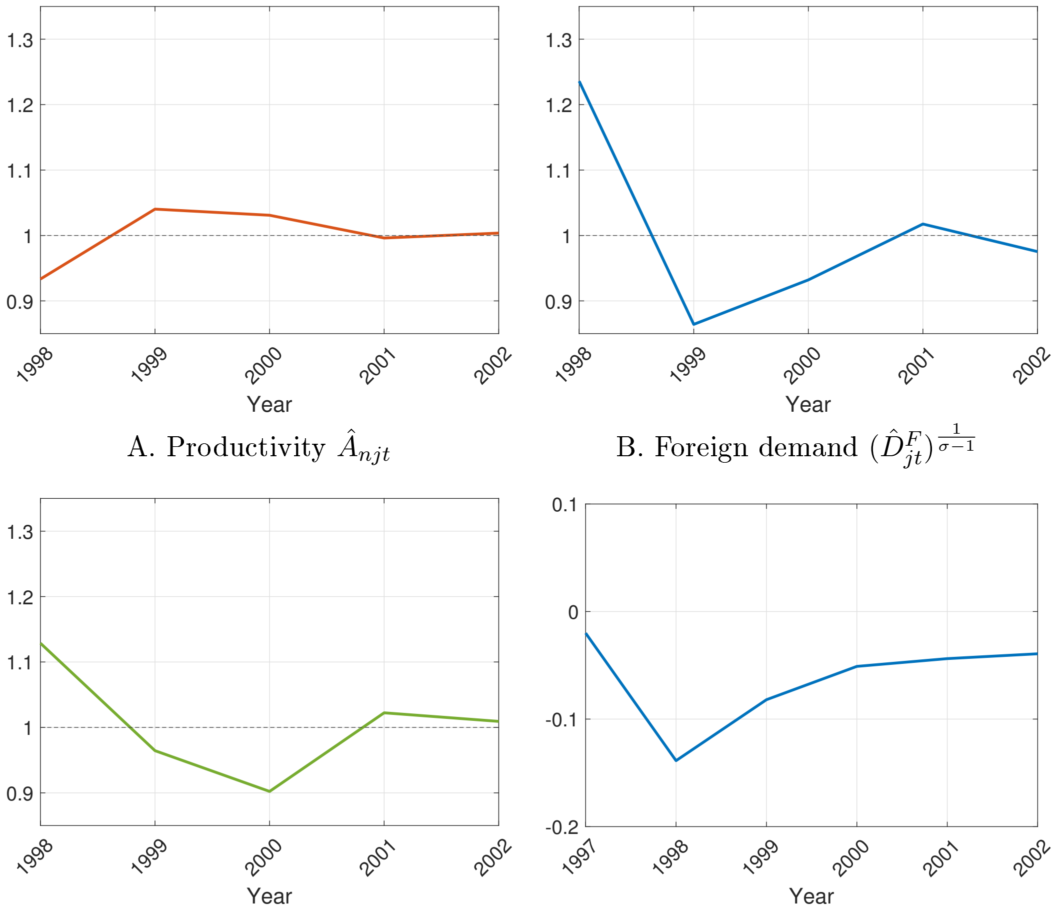
$$\hat{\mathbf{\Psi}}_t^{dev} = 1/\Big(\prod_{\tau=98}^{02} \hat{\mathbf{\Psi}}_\tau^{dev}\Big)^{\frac{1}{25}}, \quad \forall t \in \{03, \ldots, 28\} \quad \text{and} \quad \hat{\mathbf{\Psi}}_t^{dev} = 1, \quad \forall t \in \{29, \ldots, T\},$$

and the non-devaluation shocks remain unchanged: $\hat{\mathbf{\Psi}}_t^{ndev} = 1$, for $t \in \{03, \ldots, T\}$. I set the non-devaluation shocks to remain unchanged after 2002, because these two shocks are related to the long-run trends rather than short-run shocks.

Model inversion I back out a sequence of the six time-varying exogenous shocks to the fundamentals $\{\hat{\mathbf{\Psi}}_t\}_{t=t_0}^{\infty}$ by fitting the model to the data (Allen and Arkolakis, 2014; Eaton et al., 2016; Redding, 2016). While fitting the model to the data, I take into account the fact that agents have perfect foresight on these sequences of the shocks. The model is fitted to sectoral gross output distributions across regions, sectoral PPIs, aggregate real GDP, region-sector employment shares, sectoral import shares and exports, and population distribution between 1997 and 2002. I detrend sectoral PPIs and aggregate real GDP using the Hodrick-Prescott (HP) filter to isolate the cyclical component of the data from the trend components. When fitting real GDP growth, I mimic the way the South Korean statistical agencies construct statistical data for real GDP.[31] See Online Appendix D.5

[30] In the data, the capital stock growth rate was 10% in 1997, but it dropped to 5% in 1998 and remained constant around 5% after the devaluation. Because I directly take capital stock at the beginning and end of 1997 from the data, the capital stock growth rate in the model is the same as the data in 1997, but it decreased to around 2% and remained constant. Capital stock growth is higher in the data because I fit the model to the detrended data.

[31] Following the national accounting conventions, I construct real GDP growth using double deflation (Kehoe and Ruhl, 2008; Burstein and Cravino, 2015; Huo et al., 2019; di Giovanni et al., 2020). The South Korean statistical agencies use the Laspeyres chain-weighting of quantities, where the base period is given by the previous year. I also take into account the fact that the Korean statistical agencies collect price data from the designated regions and aggregate them based on the given weights to construct PPIs. Online Appendix D.6 presents the complete definition of real GDP and the procedure in detail.



A. Productivity $\hat{A}_{njt}$

B. Foreign demand $(\hat{D}^F_{jt})^{\frac{1}{\sigma-1}}$

C. Import price $\hat{P}^F_{jt}$

D. Deficit/GDP ratio

Figure 4. Backed-Out Devaluation Shocks

Notes. The figure presents the evolution of the four devaluation shocks after the devaluation. Panels A, B, and C plot the weighted average of the productivity, foreign demand, and import price shocks, where the weights are given by region-sector gross output, sectoral imports, and sectoral exports in 1997, respectively. Panel D plots the ratio of deficits to GDP in level.

for more details on the calibration procedure of the shocks.

Although all shocks are jointly identified, some data variables are more relevant to particular shocks. Regarding the four devaluation shocks, the productivity shocks are mainly identified from gross output, PPIs, and aggregate real GDP growth. Regional distributions of gross output identify the relative productivity of each region in a given year, and PPIs and aggregate real GDP identify absolute levels of the productivity shocks (Equations (4.4) and (4.14)). Conditioning on productivity shocks, aggregate import shares and exports identify the foreign import price and demand shocks (Equations (4.5) and (4.6)). Lastly, the exogenous trade deficits are directly taken from the data as standard in the trade literature.

Figure 4 displays the evolution of the backed-out devaluation shocks. Panels A, B, and C present the weighted average of the productivity, the foreign demands, and the import price shocks, where the weights are given by region-sector gross output, sectoral imports, and sectoral exports in 1997, respectively. Panel D plots the deficits-to-GDP ratio in level. In the year of the devaluation, the average productivity decreased by 8%, the average foreign demands increased by 29%, and the average import prices increased by 16% relative to the previous year. Also, the deficit ratio decreased by 12 percentage points because of increased exports and a collapse in imports.

For the non-devaluation shocks, I back out the labor productivity shocks from region-sector employment shares (Equation (4.7)) and the amenity shocks from the population distribution (Equation (4.11)). Conditioning on the productivity shocks, the labor productivity shocks rationalize decreasing trends in employment shares in manufacturing sectors (Panel B of Figure 2). The amenity shocks explain residuals of the population distribution that cannot be explained by real income. The labor productivity and amenity shocks are identified up to normalization, so I normalize the labor productivity shocks of the reference sector to be one for all regions and periods, and I also normalize the amenity shocks of the reference region to be one for all periods.

4.3.4 Counterfactual Migration Friction Shocks

Following Head and Ries (2001), I infer migration frictions from the observed migration flows under the symmetry ($\tau_{mnt} = \tau_{nmt}$, $\forall n, m \in \mathcal{N}$):

$$\mathfrak{m}_{nmt} \equiv \exp(\tau_{nmt})^{\frac{1}{\nu}} = \left(\frac{\mu_{nmt}\mu_{mnt}}{\mu_{nnt}\mu_{mmt}} \right)^{0.5}, \tag{4.22}$$

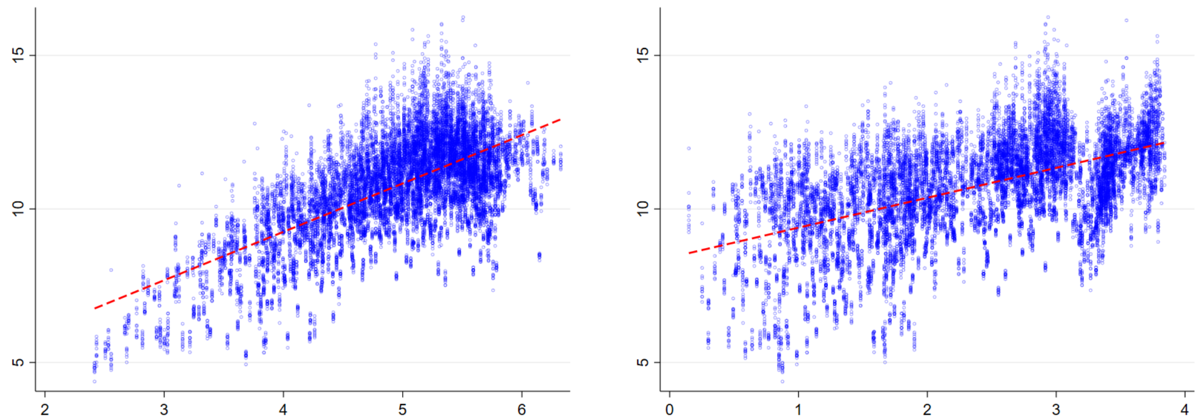
where $\mathfrak{m}_{nmt}$ captures the ease of migration in year t. Figure 5 illustrates that these backed-out frictions are highly correlated with observed proxies for migration frictions, such as distance and an index for regional conflicts. I construct this index by computing regional dissimilarity in candidates' shares of the vote in the 1992 14th presidential election, which is a good proxy for cultural, economic, and political conflicts between two regions based on the institutional details of South Korea.[32]

Using the inferred frictions, I compute the empirical distribution of changes in $\mathfrak{m}_{nmt}$ between

[32]The index is constructed using each candidate's shares of the vote. I compute the index between regions m and n as

$$\text{Index}_{nm} = 100 \times \sqrt{\frac{\sum_c (\pi_n^c - \pi_m^c)}{\text{The Number of Candidates}}},$$

where π_n^c is candidate c's share of votes of region n and the denominator is the number of candidates in the election. The southwestern regions had been culturally, economically, and politically discriminated against since the 1970s. In the '70s and '80s, the authoritarian government pursued an unequal development strategy by heavily investing in manufacturing sectors in the southeastern regions (Choi and Levchenko, 2021). Moreover, hundreds of people were massacred in 1980 during the popular uprising that happened in the southwestern regions against the authoritarian regime for democratic freedom. The unequal development strategy and the massacre led to political regionalism (Horiuchi and Lee, 2008). Since the political system became democratized in 1987, people living in the southwestern regions tended to vote for the candidate from the opposition party and against the authoritarian regime, whereas those living in the southeastern regions tended to vote for the ruling party that inherited the legacy of the authoritarian regime (Hong et al., 2022).



A. Log distance B. Index for regional conflicts

Figure 5. Correlates of the Inferred Migration Frictions

Notes. Panels A and B are the scatter plots between the inferred migration frictions and log distance and between such frictions and the index for regional conflicts. The red dashed lines are the corresponding linear fits.

1996 and 2016 across pairs and find that there were 5% reductions in migration frictions at the median.[33] Following Monte et al. (2018), I use this empirical distribution of these calculated changes and the estimated value of ν to conduct counterfactuals for empirically-plausible changes in migration frictions.

For each region-to-region pair, I compute counterfactual changes in migration frictions that are fed in 1997 as follows:

$$\hat{m}^c_{nm,97} \equiv (\hat{\mathfrak{m}}^c_{nm,97})^{\nu} = \exp(\tau^c_{nm} - \tau_{nm,96}), \tag{4.23}$$

where τ^c_{nm} is counterfactual migration frictions. In all counterfactuals, migration frictions move back to the original level in 2003: $\hat{m}^c_{nm,03} = 1/\hat{m}^c_{nm,97}$.

I consider five counterfactual scenarios. In the first scenario, migration is not allowed: $\tau^c_{nm} = \infty$, $\forall n, m \in \mathcal{N}$. For the second and third scenarios, I consider common decreases and increases by the median of the empirical distribution: $\tau^c_{nm} = 0.95 \times \tau_{nm,96}$ and $\tau^c_{nm} = 1/0.95 \times \tau_{nm,96}$, $\forall n, m \in \mathcal{N}$, where 0.95 corresponds to the median. In the fourth scenario, I consider selective decreases by the median only for migration flows to more export-oriented regions: $\tau^c_{nm} = 0.95 \times \tau_{nm,96}$ only for origin n and destination m that satisfy $\text{RegEX}_{mt_0} > \text{RegEX}_{nt_0}$. In the last scenario, I consider reductions in the components predicted by the conflict index. Specifically, I run the regression of the backed-out frictions on the region conflict index and compute predicted components by the index while

[33] Improvement of transportation infrastructure can be one factor behind these reductions. Between these periods, kilometers of paved public roads increased by 32% (from 82,000 to 109,000), and kilometers of highways increased by 235% (from 1,900 to 4,400).

Table 6: Migration Rate

Average outflow migration rate between 1997 and 2002 (%)					
Baseline	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
(1)	(2)	(3)	(4)	(5)	(6)
9.83	0	12.81	7.38	11.11	17.74

Notes. The table reports the average outflow migration rates across regions between 1997 and 2002 in the baseline and counterfactual economies. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) report them with common decreases, common increases, and selective decreases by the median of the empirical distribution, respectively; and column (6) reports them with reductions by the components predicted by the index of regional conflicts.

controlling for log distance.[34]

4.4 Quantitative Results

Migration rate Table 6 reports the average outflow migration rates between 1997 and 2002. In the baseline economy, the average rate was 9.8%.[35] Lower migration frictions led to higher migration rates. The migration rate was higher in the counterfactual with the common decreases than that with the selective decreases and the counterfactual with reductions by the components predicted by the conflict index.

Sectoral reallocation of labor and export intensity Table 7 reports growths in the aggregate top five employment shares, the aggregate export intensity of the top five sectors, and the aggregate export intensity between 1997 and 2000. In the baseline, these aggregate outcomes increased by 1.5%, 7.5%, and 14.9% in 2000, respectively.[36] Because the baseline is fitted exactly to these variables in the data, the numbers in column (1) are as observed in the data.

Lower migration frictions induced larger amounts of reallocation to more export-intensive sectors at the aggregate level, which in turn led to higher export intensity. With no migration, growths in the aggregate top five employment shares, the aggregate export intensity of the top five sectors, and

[34]When running regressions of the inferred migration frictions on log distance and the index, even after controlling for log distance, the coefficient of the index is 0.55 and statistically significant at the 1% level (Online Appendix Table D8).

[35]This rate is lower than that reported in Table 1, as regions are aggregated to 54 regions for the quantitative analysis.

[36]The numbers in the brackets are the level of the initial allocation that is common across the economies. The growth by 1.8%, 7.8%, and 14.9% implies that the top five employment shares, the top five export intensity, and the overall export intensity increased from 0.18 to 0.183, 0.32 to 0.35, and 0.15 to 0.17 in level, respectively, between 1997 and 2000.

Table 7: Aggregate Effects of Migration Frictions on Sectoral Reallocation

	Level in 1997	Growth between 1997 and 2000 (%)					
		Baseline (data)	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
		(1)	(2)	(3)	(4)	(5)	(6)
Top five emp. shares	[0.18]	1.49	0.21	1.67	1.30	2.97	1.55
Top five export intensity	[0.32]	7.52	6.42	7.69	7.37	8.39	7.83
Overall export intensity	[0.15]	14.93	13.43	15.15	14.72	16.13	15.27

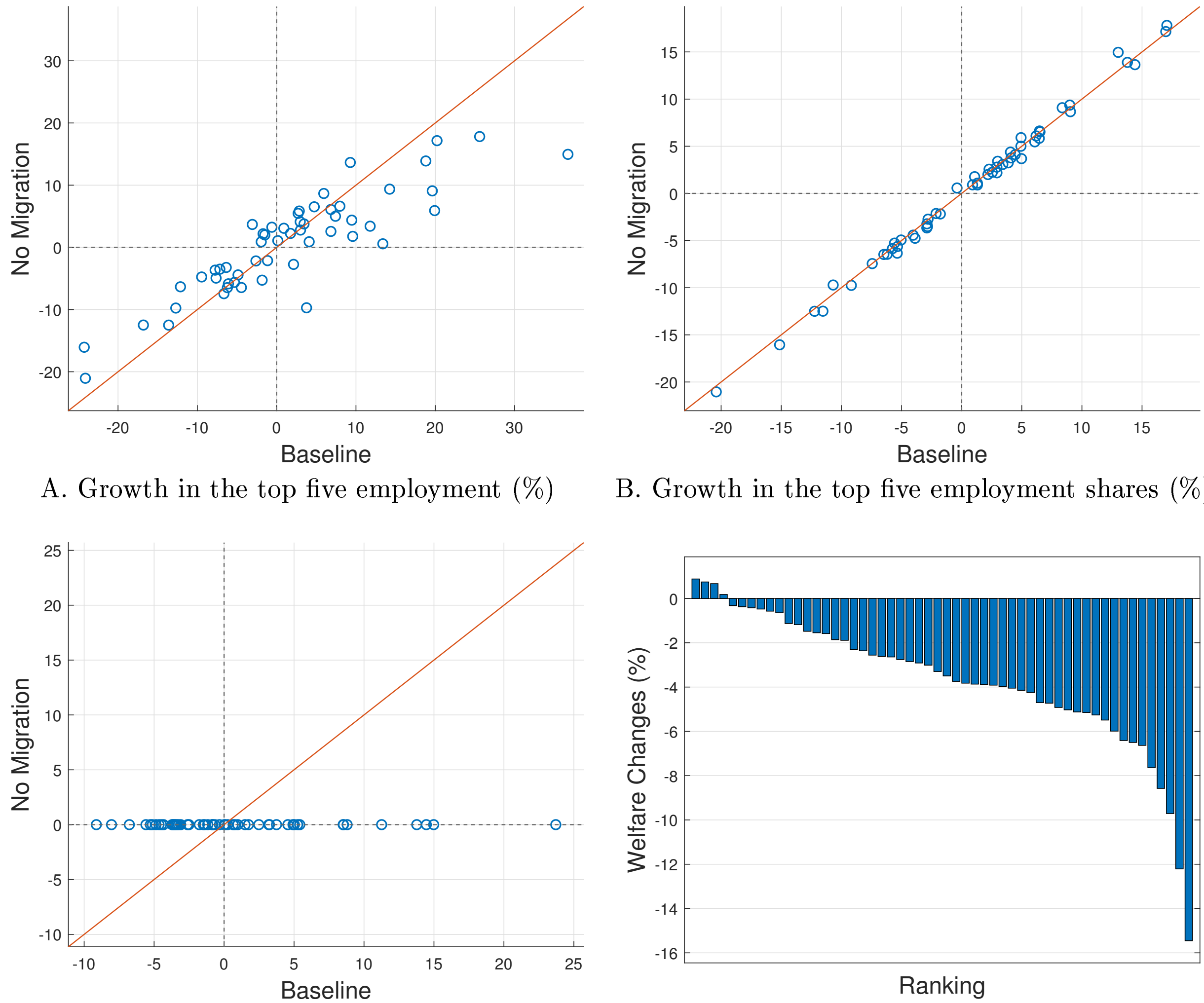
Notes. The table reports the growth rate of the aggregate-level employment in the top five sectors and the aggregate export intensity of the top five and overall manufacturing sectors between 1997 and 2000. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) report them with common decreases, common increases, and selective decreases by the median of the empirical distribution, respectively; and column (6) reports them with reductions by the components predicted by the index of regional conflicts. The numbers in the brackets are the level in 1997.

Table 8: Regional Effects of Migration Frictions on Sectoral Reallocation

	Estimated $\hat{\beta}^{reg}$, 1997–2000, $\triangle \ln y_{nt} = \beta^{reg}\text{RegEX}_{nt_0} + \epsilon_{nt}$					
	Baseline (data)	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
	(1)	(2)	(3)	(4)	(5)	(6)
Top five emp.	5.35	3.37	5.61	5.09	8.88	5.85
Pop.	2.54	0	2.86	2.18	6.37	3.06
Top five emp. shares	2.01	2.15	2.0	2.03	1.75	1.99

Notes. The table reports the estimated coefficients of β^{reg} from the regression model $\triangle \ln y_{nt} = \beta^{reg}\text{RegEX}_{nt_0} + \epsilon_{nt}$, where RegEX_{nt_0} is the standardized regional export intensity defined in Equation (3.1) and dependent variables are the growth of regional employment in the top five sectors, population, and employment shares in the top five sectors. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) report them with common decreases, common increases and selective decreases by the median of the empirical distribution, respectively; and column (6) reports them with reductions by the components predicted by the index of regional conflicts. The numbers in the bracket are the level in 1997. These results are based on the calibrated values reported in Table 5.

the aggregate export intensity are 1.3 percentage points, 1.1 percentage points, and 1.5 percentage points lower than those of the baseline. Despite smaller increases in migration rates than the counterfactual with the common decreases, the counterfactual with the selective decreases experienced higher growths in these variables, 1.5 percentage points, 0.9 percentage point, and 1.2 percentage points higher than the baseline. This is because the common decreases led to not only larger migration inflows but also larger outflows out of more export-oriented regions. These differential effects



A. Growth in the top five employment (%) B. Growth in the top five employment shares (%)

C. Growth in population (%) D. Welfare effects (%)

Figure 6. Regional Effects. Baseline versus No-Migration Counterfactual

Notes. Panels A, B, and C illustrate the growths in the regional top five employment, top five employment shares, and population in 2000 relative to 1997 of the baseline and the counterfactual with no migration. Each dot represents a region. X- and y-axes correspond to the baseline and the no-migration counterfactual. The red line is the 45-degree line. Panel D illustrates the regional welfare changes (Equation (4.24)), in descending order, in the counterfactual with no migration relative to the baseline.

of the selective and the common decreases indicate the effectiveness of migration policies to boost aggregate exports depends on both the level and direction of the reductions.

The documented aggregate effects were driven by increased migration inflows to more export-oriented regions. To show this result, I regress growths in regional outcomes of interest between 1997 and 2000 on the standardized regional export intensity,

$$\triangle \ln y_{nt} = \beta^{reg}\text{RegEX}_{nt_0} + \epsilon_{nt},$$

and report the estimated $\hat{\beta}^{reg}$ that captures differential growth of y_{nt} depending on the regional export intensity. Positive estimates of β^{reg} imply that more export-oriented regions experienced higher growth in y_{nt}, and larger magnitude of the positive estimates implies even higher growth. The dependent variables are regional growths in the top five employment, population, and top five employment shares.

Table 8 reports the estimated $\hat{\beta}^{reg}$. In all economies, more export-oriented regions experienced higher growths in those three outcomes, implied by the positively estimated coefficients. However, the magnitude of the estimated coefficients differed across economies depending on their level of migration frictions. With lower frictions, there were larger increases in population and the top five employment in more export-oriented regions due to increased migration inflows, reflected by higher $\hat{\beta}^{reg}$. That said, at the same time, because of the upward-sloping labor supply curve, these inflows decreased the magnitude of the responsiveness of the top five employment shares in more export-oriented regions, reflected by the lower magnitude of $\hat{\beta}^{reg}$ with lower migration frictions.

Panels A, B, and C of Figure 6 compare growths in regional top five employment, population, and top five employment shares between 1997 and 2000 of the baseline and the no-migration counterfactual. Variation in the top five employment, $L_{njt} = \lambda_{njt} L_{nt}$, between the two economies can come from variation in either the top five employment shares, λ_{njt}, or population, L_{nt}. The variation in population through migration explains most of the variation in the top five employment, of which only about 1% can be explained by the changes in the top five employment shares within regions.

Real GDP Having established that migration frictions affected amounts of sectoral reallocation and export intensities, I examine how these changes translate into real GDP growth. Real GDP is the notion of changes in total physical output produced in the economy. In the model, following the practice of the South Korean statistical agencies, I construct chain-weighted real GDP.

Table 9 reports the cumulative real GDP growth after the devaluation. Real GDP dropped by 11.2% in the year of the devaluation. In the no-migration counterfactual, the cumulative real GDP growth between 1997 and 2000 was 0.3 percentage point lower than the baseline. Also, the selective decreases boosted real GDP growth more effectively than the common decreases. With the selective decreases, the growth could have been 0.2 percentage point higher. These results again imply that direction of reductions in frictions matters for the aggregate outcomes.

Welfare I also examine the welfare effects of the counterfactual migration friction changes. I measure welfare changes of workers initially located in region n in the counterfactuals relative to the baseline in terms of consumption equivalent variation. These welfare changes can be expressed as

$$\widehat{\text{Wel}}_{nt_0}^{c} = (1-\beta) \sum_{\tau=t_0}^{\infty} \beta^{\tau} \ln \frac{\hat{C}_{n\tau}^{c}}{(\hat{\mu}_{nn\tau}^{c})^{\nu}}, \tag{4.24}$$

Table 9: Real GDP Growth after the Devaluation

	Cumulative real GDP growth (%)					
	Baseline	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflicts
Years since the devaluation	(1)	(2)	(3)	(4)	(5)	(6)
0 year	-11.16	-11.15	-11.17	-11.15	-11.13	-11.19
1 year after	-3.90	-3.99	-3.90	-3.90	-3.78	-3.92
2 years after	-1.07	-1.32	-1.06	-1.10	-0.87	-1.08
3 years after	-2.80	-3.14	-2.78	-2.84	-2.57	-2.83

Notes. This table reports the cumulative real GDP growth after the devaluation relative to 1997.

Table 10: Aggregate Welfare Effects of Migration Frictions

Aggregate welfare changes, $\widehat{AggWel}^c_{t_0}$ (%)				
No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
(1)	(2)	(3)	(4)	(5)
-1.91	0.71	-0.59	0.44	2.10

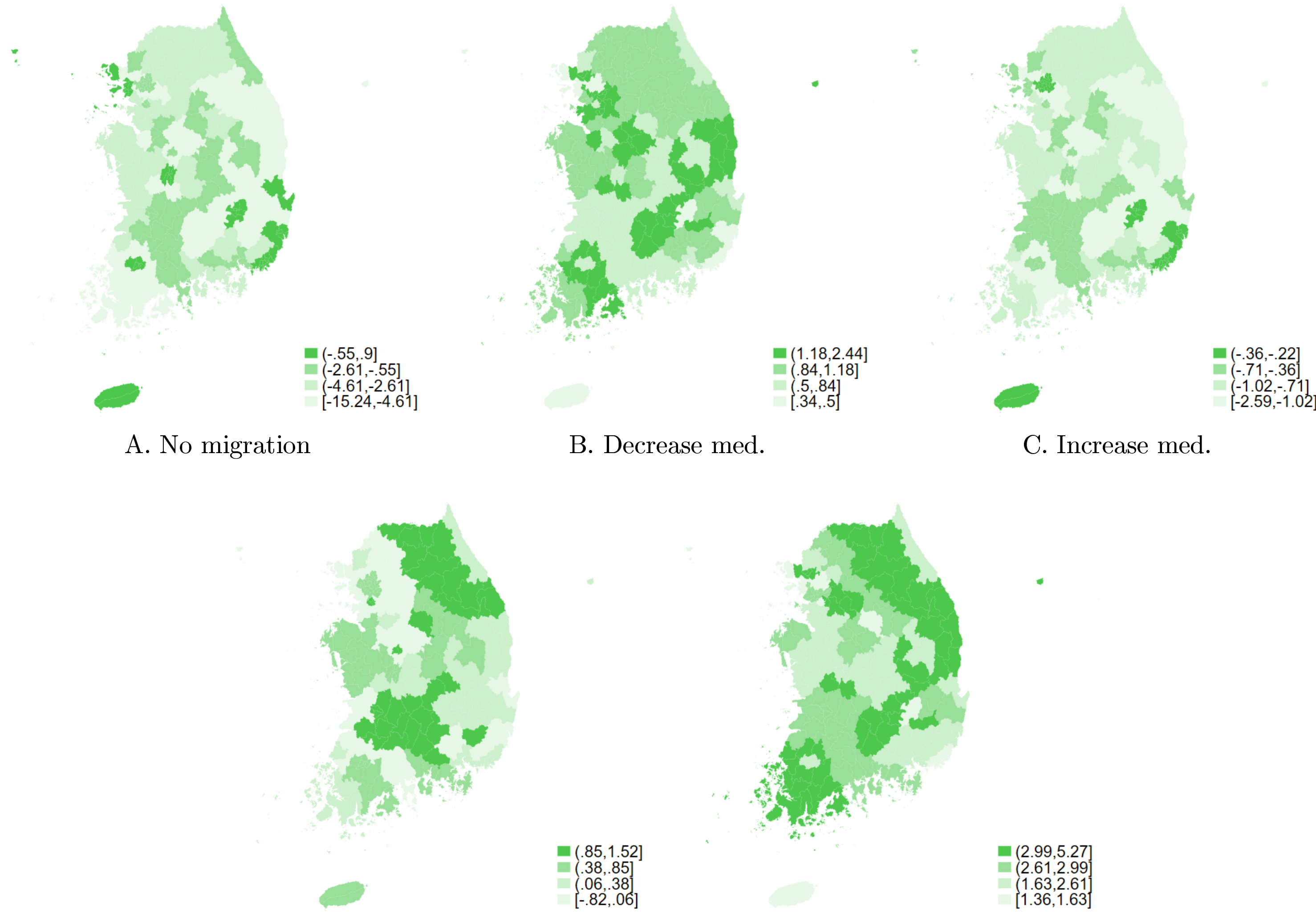
Notes. This table reports the aggregate welfare effects of the counterfactual migration friction changes relative to the baseline. The aggregate welfare effects are defined as the weighted average of the regional welfare effects (Equation (4.24)), where the weights are given by the initial population.

where $\hat{x}^c_t$ denotes the ratio of the same variable x in the counterfactual and baseline at a given time: $\hat{x}^c_t \equiv x^c_t / x_t$.[37] I define the aggregate welfare changes as the weighted average of regional welfare changes, where the weights are given by the initial population:

$$\widehat{\mathrm{AggWel}}^c_{t_0} = \sum_{n \in \mathcal{N}} \frac{L_{nt_0}}{\sum_{m \in \mathcal{N}} L_{mt_0}} \widehat{\mathrm{Wel}}^c_{nt_0}.$$

Table 10 reports the aggregate welfare changes of the counterfactuals relative to the baseline. Overall, lower migration frictions improved the aggregate welfare. In the no-migration counterfactual, there was a welfare loss of 1.9% relative to the baseline. Although growths in the aggregate export intensity and real GDP were higher in the counterfactual with the selective decreases than the common decreases, the welfare gains were larger with the common decreases, implying that policies that bring higher aggregate export intensity or real GDP growth do not necessarily bring the largest

[37] In Online Appendix Section C.2, I derive the welfare formula in Equation (4.24) in detail.



A. No migration

B. Decrease med.

C. Increase med.

D. Decrease med. (selective)

E. No regional conflicts

Table 11: Region Welfare Effects of Counterfactual Migration Friction Changes Relative to the Baseline Economy

Notes. This figure plots the welfare effects of the counterfactual migration friction changes relative to the baseline. Panels A, B, C, D, and E consider the counterfactuals with no migration, the common decreases by the median, the common increases by the median, the selective decreases by the median, and no-regional conflicts, respectively. Regions are colored based on the quartiles and colored darker with higher welfare changes.

welfare gains.

Lower migration frictions had distributional consequences across regions, depending on their regional export-intensity (Figure 11). For example, with no migration, the welfare effects varied from about 0.8 to negative 15% (Panel D of Figure 6).[38] With lower migration frictions, the welfare of workers initially located in more export-oriented regions (the northwestern and southeastern regions) tended to deteriorate because increased migration inflows lowered their wages by increasing labor supply. These distributional consequences are also graphically vivid in the counterfactual with the selective decreases (Panel D of Figure 11), where the northwestern and southeastern regions got relatively worse off. With reductions in the components predicted by the index of regional conflicts, the southwestern regions had the largest welfare gains (Panel E of Figure 11) because these regions had not only lower export-intensity, but also higher migration costs to more export-oriented regions due to conflicts.

Robustness I conduct robustness analysis with different values of σ, θ, $1/\nu$, and ψ. I consider alternative values of $\sigma = 4$, $\theta = 2$, $1/\nu = 0.5$, or $\psi = 0.5$, which are other commonly used values in the literature. For each set of different values of the parameters, the model is re-calibrated and fitted to the data. I also conduct analysis that feeds permanent migration friction shocks instead of temporary ones. Online Appendix Tables D9, D10, D11, D12, and D13 report the results.

Because shocks are identified up to the value of σ, lower values of σ imply smaller magnitude of $\{\hat{A}_{njt}, P^F_{jt}, D^F_{jt}\}$ and therefore decrease magnitude of the drop in real GDP growth and responsiveness to migration friction changes. Also, lower values of $1/\nu$ imply that the welfare becomes more sensitive to changes in own migration shares, increasing the magnitude of the welfare effects. The permanent reductions had larger welfare consequences because they permanently made workers' migration less or more costly. However, they did not affect the results on transitional dynamics.

5 Conclusion

This paper studies how internal migration and its frictions affected sectoral reallocation of labor after the 1998 South Korean large devaluation episode. Exploiting cross-sectional variation in industrial composition, I provide empirical evidence on reallocation of labor to more export-intensive sectors and to more export-oriented regions. This empirical evidence motivates that sectoral and spatial reallocation of labor could have been interlinked.

Motivated by the evidence, I build a dynamic spatial general equilibrium model to quantify the effects of migration frictions on the adjustment of the economy to the devaluation and evaluate policies that temporarily reduce migration frictions. I find that if migration were not allowed, fewer workers would be reallocated to more export-intensive sectors, which leads to lower aggregate export intensity and real GDP growth. I also find that temporary empirically-plausible reductions can

[38]Two regions that experienced more than 10% welfare loss are the rural regions with the first- and the second-lowest own-migration shares in 1997 that were experiencing large population loss. Low own-migration shares led these regions to have large welfare losses, although migration was only temporarily not allowed.

facilitate sectoral reallocation and boost aggregate export intensity and real GDP growth. These findings suggest that tighter spatial linkages across factor markets can improve the flexibility of an economy, and that migration policies can be one of the policy options to stimulate aggregate exports and economic recovery after large devaluations.

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ONLINE APPENDIX

(NOT FOR PUBLICATION)

A Appendix: Data

A.1 Construction of Data Used for Both Empirical and Quantitative Analysis

Region-sector employment I use the Census on Establishment to construct region-sector employment shares. The Census on Establishment covers the universe of formal establishments with one or more employees except for agriculture, forestry, and fisheries businesses by individual owners and establishments related to national defense, housekeeping services, and international and foreign organizations. On average, approximately 2.9 million establishments are covered by the data set across the sample period from 1994 to 2002. The data set has information on geographical location, sectors, and employment of establishments. I convert the Korean Sector Industry Code (KSIC) to the ISIC Rev 3. The sample in 1994 is used to construct the initial employment shares for the shift-share regressor of the empirical analysis.

Region-to-region migration flows I construct region-to-region migration flows using the internal migration and population data sets obtained from the Statistics Korea. Migration flows are calculated as the total number of migrants between origin and destination regions divided by lagged populations of origin regions. Own migrants are calculated as the lagged population minus the sum of migrants to other regions. Given that my focus is the working population, I restrict the samples of populations and migration flows to people aged between 20 and 55 years.

Sectoral trade data and IO tables Sectoral trade data is obtained from the WIOD between 1995 and 2002. Countries except for South Korea are aggregated and classified as the Rest of the World (ROW). Trade data and IO tables in 1993 used to construct the initial sectoral export intensities, SecEX_{njt_0}, are obtained from the Bank of Korea.

Sector classification I categorize sectors into 15 sectors. This grouping is reported in Table A1.

A.2 Construction of Data Only Used for the Quantitative Analysis

Region-sector gross output In order to construct region-sector gross output, I combine the WIOD IO tables and the Census of Establishment. From the WIOD IO tables, I obtain the country-level sectoral gross output. I allocate this sectoral gross output across regions using the region-sector employment shares calculated from the Census of Establishment. Specifically, region-sector gross output is calculated as $\mathrm{GO}_{njt} = \tilde{\omega}_{nt}^{j} \times \mathrm{GO}_{jt}^{WIOD}$. GO_{jt}^{WIOD} is sector j's gross output obtained from the WIOD. $\tilde{\omega}_{nt}^{j}$ is a share of sector j employment of region n to total sector j employment: $\tilde{\omega}_{nt}^{j} = \frac{\mathrm{Emp}_{njt}}{\sum\limits_{m} \mathrm{Emp}_{mjt}}$.

Region-sector real capital stock To construct region-sector real capital stock series, I combine the four data sets: the Census of Establishment, the Mining and Manufacturing Survey, the WIOD Socio Economic Accounts (WIOD-SEA), and the IMF Investment and Capital Stock Database (IMF-ICSD). I first allocate the aggregate real capital stock from the IMF-ICSD using country-sector level

Table A1: Sector Classification

Aggregated Industry	Industry
1. Commodity	Agriculture, hunting and forestry (A), Fishing (B) Mining and quarrying (C)
2. Food, Beverages, and Tobacco	Food products and beverages (15), Tobacco products (16)
3. Textiles, Apparel, & Leather	Textiles (17), Apparel (18) Leather, luggage, handbags, saddlery, harness, and footwear (19)
4. Wood, Paper & Printing	Wood and of products, cork (20) Paper and paper products (21) Publishing and printing (22)
5. Chemicals, Petrochemicals, and Rubber and Plastic Products	Coke, refined petroleum products and nuclear fuel (23) Chemicals and chemical products (24) Rubber and plastics products (25)
6. Non-Metallic Mineral Products	Other non-metallic mineral products (26)
7. Basic and Fabricated Metals	Basic metals (27), Fabricated metals (28)
8. Electrical Equipment	Office, accounting and computing machinery (30) Electrical machinery and apparatus n.e.c. (31) Ratio, television and communication equipment and apparatus (32) Medical, precision, and optical instruments, watches and clocks (33)
9. Machinery and Transport Equipment	Machinery and equipment n.e.c. (29) Motor vehicles, trailers, and semi trailers (34) Other transport equipment (35)
10. Manufacturing n.e.c.	Manufacturing n.e.c. (36), Recycling (37)
11. Utilities	Electricity, gas and water supply (E)
12. Construction	Construction (F)
13. Whole and Retail	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (G)
14. Transport Service	Land transport; transport via pipelines (60) Water transport (61), Air transport (62) Supporting and auxiliary transport activities; activities of travel agencies (63)
15. Other Service	Hotels and restaurants (H) Post and telecommunications (64), Financial intermediation (J) Real estate, renting, and business activities (K) Public administration and defense (L); compulsory social security (L) Education (M), Health and social work (N) Other community, social and personal service activities (O) Activities of private households as employers and undifferentiated production activities of private households (P)

Note. The codes inside the parenthesis denote the ISIC rev 3.1. industry codes.

nominal capital stock shares from the WIOD-SEA: $K_{jt} = \tilde{\omega}_{jt}^{K} \times K_t$, where K_t is the aggregate real capital stock from the IMF-ICSD and $\tilde{\omega}_{jt}^{K}$ is a share of sector j nominal capital stock to the total nominal capital stock across sectors from the WIOD-SEA.

Using the Mining and Manufacturing Survey that has information on nominal fixed assets of manufacturing establishments, I calculate region-sector fixed asset shares:

$$\tilde{\omega}_{njt}^{K} = \frac{\text{Fassets}_{njt}}{\sum_{n' \in \mathcal{N}} \text{Fassets}_{n'jt}},$$

where Fassets_{njt} is the sum of fixed assets of sector j establishments in region n. Then, I allocate region-sector real capital stock using these computed shares: $K_{njt} = \tilde{\omega}_{njt}^{K} \times K_{jt}$. For the non-manufacturing sectors, I do not have information on region-sector level nominal fixed assets, so I use region-sector employment shares to allocate region-sector real capital stock.

Sectoral PPI and real gross output Sectoral PPIs and real gross output are obtained from the OECD STAN Database. I apply the HP filter to 30 years of these variables to remove the trend component and isolate the cyclical component. I set the smoothing parameter to 100.

B Appendix: Empirics

B.1 Additional Figures and Tables

Table B2: Summary of Rotemberg Weights

Spec.	Sectoral reallocation		Spatial reallocation	
Dep.	Top five	Overall	Inflow	Outflow
	(1)	(2)	(3)	(4)
Share of $\hat{\alpha}_j < 0$	0.467	0.467	0.467	0.467
Share of top fivelargest $\hat{\alpha}_j$	0.963	0.963	0.963	0.963
$\sum_{j\|\hat{\alpha}_j<0} \hat{\alpha}_j \hat{\beta}_j$	-0.009	-0.005	-0.016	0.009
$\sum_{j\|\hat{\alpha}_j>0} \hat{\alpha}_j \hat{\beta}_j$	0.046	0.020	0.076	-0.049

Note. This table reports the summary of the Rotemberg weights, $\hat{\alpha}_j$, and the just-identified IV estimators based on each share, $\hat{\beta}_j$.

Table B3: Rotemberg Weights

Spec.	Sectoral reallocation				Spatial reallocation			
Dep.	Top five		Overall		Inflow		Outflow	
	$\hat{\alpha}_j$	$\hat{\beta}_j$	$\hat{\alpha}_j$	$\hat{\beta}_j$	$\hat{\alpha}_j$	$\hat{\beta}_j$	$\hat{\alpha}_j$	$\hat{\beta}_j$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Commodity	-0.007	0.261	-0.007	0.064	-0.007	0.138	-0.007	-0.028
Food, Beverages, and Tobacco	-0.002	-0.269	-0.002	-0.097	-0.001	0.011	-0.001	-0.297
Textiles, Apparel, & Leather	0.532	0.017	0.532	0.005	0.519	0.041	0.519	-0.029
Wood, Paper & Printing	0.006	0.041	0.006	-0.024	0.006	0.170	0.006	-0.055
Chemicals	0.063	0.087	0.063	0.050	0.066	0.118	0.066	-0.061
Non-Metallic Mineral Products	0.003	0.351	0.003	-0.178	0.003	0.100	0.003	-0.103
Basic and Fabricated Metals	0.047	0.108	0.047	0.091	0.044	0.021	0.045	-0.072
Electrical Equipment	0.377	0.050	0.377	0.021	0.393	0.079	0.393	-0.035
Machinery and Transport Equipment	0.111	0.028	0.111	0.009	0.111	0.076	0.111	-0.088
Manufacturing n.e.c.	0.034	0.096	0.034	0.040	0.034	0.164	0.034	-0.086
Utilities	0.000	-0.054	0.000	-0.043	0.000	0.045	0.000	-0.035
Construction	0.000	-0.032	0.000	-0.045	0.000	0.067	0.000	-0.053
Whole and Retail	-0.089	0.055	-0.089	0.034	-0.092	0.080	-0.091	-0.058
Transport Service	-0.043	0.024	-0.043	0.029	-0.044	0.127	-0.044	-0.039
Other Service	-0.032	0.061	-0.032	0.025	-0.033	0.068	-0.032	-0.051

Note. This table reports the Rotemberg weights, $\hat{\alpha}_j$, and the just-identified IV estimators based on each share, $\hat{\beta}_j$.

Table B4: Robustness. Alternative Regional Exposure Measure. OLS First-Difference. Sectoral Reallocation of Labor. Increased Reallocation of Labor to More Export-Intensive Sectors within Regions

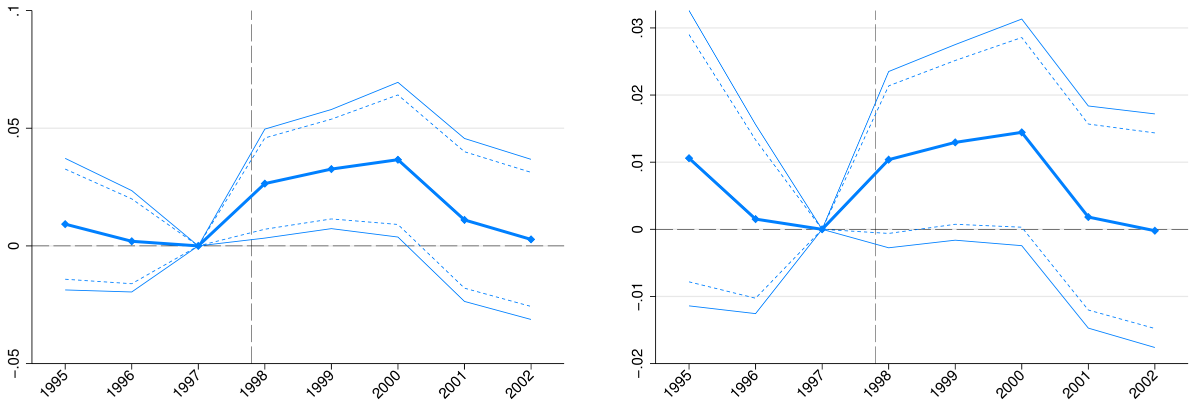
Dep.	△ Top five mfg., 1997-2000				△ Overall mfg., 1997-2000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RegEXIM_{nt_0}	0.03^{*}	0.04^{**}	0.03^{**}	0.04^{**}	0.01^{*}	0.01^{*}	0.02^{**}	0.02^{**}
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial emp.		-0.02^{*}		-0.02		-0.00		-0.00
		(0.01)		(0.01)		(0.01)		(0.01)
Labor demand			-0.98	-0.87			-0.50	-0.50
			(1.08)	(1.09)			(0.46)	(0.47)
Adj. R^2	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.01
# Cluster	121	121	121	121	121	121	121	121
N	121	121	121	121	121	121	121	121

Note. This table reports the OLS estimates of Equation (3.3). Dependent variables are changes in log of the top five most export-intensive and overall manufacturing sectors between 1997 and 2000 in columns (1)-(4) and (5)-(8), respectively. RegEXIM is the regional export measure defined in Equation (3.6). Controls include initial log employment and the constructed labor demand shocks. Standard errors are reported in parentheses, two-way clustered at the regional levels. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B5: Robustness. Alternative Regional Exposure Measure. OLS First-Difference. Spatial Reallocation of Labor. Increased Migration Flows to More Export-Oriented Regions

Dep.	△ Migration inflows, 1997-2000				△ Migration outflows, 1997-2000			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RegEXIM_{nt_0}	0.06^{***}	0.06^{***}	0.06^{***}	0.06^{***}	-0.05^{***}	-0.04^{***}	-0.05^{***}	-0.04^{***}
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial emp.		0.00		0.00		-0.03^{***}		-0.03^{***}
		(0.01)		(0.01)		(0.01)		(0.01)
Labor demand			-0.07	-0.11			-0.11	0.13
			(0.60)	(0.62)			(0.59)	(0.59)
Origin FE	✓	✓	✓	✓				
Dest. FE					✓	✓	✓	✓
Adj. R^2	0.04	0.04	0.04	0.04	0.07	0.08	0.07	0.08
# Cluster 1	121	121	121	121	121	121	121	121
# Cluster 2	121	121	121	121	121	121	121	121
N	13336	13336	13336	13336	13336	13336	13336	13336

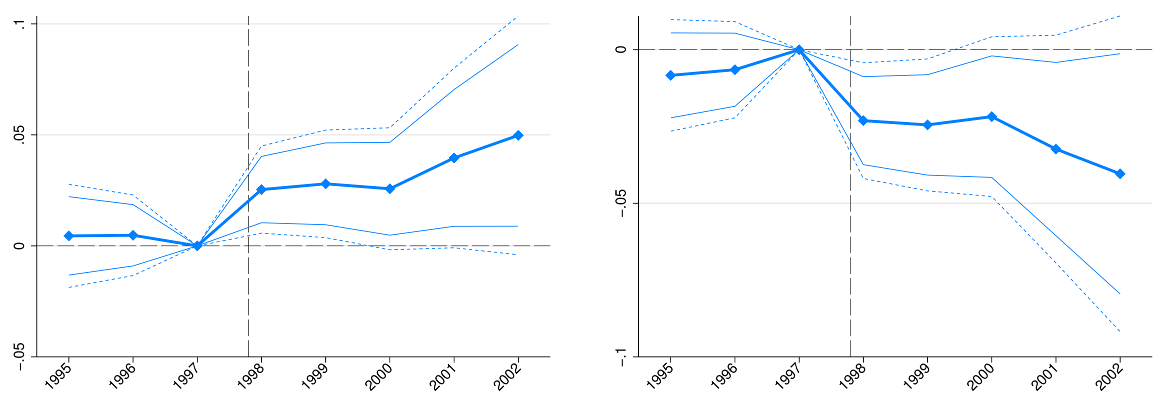
Note. This table reports the OLS estimates of Equation (3.5). Dependent variables are changes in log migration inflow and outflow shares between 1997 and 2000 in columns (1)-(4) and (5)-(8), respectively. RegEXIM is the regional exposure measure defined in Equation (3.6). Controls include initial log employment and the constructed labor demand shocks. Standard errors are reported in parentheses, two-way clustered at the origin and destination levels. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.



A. Top five mfg., RegEXIM$_{nt_0}$ B. Overall mfg., RegEXIM$_{nt_0}$

Figure B7. Robustness. Alternative Regional Exposure Measure. Event Study. Sectoral Reallocation of Labor. Workers Reallocated to More Export-Intensive Sectors within Regions

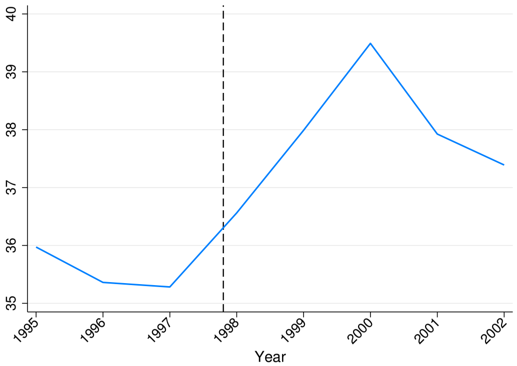
Note. This figure illustrates the estimated β_τ in Equation (3.2). In Panels A and B, the dependent variables are the log of employment shares in the top five and overall manufacturing sectors. RegEXIM is the regional exposure measure defined in Equation (3.6). The black dashed line indicates the year of the devaluation. The figure reports 90 and 95 percent confidence intervals based on standard errors clustered at the regional level.



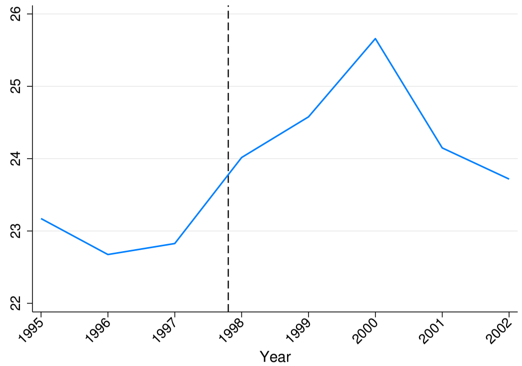
A. Migration inflows, Dest. RegEXIM$_{mt_0}$ B. Migration outflows, Origin RegEXIM$_{nt_0}$

Figure B8. Robustness. Alternative Regional Exposure Measure.Event Study. Spatial Reallocation of Labor. Workers Migrated to More Export-Oriented Regions.

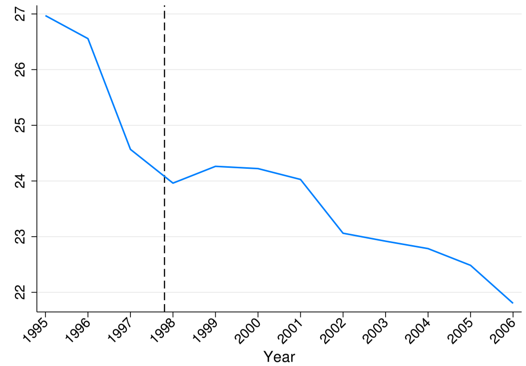
Note. This figure illustrates the estimated β_τ in Equation (3.4). The dependent variables are the log of migration shares between origin and destination regions. In Panels A and B, the estimated coefficients for RegEXIM$_{nt_0}$ of origin and destination are plotted. RegEXIM is the regional exposure measure defined in Equation (3.6). I estimate Equation (3.4) using PPML to deal with statistical zeros. The black dashed line indicates the year of the devaluation. The figure reports 90 and 95 percent confidence intervals based on standard errors two-way clustered at the origin and destination levels.



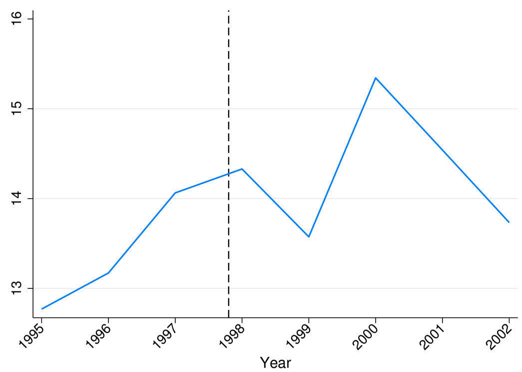
A. Top five gross output shares (%)



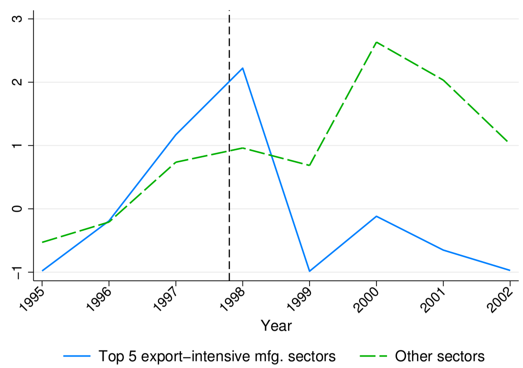
B. Top five value-added shares (%)



C. Mfg. employment shares (%)



E. Aggregate import intensity (%)



E. Import intensities by sectors (%)

Figure B9. Aggregate Patterns after the Devaluation

Notes. Panels A and B plot the aggregate gross output and value-added shares of the top five most export-intensive manufacturing sectors. Panel C plots the aggregate employment shares in the overall manufacturing sectors. Panel D plots the aggregate import intensity. Panel E plots the import intensity of the top five most export-intensive manufacturing sectors and the other remaining sectors.

C Appendix: Theory

C.1 Landlords' Intertemporal Utility Maximization Problem

Landlords' utility maximization problem can be written as:

$$\max_{\{C^k_{ns}, K_{n,s+1}\}^{\infty}_{s=t_0}} \sum_{s=t_0}^{\infty} \beta^{t_0+s} U(C^k_{ns}),$$

subject to the budget constraint:

$$P_{nt}C^k_{nt} + P_{nt}(K_{n,t+1} - (1-\delta)K_{nt}) = r_{nt}K_{nt}.$$

I can rewrite this problem as the following Lagrangian:

$$\mathcal{L} = \sum_{s=t_0}^{\infty} \beta^s U(C^k_{ns}) + \mu_s[r_{ns}K_{ns} - P_{ns}C^k_{ns} - P_{ns}(K_{n,s+1} - (1-\delta)K_{ns})].$$

The first-order conditions are

$$\beta^t U'_{nt} = \mu_t P_{nt}$$

and

$$P_{nt}\mu_{nt} = \mu_{t+1}(r_{n,t+1} - P_{n,t+1}(1-\delta)).$$

Combining these two first-order conditions, I obtain the following Euler equation:

$$U'_{nt} = \beta R_{n,t+1} U'_{n,t+1}.$$

Substituting $U(C^k_{nt}) = \frac{(C^k_{nt})^{1-1/\psi}}{1-1/\psi}$, I obtain

$$(C^k_{nt})^{-1/\psi} = \beta R_{n,t+1}(C^k_{n,t+1})^{-1/\psi}.$$

Following Kleinman et al. (2021), using the guess-and-verify method, I show that $C^k_{nt} = \zeta_{nt}R_{nt}K_{nt}$ where

$$\zeta^{-1}_{nt} = 1 + \beta^{\psi}\left(R^{\frac{\psi-1}{\psi}}_{n,t+1}\zeta^{-\frac{1}{\psi}}_{n,t+1}\right)^{\psi}.$$

The budget constraint implies that $K_{n,t+1} = (1-\zeta_{nt})R_{nt}K_{nt}$ holds. Substituting guessed $K_{n,t+1}$ and C^k_{nt} into the Euler equation, it can be checked that the guess satisfies the Euler equation.

C.2 Welfare

I denote V_{nt} and V_{nt}^c as the present discounted value of utility at period t in region n under the baseline and counterfactual shocks. Superscript c denotes counterfactual variables. I can write the baseline expected lifetime utility of living in region n at period t as

$$V_{nt} = \ln C_{nt} + \beta V_{n,t+1} + \nu \ln \left(\sum_m \exp(\beta(V_{m,t+1} - V_{n,t+1}) - \tau_{nmt} + B_{nt})^{\frac{1}{\nu}} \right) \tag{C.1}$$

where the second term on the RHS of the above equation is the option value of beginning at region n at period t. This option value can be expressed as own migration share:

$$\nu \ln \left(\sum_m \exp(\beta(V_{m,t+1} - V_{n,t+1}) - \tau_{nmt} + B_{nt})^{\frac{1}{\nu}} \right) = -\nu \ln \mu_{nnt}. \tag{C.2}$$

Plugging this into the value function, I can obtain

$$V_{nt} = \ln C_{nt} + \beta V_{n,t+1} - \nu \ln \mu_{nnt}. \tag{C.3}$$

Iterating the above equation, I obtain

$$V_{nt} = \sum_{s=t}^{\infty} \beta^{s-t} \ln C_{ns} - \nu \sum_{s=t}^{\infty} \beta^{s-t} \ln \mu_{nns}. \tag{C.4}$$

Using the above expression, I can express the lifetime utilities in the baseline and the counterfactual economy as follows:

$$V_{nt} = \sum_{s=t}^{\infty} \beta^{s-t} \ln \left(\frac{C_{ns}}{(\mu_{nns})^{\nu}} \right), \qquad V_{nt}^c = \sum_{s=t}^{\infty} \beta^{s-t} \ln \left(\frac{C_{ns}^c}{(\mu_{nns}^c)^{\nu}} \right). \tag{C.5}$$

I measure the changes in welfare between the baseline and the counterfactual in terms of compensating variation, defined as the scalar δ_n^{wel} that satisfies

$$\sum_{s=t}^{\infty} \beta^{s-t} \ln \left(\frac{\delta_n^{wel} C_{ns}}{(\mu_{nns})^{\nu}} \right) = V_{nt}^c. \tag{C.6}$$

Rearranging the equation,

$$\ln \delta_n^{wel} = (1-\beta) \sum_{s=t}^{\infty} \beta^{s-t} \ln \left(\frac{(I_{ns}^c / I_{ns})}{(P_{ns}^c / P_{ns})(\mu_{nns}^c / \mu_{nns})^{\nu})} \right),$$

which can be rewritten as

$$\ln \delta_n^{wel} = (1-\beta) \sum_{s=t}^{\infty} \beta^{s-t} \ln \left(\frac{\hat{I}_{ns}^c}{\hat{P}_{ns}^c (\hat{\mu}_{nns}^c)^{\nu})} \right),$$

where $\hat{x}_t^c$ denotes changes of variable x between the baseline and counterfactual economies in given time: $\hat{x}_t^c \equiv x_t^c / x_t$.

D Appendix: Quantification

D.1 Regression Model of Sectoral Labor Supply Elasticity

In this section, I describe the derivation and estimation procedure of Equation (4.18). By taking the log of Equation (4.7), I can derive the following regression model:

$$\ln \lambda_{njt} = \theta \ln W_{njt} + \sum_{k \in \mathcal{J}} W^{\theta}_{nkt} + \ln E_{njt}.$$

The labor productivity shock $\ln E_{njt}$ can be decomposed into four components that are varying at region-year, sector-year, region-sector, and region-sector-year levels: $e_{njt} \equiv \ln E_{njt} = \tilde{e}_{nt} + \tilde{e}_{jt} + \tilde{e}_{nj} + \tilde{e}_{njt}$, where $\tilde{e}_{nt}$ and $\tilde{e}_{jt}$ are region- and sector-year components, $\tilde{e}_{nj}$ is time-invariant region-sector components, and $\tilde{e}_{njt}$ is region-sector-year components. Then, the above regression model can be re-expressed as in Equation (4.18):

$$\ln \lambda_{njt} = \theta \ln W_{njt} + \underbrace{\delta_{nt}}_{= \sum\limits_{k \in \mathcal{J}} W^{\theta}_{nkt} + \tilde{e}_{nt}} + \underbrace{\delta_{jt}}_{= \tilde{e}_{jt}} + \underbrace{\delta_{nj}}_{= \tilde{e}_{nj}} + \tilde{e}_{njt}.$$

Region-year fixed effects δ_{nt} absorb $\tilde{e}_{nt}$ and $\sum_{k \in \mathcal{J}} W^{\theta}_{nkt}$. δ_{nj} absorbs $\tilde{e}_{nj}$. Sector-year fixed effects δ_{jt} absorb $\tilde{e}_{jt}$. Because the residual labor productivity shocks affect the determination of wages, W_{njt} and $\tilde{e}_{njt}$ are correlated, leading to the endogeneity problem. Therefore, I estimate the equation using the IV in Equation (4.19).

To estimate the regression model in Equation (4.18), I need data on region-sector wages. I obtain these wages from the Mining and Manufacturing Survey, which contains wage bill information for mining and manufacturing establishments. Using the information on wage bills and location of production, I calculate region-sector wages as the weighted average of wage bills divided by total employment of establishments within region-sectors, where the weights are given by establishment-level value-added. The Mining and Manufacturing Survey only has information on wages for the mining and manufacturing sectors, so I estimate Equation (4.18) only for the mining and manufacturing sectors.

To use the data more efficiently, I use overlapping 3-year long-differences: 1996-1999 and 1997-2000. Table D6 reports the second and first stage results in columns (1) and (2), respectively. The estimated θ is around 1.3, statistically significant at the 5% level. The first stage F-statistics is 9.4, slightly below the rule of thumb value of 10. This suggests that the estimates may suffer from the weak IV problem. Therefore, I conduct the inference based on Anderson-Rubin (AR) statistics which are robust to the weak IV problem. The AR statistics clearly reject the null that $\theta = 0$ at the 1% level and its confidence interval covers the value of the second-stage estimates.

Table D6: Estimation of Sectoral Labor Supply Elasticity θ

	Second-stage	First-stage
	(1)	(2)
Wage	1.34**	
	(0.63)	
IV		3.10***
		(1.65)
AR	10.14	
AR-p	(0.00)	
AR-CI	$[0.50, \infty)$	
KP-F	9.4	
N	1076	1076

Notes. This table reports the second- and first-stage estimation results of Equation (4.18). The IV is defined in Equation (4.19). AR, AR-p, and AR-CI are Anderson-Rubin statistics, its p-values, and confidence intervals. KP-F is the Kleinbergen-Paap F-statistics. Standard errors are reported in parentheses, clustered at the region-sector level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D7: Estimation of Migration Elasticity $1/\nu$

	Second-stage	First-stage
	(1)	(2)
$\ln I_{nt}/P_{nt}$	0.69***	
	(0.25)	
IV		0.03***
		(0.00)
KP-F	21.62	
# clusters (Origin)	54	54
# clusters (Dest.)	54	54
N	5830	5830

Notes. This table reports the second- and first-stage estimation results of Equation (4.20). The IV is defined in Equation (4.21). AR, AR-p, and AR-CI are Anderson-Rubin statistics, its p-values, and confidence intervals, respectively. KP-F is the Kleinbergen-Paap F-statistics. Standard errors are reported in parentheses, two-way clustered at the origin and destination levels. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

D.2 Regression Model of Migration Elasticity

In this section, I describe the derivation and estimation procedure of Equation (4.20). From Equations (4.9) and (4.10), I can derive the following equation:

$$V_{nt} = \ln C_{nt} - \nu \ln \mu_{nmt} + \beta V_{m,t+1} + B_{mt} - \tau_{nmt}, \quad \forall n, m.$$

Using the above equation for pairs nn and nm and subtracting one from the other,

$$\ln \frac{\mu_{nmt}}{\mu_{nnt}} = \frac{\beta}{\nu}(V_{m,t+1} - V_{n,t+1}) + \frac{1}{\nu}(B_{mt} - B_{nt}) - \frac{1}{\nu}\tau_{nmt}$$

Using Equation (4.9), the above expression can be written as

$$\ln \frac{\mu_{nmt}}{\mu_{nnt}} = \frac{\beta}{\nu} \ln \frac{I_{m,t+1}/P_{m,t+1}}{I_{n,t+1}/P_{n,t+1}} + \frac{\beta}{\nu}\Bigg(\nu \ln \sum_{n'} \exp(\beta V_{n',t+2} + B_{n',t+1} - \tau_{mn',t+1}) - \nu \ln \sum_{n'} \exp(\beta V_{n',t+2} + B_{n',t+1} - \tau_{nn',t+1})\Bigg) + \frac{1}{\nu}(B_{mt} - B_{nt}) - \frac{1}{\nu}\tau_{nmt}.$$

Using Equation (4.10) and subtracting and adding $\beta V_{m,t+2} + B_{m,t+1} - \tau_{mn,t+1}$ on the right-hand side of the above equation, I obtain that

$$\ln \frac{\mu_{nmt}}{\mu_{nnt}} = \frac{\beta}{\nu} \ln \frac{I_{m,t+1}/P_{m,t+1}}{I_{n,t+1}/P_{n,t+1}} + \beta \ln \frac{\mu_{mn,t+1}}{\mu_{mm,t+1}} + \frac{1}{\nu}(B_{mt} - B_{nt}) + \frac{1}{\nu}(\beta \tau_{mn,t+1} - \tau_{nm,t}).$$

Amenities and migration frictions can be decomposed into time-invariant and time-varying components: $B_{nt} = \tilde{B}_n + \tilde{B}_{nt}$ and $\tau_{nmt} = \tilde{\tau}_{nm} + \tilde{\tau}_{nmt}$. This gives me the following estimable regression model:

$$\ln \frac{\mu_{nmt}}{\mu_{nnt}} = \frac{\beta}{\nu} \ln \frac{I_{m,t+1}/P_{m,t+1}}{I_{n,t+1}/P_{n,t+1}} + \beta \ln \frac{\mu_{mn,t+1}}{\mu_{mm,t+1}} + \delta_{nm} + \tilde{\epsilon}_{nmt}.$$

The pair time-invariant fixed effects δ_{nm} absorb time invariant migration frictions and differences in amenities: $(\beta - 1)/\nu \times \tilde{\tau}_{nm}$ and $(1/\nu) \times (\tilde{B}_{mt} - \tilde{B}_{nt})$. $\tilde{\epsilon}_{nmt}$ is the structural error term that is a function of time-varying amenities and migration friction shocks: $\tilde{\epsilon}_{nmt} \equiv (1/\nu) \times (\beta \tilde{\tau}_{mn,t+1} - \tilde{\tau}_{nmt})$ and $(1/\nu) \times (\tilde{B}_{mt} - \tilde{B}_{nt})$.

Estimating Equation (4.18) requires information on regional price levels. I construct the regional price levels using the data on the regional CPI and housing prices which are obtained from the Statistics Korea. The regional CPI data is only available for a few regions, whereas the regional housing prices are available for all regions. Therefore, following Moretti (2017), I impute the CPI for regions with missing CPI. For the subset of regions with non-missing CPI, I run the following regression:

$$gCPI_{n,t+1} = \pi \times gHP_{n,t+1} + \delta_t + \epsilon_{nt},$$

where $gCPI_{n,t+1}$ and $gHP_{n,t+1}$ are growth of CPI and housing price in region n between t and $t+1$. Using the estimated coefficients $\hat{\pi}$ and $\hat{\delta}_t$ and housing prices, I impute the growth of CPI for missing regions and compute CPI after normalizing the 1992 level to one.

Shocks to migration frictions are correlated with real income because these shocks affect migration flows and, therefore, labor supply. Thus, I estimate the equation using the IV defined in Equation (4.21). Table D7 reports the results. The estimated coefficient is 0.69 and is statistically significant at the 1% level with strong first-stage results.

D.3 Shock Formulation of the Model

Following Caliendo et al. (2019), I break down the equilibrium into two parts: a static equilibrium in which goods and factor market clearing conditions hold, taking populations and capital stock as given, and a dynamic equilibrium that solves forward-looking migration and investment decisions of workers and landlords.

Static equilibrium Unit costs are expressed as:

$$\hat{c}_{nj,t+1} = \frac{1}{\hat{A}_{nj,t+1}} (\hat{W}_{nj,t+1})^{\gamma_j^V} \left(\frac{\hat{H}_{nj,t+1}}{\hat{K}_{nj,t+1}} \right)^{\gamma_j^K} \prod_{k=1}^{J} (\hat{P}_{nj,t+1})^{\gamma_j^k}.$$

Price indices are expressed as:

$$(\hat{P}_{nj,t+1})^{1-\sigma} \sum_{m \in \mathcal{N}} \pi^j_{mnt} (\hat{c}_{nj,t+1})^{1-\sigma} + \pi^j_{Fnt} (\hat{P}^F_{j,t+1})^{1-\sigma}.$$

Domestic trade shares are

$$\hat{\pi}^j_{mn,t+1} = \left(\frac{\hat{c}_{mj,t+1}}{\hat{P}_{nj,t+1}} \right)^{1-\sigma}.$$

Import trade shares are

$$\hat{\pi}^j_{Fn,t+1} = \left(\frac{\hat{P}^F_{j,t+1}}{\hat{P}_{nj,t+1}} \right)^{1-\sigma}.$$

Exports are

$$\mathrm{EX}_{nj,t+1} = (\hat{c}_{nj,t+1})^{1-\sigma} \hat{D}^F_{j,t+1} \mathrm{EX}_{njt}.$$

The average wages of each region are

$$\hat{W}_{n,t+1} = \left(\sum_{j \in \mathcal{J}} \lambda_{njt} \hat{W}^{\theta}_{nj,t+1} \right)^{\frac{1}{\theta}}.$$

Workers' income is

$$\hat{I}_{n,t+1} = \frac{(1+\iota_{t+1})}{(1+\iota_t)} \hat{W}_{n,t+1}.$$

Regional employment shares are

$$\hat{\lambda}_{nj,t+1} = \hat{E}_{nj,t+1} \left(\frac{\hat{W}_{nj,t+1}}{\hat{W}_{n,t+1}} \right)^{\theta}.$$

Sectoral labor supply is given by

$$\hat{H}_{nj,t+1} = (\hat{\lambda}_{nj,t+1})^{\frac{\theta-1}{\theta}} \hat{L}_{n,t+1}.$$

Goods market clearing implies that

$$\mathrm{GO}_{nj,t+1} = \sum_{m\in\mathcal{N}} \pi^{j}_{mn,t+1} \times \left[\sum_{k\in\mathcal{J}} \gamma^{j}_{k}\mathrm{GO}_{mk,t+1} + \alpha_j((1+\iota_{t+1})\hat{W}_{n,t+1}\hat{L}_{n,t+1}W_{nt}L_{nt} + \sum_{k'\in\mathcal{J}} \gamma^{K}_{j}\mathrm{GO}_{mk',t+1}) \right] + \mathrm{EX}_{nj,t+1}.$$

Labor market clearing implies that

$$W_{nj,t+1}H_{nj,t+1} = \gamma^{H}_{j}\mathrm{GO}_{nj,t+1}.$$

Capital market clearing implies that

$$K_{nj,t+1} = \left(\frac{(\gamma^{K}_{j}/\gamma^{H}_{j})\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}W_{njt}H_{njt}}{\sum_{k\in\mathcal{J}}(\gamma^{K}_{k}/\gamma^{H}_{k})\hat{W}_{nk,t+1}\hat{H}_{nk,t+1}W_{nkt}H_{nkt}} \right) K_{n,t+1}$$

Dynamic equilibrium Define $u_{nt} \equiv \exp(V_{nt})$, $b_{nt} \equiv \exp(B_{nt})$ and $m_{nmt} \equiv \exp(\tau_{nmt})$. Then, $\hat{u}_{n,t+1} \equiv \exp(V_{n,t+1} - V_{nt})$, $\hat{b}_{n,t+1} \equiv \exp(B_{n,t+1} - B_{nt})$, and $\hat{m}_{nm,t+1} \equiv \exp(\tau_{nm,t+1} - \tau_{nmt})$. Given initial allocation and an anticipated convergence sequence of changes in shocks, the following system of nonlinear equations is satisfied. Gross return on capital is given by

$$R_{n,t+1} = \frac{\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}}{\hat{P}_{nj,t+1}\hat{K}_{nj,t+1}} \Big(R_{nt} - (1-\delta) \Big) + (1-\delta).$$

Capital stock evolves according to

$$K_{n,t+2} = (1 - \zeta_{n,t+1})R_{n,t+1}K_{n,t+1}.$$

Landlords' consumption shares evolve according to

$$\zeta_{n,t+1} = \left(\frac{\zeta_{nt}}{1-\zeta_{nt}} \right) \beta^{\psi} R^{\psi-1}_{n,t+1}.$$

Migration shares are expressed as

$$\mu_{nm,t+1} = \frac{\mu_{nmt}(\hat{u}_{m,t+2})^{\frac{\beta}{\nu}}(\hat{b}_{m,t+1})^{\frac{1}{\nu}}(\hat{m}_{nm,t+1})^{-\frac{1}{\nu}}}{\sum_{m'\in\mathcal{N}} \mu_{nm't}(\hat{u}_{m',t+2})^{\frac{\beta}{\nu}}(\hat{b}_{m',t+1})^{\frac{1}{\nu}}(\hat{m}_{nm,t+1})^{-\frac{1}{\nu}}}. \tag{D.1}$$

The population evolves according to

$$L_{n,t+1} = \sum_{m \in \mathcal{N}} \mu_{mnt} L_{mt}$$

Value functions are given by

$$\hat{u}_{n,t+1} = \left(\frac{\hat{I}_{nt}}{\hat{P}_{nt}} \right) \left(\sum_{m' \in \mathcal{N}} \mu_{nm't} (\hat{u}_{m',t+2})^{\frac{\beta}{\nu}} (\hat{b}_{m',t+1})^{\frac{1}{\nu}} (\hat{m}_{nm',t+1})^{-\frac{1}{\nu}} \right)^{\nu}. \tag{D.2}$$

Derivation of Equations (D.1) **and** (D.2) I derive expressions in Equations (D.1) and (D.2). Migration shares can be expressed as

$$\begin{aligned}
\mu_{nm,t+1} &= \frac{\exp(\beta V_{m,t+2} + B_{m,t+1} - \tau_{nm,t+1})^{\frac{1}{\nu}}}{\sum\limits_{m' \in \mathcal{N}} \exp(\beta V_{m',t+2} + B_{m',t+1} - \tau_{nm',t+1})^{\frac{1}{\nu}}} \\
&= \frac{(\hat{u}_{m,t+1})^{\frac{\beta}{\nu}} (\hat{b}_{m,t+1})^{\frac{1}{\nu}} (\hat{m}_{mn,t+1})^{-\frac{1}{\nu}} \exp(\beta V_{m,t+1} + B_{mt} - \tau_{nmt})^{\frac{1}{\nu}}}{\sum\limits_{m' \in \mathcal{N}} (\hat{u}_{m',t+1})^{\frac{\beta}{\nu}} (\hat{b}_{m',t+1})^{\frac{1}{\nu}} (\hat{m}_{nm',t+1})^{-\frac{1}{\nu}} \exp(\beta V_{m',t+1} + B_{m't} - \tau_{nm't})^{\frac{1}{\nu}}}.
\end{aligned}$$

After dividing both the denominator and numerator of the above equation by $\sum\limits_{m' \in \mathcal{N}} \exp(\beta V_{m',t+1} + B_{m',t} - \tau_{nm't})^{\frac{1}{\nu}}$, I can obtain the expression in Equation (D.1).

After taking Equation (4.9) in time differences, I obtain that

$$V_{n,t+1} - V_{n,t} = \ln \frac{I_{n,t+1}}{P_{n,t+1}} - \ln \frac{I_{nt}}{P_{nt}} + \nu \ln \frac{\sum\limits_{m \in \mathcal{N}} \exp(\beta V_{m,t+2} + B_{m,t+1} - \tau_{nm,t+1})^{\frac{1}{\nu}}}{\sum\limits_{m \in \mathcal{N}} \exp(\beta V_{m,t+1} + B_{mt} - \tau_{nmt})^{\frac{1}{\nu}}}.$$

Taking exponential from both sides and using the expressions of $\hat{u}_{n,t+1}$ and $\mu_{nm,t+1}$, I can obtain the expression in Equation (D.2):

$$\hat{u}_{n,t+1} = \left(\frac{\hat{I}_{n,t+1}}{\hat{P}_{n,t+1}} \right) \left(\sum_{m \in \mathcal{N}} \mu_{nmt} (\hat{u}_{m,t+2})^{\frac{\beta}{\nu}} (\hat{b}_{m,t+1})^{\frac{1}{\nu}} (\hat{m}_{nm,t+1})^{-\frac{1}{\nu}} \right)^{\nu}.$$

D.4 Algorithm

In this section, I describe the solution algorithm used to solve the model.

- Step 1. Given the path of the shocks $\{\hat{\mathbf{\Psi}}_t\}_{t=t_0}^{T}$ and $\{\hat{\boldsymbol{\tau}}_t^c\}_{t=t_0}^{T}$, guess the path of $\{\hat{u}_{nt}^{(0)}\}_{n=1,t=t_0+1}^{N,T+1}$ and $\{\zeta_{nt}^{(0)}\}_{n=1,t=t_0+1}^{N,T+1}$. The path converges at $T+1$, so set $\hat{u}_{n,T+1}^{(0)} = 1$, $\forall n \in \mathcal{N}$.

- Step 2. Based on the guessed consumption rates and the observed allocation of capital $\{K_{nt_0}\}_{n=1}^{N}$ and $\{K_{n,t_0+1}\}_{n=1}^{N}$, set the gross return of capital at time t_0+1 as follows:

$$R_{n,t_0+1} = \frac{K_{n,t_0+1}}{K_{nt_0}}(1-\zeta_{nt_0}^{(0)}).$$

- Step 3. Given the initial allocation of migration shares $\{\mu_{nmt_0}\}_{n,m=1}^{N}$, using the guessed $\{\hat{u}_{nt}^{(0)}\}_{n=1,t=t_0+1}^{N,T+1}$, compute path of migration shares $\{\mu_{nmt}\}_{n,m=1,t=t_0+1}^{N,T+1}$:

$$\mu_{nm,t+1} = \frac{\mu_{nmt}(\hat{u}_{m,t+2})^{\frac{\beta}{\nu}}(\hat{b}_{m,t+1})^{\frac{1}{\nu}}(\hat{m}_{nm,t+1})^{\frac{1}{\nu}}}{\sum_{m'\in\mathcal{N}}\mu_{nm't}(\hat{u}_{m',t+2})^{\frac{\beta}{\nu}}(\hat{b}_{m',t+1})^{\frac{1}{\nu}}(\hat{m}_{nm',t+1})^{\frac{1}{\nu}}}.$$

  Using the computed migration shares $\{\mu_{nmt}\}_{n,m=1,t=1}^{N,T+1}$, compute population for periods $t \geq t_0+1$:

$$L_{n,t+1} = \sum_{m\in\mathcal{N}}\mu_{mnt}L_{mt}.$$

  and calculate $\{\hat{L}_{nt}\}_{n=1,t=t_0}^{N,T}$.

- Step 4. For $t > t_0$,

  1. Using calculated $\{\hat{L}_{n,t+1}\}_{n=1}^{N}$ and $\{\hat{K}_{n,t+1}\}_{n=1}^{N}$, solve for $\{\hat{W}_{nj,t+1}\}_{n=1,j=1}^{N,J}$ that satisfy the system of equations of the static equilibrium in Section D.3 for each t.
     (a) Guess $\{\hat{W}_{nj,t+1}^{(0)}\}_{n=1,j=1}^{N,J}$ and $\{\hat{P}_{nj,t+1}^{(0)}\}_{n=1,j=1}^{N,J}$
     (b) Based on $\{\hat{W}_{nj,t+1}^{(0)}\}_{n=1,j=1}^{N,J}$, calculate the average wages $\{\hat{W}_{n,t+1}\}_{n=1}^{N}$ and regional employment shares $\{\hat{\lambda}_{nj,t+1}\}_{n=1,j=1}^{N,J}$. Then, iterate $\{\hat{P}_{nj,t+1}^{(0)}\}_{n=1,j=1}^{N,J}$ until convergence using the formulas for unit costs and price indices in Section D.3.
     (c) Check whether $\{\hat{W}_{nj,t+1}^{(0)}\}_{n=1,j=1}^{N,J}$ satisfy the labor market clearing condition. If not, go back to step (a).

2. Compute the next period gross return on capital $\{R_{n,t+1}\}_{n=1}^{N}$[39]:

$$R_{n,t+1} = (1-\delta) + \frac{\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}}{\hat{P}_{n,t+1}\hat{K}_{nj,t+1}}(R_{nt} - (1-\delta)).$$

Because of cost minimization, the above expression holds for any $j \in \mathcal{J}$.

3. Using the next period gross return on capital $\{R_{n,t+1}\}_{n=1}^{N}$ and guessed $\{\zeta_{n,t+1}^{(0)}\}_{n=1}^{N}$, compute capital $\{K_{n,t+2}\}_{n=1}^{N}$ in period $t+2$:

$$K_{n,t+2} = (1-\zeta_{n,t+1}^{(0)})R_{n,t+1}K_{n,t+1}.$$

- Step 5. For each t, solve backward for $\{\hat{u}_{nt}^{(1)}\}_{n=1,t=t_0+1}^{N,T+1}$:

$$\hat{u}_{n,t+1}^{(1)} = \left(\frac{\hat{I}_{n,t+1}}{\hat{P}_{n,t+1}}\right)\left(\sum_{m\in\mathcal{N}} \mu_{nmt}(\hat{u}_{m,t+2}^{(0)})^{\frac{\beta}{\nu}}(\hat{b}_{m,t+1})^{\frac{1}{\nu}}(\hat{m}_{nm,t+1})^{-\frac{1}{\nu}}\right)^{\nu}.$$

- Step 6. For each t, solve backward for $\{\zeta_{nt}^{(1)}\}_{n=1,t=1}^{N,T+1}$:

$$\zeta_{nt}^{(1)} = \frac{\zeta_{n,t+1}^{(0)}}{\zeta_{n,t+1}^{(0)} + \beta^{\psi}R_{n,t+1}^{\psi-1}},$$

where $R_{n,T+1} = 1/\beta$ is imposed.

- Step 7. Take $\{(1-\omega)\hat{u}_{nt}^{(0)} + \omega\hat{u}_{nt}^{(1)}\}_{n=1,t=t_0+1}^{N,T+1}$ and $\{(1-\omega)\zeta_{nt}^{(0)} + \omega\zeta_{nt}^{(1)}\}_{n=1,t=t_0+1}^{N,T+1}$ for some weights $\omega \in (0,1]$, and return to Step 2. Continue until both $\{\hat{u}_{nt}^{(1)}\}_{n=1,t=t_0+1}^{N,T+1}$ and $\{\zeta_{nt}^{(1)}\}_{n=1,t=t_0+1}^{N,T+1}$ converge.

[39]Because $R_{n,t+1} \equiv (1-\delta) + \frac{r_{n,t+1}}{P_{n,t+1}}$, $\frac{R_{n,t+1}-(1-\delta)}{R_{nt}-(1-\delta)} = \frac{\hat{r}_{n,t+1}}{\hat{P}_{n,t+1}}$ holds. The cost minimization implies that $\frac{\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}}{\hat{r}_{n,t+1}\hat{K}_{nj,t+1}} = 1$, $\forall j \in \mathcal{J}$. Substituting $\hat{r}_{n,t+1}$ by $\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}/\hat{K}_{nj,t+1}$ in $\frac{R_{n,t+1}-(1-\delta)}{R_{nt}-(1-\delta)} = \frac{\hat{r}_{n,t+1}}{\hat{P}_{n,t+1}}$, we can obtain that $R_{n,t+1} = (1-\delta) + \frac{\hat{W}_{nj,t+1}\hat{H}_{nj,t+1}}{\hat{P}_{n,t+1}\hat{K}_{nj,t+1}}(R_{nt} - (1-\delta))$.

D.5 Calibration of Shocks and Initial Trade Shares

In this section, I describe the calibration procedure of the shocks, region-sector exports and import shares, and region-to-region trade shares of the initial period.

- Step 1. Let $\tilde{c}_{njt}$ denote for the unit cost of sector j in region n: $\tilde{c}_{njt} \equiv c_{njt}/A_{njt}$. The static trade equilibrium of each period can be expressed as follows:

$$
\begin{aligned}
\mathrm{GO}_{njt} &= (d^j_{nF}\tilde{c}_{njt})^{1-\sigma} D^F_{jt} \\
&\quad + \sum_{m\in N} \pi^j_{nmt} \Big[\sum_{k\in\mathcal{J}} \gamma^j_k \mathrm{GO}_{mkt} + \alpha_j \Big(\sum_{k'\in\mathcal{J}} (1+\iota_t)\gamma^H_{k'} \mathrm{GO}_{mk't} + \gamma^K_{k'} \mathrm{GO}_{mk't} \Big) \Big], \\
\mathrm{IM}_{jt} &= \sum_{n\in\mathcal{N}} \left[\pi^j_{Fnt} \Big[\sum_{k\in\mathcal{J}} \gamma^j_k \mathrm{GO}_{mkt} + \alpha_j \Big(\sum_{k'\in\mathcal{J}} (1+\iota_t)\gamma^H_{k'} \mathrm{GO}_{mk't} + \gamma^K_{k'} \mathrm{GO}_{mk't} \Big) \Big] \right], \\
\mathrm{EX}_{jt} &= \sum_{n\in\mathcal{N}} EX_{njt},
\end{aligned}
$$

  where

$$
\pi^j_{mnt} = \frac{(d^j_{mn}\tilde{c}_{mjt})^{1-\sigma}}{\sum_{m'\in\mathcal{N}} (d^j_{m'n}\tilde{c}_{m'jt})^{1-\sigma} + (d^j_{nF}P^F_{jt})^{1-\sigma}}, \qquad \pi^j_{Fnt} = \frac{(d^j_{Fn}P^F_{jt})^{1-\sigma}}{\sum_{m'\in\mathcal{N}} (d^j_{m'n}\tilde{c}_{m'jt})^{1-\sigma} + (d^j_{nF}P^F_{jt})^{1-\sigma}}, \tag{D.3}
$$

  and

$$
EX_{njt} = (d^j_{nF}\tilde{c}_{njt})^{1-\sigma} D^F_{jt}. \tag{D.4}
$$

  Given the data on region-sector gross output, GO_{njt}, sectoral exports, EX_{jt}, sectoral imports, IM_{jt}, and the parametrized trade costs, d^j_{mn} and d^j_{Fn}, the above system of equations holds for each j and t. The above system of equation has $N+2$ number of equations with the same number of unknowns,$\{\tilde{c}_{njt}, P^F_{jt}, D^F_{jt}\}^{N,J}_{n=1,j=1}$, and the system of equation is exactly identified up to scale. Without loss of generality, I re-express P^F_{jt}. D^F_{jt}, and $\tilde{c}_{njt}$ relative to the unit cost of the reference region for each j and t: $\bar{c}_{njt} = \tilde{c}_{njt}/\tilde{c}_{n_0jt}$, $\bar{P}^F_{jt} = P^F_{jt}/\tilde{c}_{n_0jt}$, and $\bar{D}^F_{jt} = D^F_{jt}/\tilde{c}^{1-\sigma}_{n_0jt}$, where n_0 denotes the reference region. Then, I solve for $\bar{c}_{njt}$, $\bar{P}^F_{jt}$, and $\bar{D}^F_{jt}$ for each j and t upto normalization.

- Step 2. Using the backed-out $\{\bar{c}_{njt}, \bar{P}^F_{jt}, \bar{D}^F_{jt}\}^{N,J,02}_{n=1,j=1,t=98}$ for each sector and period, I can compute region-to-region trade shares and region-sector import shares from Equation (D.3) and regions-sector exports from Equation (D.4).

- Step 3. Once I back out $\{\bar{c}_{njt}, \bar{P}^F_{jt}, \bar{D}^F_{jt}\}^{N,J,02}_{n=1,j=1,t=98}$, region-sector price indices can be written as a function of the unit cost of the reference region, $\tilde{c}_{n_0jt}$:

$$P_{njt} = \left[\sum_{m \in \mathcal{N}} (d^j_{mn} \tilde{c}_{mjt})^{1-\sigma} + (d^j_{Fn} P^F_{jt})^{1-\sigma} \right]^{\frac{1}{1-\sigma}} = \tilde{c}_{n_0jt} \times \left[\sum_{m \in \mathcal{N}} (d^j_{mn} \bar{c}_{mjt})^{1-\sigma} + (d^j_{Fn} \bar{P}^F_{jt})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}.$$

Using the above expression, changes in region-sector price indices can be expressed as:

$$\hat{P}_{nj,t+1} = \hat{\tilde{c}}_{n_0j,t+1} \times \underbrace{\frac{\left[\sum_{m \in \mathcal{N}} (d^j_{mn} \bar{c}_{mj,t+1})^{1-\sigma} + (d^j_{Fn} \bar{P}^F_{j,t+1})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}}{\left[\sum_{m \in \mathcal{N}} (d^j_{mn} \bar{c}_{mjt})^{1-\sigma} + (d^j_{Fn} \bar{P}^F_{jt})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}}}_{\text{Obtained from the previous step}}.$$

Because I obtained $\bar{c}_{njt}$ and $\bar{P}^F_{jt}$ in level in the previous steps, the second term of the right-hand side is known. Therefore, once I pin down $\hat{\tilde{c}}_{n_0j,t+1}$, I can also pin down $\hat{P}_{nj,t+1}$.

In the model, I construct changes in the sector j's PPI as follows:

$$\hat{P}^{agg}_{j,t+1} = \left[\sum_{n \in \mathcal{N}} \omega_{njt} \hat{P}^{1-\sigma}_{nj,t+1} \right]^{\frac{1}{1-\sigma}},$$

where $\omega_{njt} \equiv \frac{\text{GO}_{njt}}{\sum_{m \in \mathcal{N}} \text{GO}_{mjt}}$. Because $\hat{P}_{njt}$ is a function of $\hat{\tilde{c}}_{n_0j,t+1}$ for all regions, $\hat{P}^{agg}_{jt}$ is pinned down by $\hat{\tilde{c}}_{n_0j,t+1}$.

Then, I choose one reference sector j_0 and pin down $\hat{\tilde{c}}_{n_0jt}/\hat{\tilde{c}}_{n_0j_0t}$ by fitting the PPI changes in the model relative to the reference sector $\widehat{PPI}_{jt}/\widehat{PPI}_{j_0t}$ to the counterpart of the data.

- Step 4. Because I pin down $\hat{\tilde{c}}_{n_0jt}/\hat{\tilde{c}}_{n_0j_0t}$ in the previous step, the remaining object is $\hat{\tilde{c}}_{n_0j_0t}$. I pin down $\hat{\tilde{c}}_{n_0j_0t}$ by fitting changes in the real value-added of the reference sector. The changes in the reference sector can be written as follows:

$$\frac{\sum_{n \in \mathcal{N}} \omega^V_{njt} \hat{VA}_{nj,t+1}}{\hat{P}^{agg}_{j,t+1}}.$$

where $\sum_{n\mathcal{N}} \omega^V_{njt} \hat{VA}_{nj,t+1}$ are changes in sector j's aggregate value-added and ω^V_{njt} is region n's sector j value-added weight.

- Step 5. I compute changes in region-sector level unit costs, import prices, and foreign demands

$$\hat{c}_{nj,t+1} = \hat{\tilde{c}}_{n_0j,t+1} \times \hat{\bar{c}}_{nj,t+1}, \quad \hat{P}^F_{j,t+1} = \hat{\tilde{c}}_{n_0j,t+1} \times \hat{\bar{P}}^F_{jt}, \quad \text{and} \quad \hat{D}^F_{j,t+1} = \hat{\tilde{c}}^{1-\sigma}_{n_0j,t+1} \times \hat{\bar{D}}^F_{jt}.$$

Note that I obtain $\hat{\tilde{c}}_{n_0j,t+1}$ from Steps 3 and 4, and $\hat{\bar{c}}_{nj,t+1}$, $\hat{\bar{P}}^F_{jt}$ and $\hat{\bar{D}}^F_{jt}$ from Step 1.

- Step 6. In this step, I calibrate productivity, amenity, and labor productivity shocks: $\{\hat{A}_{njt}, \hat{b}_{nt}, \hat{E}_{njt}\}_{n=1,j=1,t=98}^{N,J,T}$.

  Note that $\hat{\tilde{c}}_{njt}$ is composed of changes in price of input bundles $\hat{c}_{njt}$ and productivity $\hat{A}_{njt}$. In order to back out $\hat{A}_{njt}$, I have to separately identify $\hat{c}_{njt}$ and $\hat{A}_{njt}$ from $\hat{\tilde{c}}_{njt}$. To solve for $\hat{c}_{njt}$, I need to compute wages which require information of $\hat{E}_{njt}$ and population distribution that depends on $\hat{b}_{nt}$. These variables are determined in the dynamic equilibrium due to the perfect foresight of the agents. Therefore, I need to solve for the full dynamic model to back out these shocks.

  I use the following algorithm to back out $\{\hat{A}_{njt}, \hat{b}_{nt}, \hat{E}_{njt}\}_{n=1,j=1,t=98}^{N,J,T}$:

  A. Guess $\{\hat{A}_{njt}^{(0)}, \hat{b}_{nt}^{(0)}, \hat{E}_{njt}^{(0)}\}_{n=1,j=1,t=98}^{N,J,02}$
     (a) Based on the guess of $\{\hat{A}_{njt}^{(0)}\}_{n=1,j=1,t=98}^{N,J,02}$, set the future sequence of productivity shocks after 2003: $\hat{A}_{njt}^{(0)} = 1/\left(\prod_{\tau=98}^{02} \hat{A}_{nj\tau}^{(0)}\right)^{\frac{1}{25}}$, $\forall t \in \{03, \ldots, 28\}$ and $\hat{A}_{njt}^{(0)} = 1$, $\forall t \in \{29, \ldots, T\}$.
     (b) $\hat{b}_{nt}^{(0)} = \hat{E}_{njt}^{(0)} = 1$, $\forall n \in \mathcal{N}$, $\forall j \in \mathcal{J}$, $\forall t \in \{03, \ldots, T\}$

  B. Solve the model using the algorithm described in Section D.4.

  C. Update a guess of $\{\hat{A}_{njt}^{(0)}\}_{n=1,j=1,t=98}^{N,J,02}$ based on the following steps.
     (a) Compare $\hat{c}_{njt}^{(0)}$ computed from the model based on the guess to $\hat{c}_{njt}^{data}$ obtained in the Step 5.
     (b) If $\hat{c}_{njt}^{(0)} > \hat{c}_{njt}$, compute a new guess of $\hat{A}_{njt}^{(1)}$ by decreasing $\hat{A}_{njt}^{(0)}$ and vice versa.
     (c) Use $\{\hat{A}_{njt}^{(1)}\}_{n=1,j=1,t=98}^{N,J,02}$ as a new guess and iterate steps B and C(a, b, c) until $|\hat{c}_{njt}^{(0)} - \hat{c}_{njt}^{data}| < \epsilon$, $\forall n \in \mathcal{N}$, $\forall j \in \mathcal{J}$, $\forall t \in \{98, \ldots, 02\}$ for some thresholds ϵ.

  D. Update a guess of $\{\hat{E}_{njt}^{(0)}\}_{n=1,j=1,t=98}^{N,J,02}$ based on the following steps. Because $\hat{E}_{njt}$ is identified up to normalization within each region, I set $\hat{E}_{nj_0t} = 1$ for one reference sector j_0 across regions and periods.
     (a) Compare $\hat{\lambda}_{njt}^{(0)}$ computed from the model based on the guess to $\hat{\lambda}_{njt}^{data}$ obtained from the data (Equation (4.7)).
     (b) If $\hat{\lambda}_{njt}^{(0)} > \hat{\lambda}_{njt}$, compute a new guess of $\hat{E}_{njt}^{(1)}$ by decreasing $\hat{E}_{njt}^{(0)}$ and vice versa.
     (c) Use $\{\hat{E}_{njt}^{(1)}\}_{n=1,j=1,t=98}^{N,J,02}$ as a new guess and iterate steps B, C(a, b, c), and D(a, b, c) until $|\hat{\lambda}_{njt}^{(0)} - \hat{\lambda}_{njt}^{data}| < \epsilon$, $\forall n \in \mathcal{N}$, $\forall j \in \mathcal{J}$, $\forall t \in \{98, \ldots, 02\}$ for some thresholds ϵ.

  E. Update a guess of $\{\hat{b}_{nt}^{(0)}\}_{n=1,t=98}^{N,02}$ based on the following steps. Because $\hat{b}_{nt}$ is identified up to normalization, I normalize $\hat{b}_{n_0t} = 1$ for one reference region n_0.
     (a) Compare $L_{nt}^{(0)}$ computed from the model based on the guess to L_{nt}^{data} obtained from the data (Equation (4.11)).

(b) If $L_{nt}^{(0)} > L_{nt}^{data}$, then compute a new guess of $b_{nt}^{(1)}$ by decreasing $b_{nt}^{(0)}$ and vice versa.

(c) Use $\{\hat{b}_{nt}^{(1)}\}_{n=1,t=98}^{N,02}$ as a new guess and iterate steps B, C(a, b, c), D(a, b, c) and E(a, b, c) until $|L_{nt}^{(0)} - L_{nt}^{data}| < \epsilon$, $\forall n \in \mathcal{N}$, $\forall t \in \{98, \ldots, 02\}$ for some thresholds ϵ.

F. Repeat steps A-E until convergence.

D.6 The GDP Deflator Construction

This subsection describes how I construct the GDP deflator following the practice of the system of national accounts in South Korea. Following the UN Statistics Division in its System of National Accounts, the South Korean statistical agencies use the Laspeyres chain-weighting of quantities, where the base period is given by the previous year. Therefore, I define chain-weighted real GDP, evaluated at a base price in $t-1$, as follows:

$$Y_t = \sum_{j \in \mathcal{J}} (P^Y_{j,t-1} Q_{jt} - P^M_{j,t-1} M_{jt}),$$

where Q_{jt} is the measured physical output of sector j, $P^Y_{j,t-1}$ is the base price of gross output, $P^M_{j,t-1}$ is input base price of sector j, and M_{jt} is the measured physical input used.

We denote changes in variables relative to their base values as hat: $\hat{x}_t \equiv x_t / x_{t-1}$. The gross changes in real GDP can be expressed as

$$\hat{Y}_t = \sum_{j \in \mathcal{J}} \omega^Y_{j,t-1} \left(\hat{Q}_{jt} - \omega^M_{j,t-1} \hat{M}_{jt} \right).$$

$\omega^Y_{j,t-1}$ is the ratio of sector j's gross output to the aggregate value added in the base year, that is, the Domar weight of sector j in the base year:

$$\omega^Y_{j,t-1} \equiv \frac{P_{j,t-1} Q_{j,t-1}}{Y_{t-1}}.$$

$\omega^M_{j,t-1}$ is sector j's shares of total input expenditures to gross output. Because I assumed the time-invariant CRS Cobb-Douglas production function, $\omega^M_{j,t-1}$ is constant across regions and time. Both $\omega^Y_{j,t-1}$ and $\omega^M_{j,t-1}$ can be directly obtained from nominal values of the data in 1997.

In practice, to measure $\hat{Q}_{njt}$ and $\hat{M}_{njt}$, the national statistical agencies measure nominal gross output and PPIs, and deflate the nominal gross output changes using PPI changes, $\hat{P}^Y_{jt}$. Then, $\hat{Q}_{jt}$ is measured as

$$\hat{Q}_{jt} = \frac{1}{\hat{P}^Y_{jt}} \times \frac{\sum_{n \in \mathcal{N}} P_{njt} Q_{njt}}{\sum_{n \in \mathcal{N}} P_{nj,t-1} Q_{nj,t-1}}.$$

The Korean statistical agencies collect price data from the designated regions and aggregate them based on the given weights to construct PPIs. To mimic this procedure, I define PPI changes as follows:

$$\hat{P}^Y_{jt} = \sum_{n \in \mathcal{N}^s} \omega^s_{nj,t-1} \times \hat{P}_{njt},$$

where N^s is the set of regions that are included in the designated regions.[40] The weights are given

[40]Regions in the states of Chungchungnam-do, Gyeongsangbuk-do, and Jeollabuk-do were excluded.

as region n's shares of sector j's total sum of gross output across the designated regions: $\omega^s_{nj,t-1} \equiv \frac{GO_{nj,t-1}}{\sum_{m\in\mathcal{N}^s} GO_{mj,t-1}}$.

Following that statistical agencies construct the input deflators using the IO tables and measured PPIs, I construct the input deflators as

$$\hat{P}^M_{njt} = (1-\pi^{s,j}_{F,t-1})\Big(\sum_{k\in\mathcal{J}} \pi^{k,M}_{j,t-1}\hat{P}^Y_{kt}\Big) + \pi^{s,j}_{F,t-1}\hat{P}^F_{jt}.$$

$\pi^{s,j}_{F,t-1} \equiv \frac{\sum_{n\in\mathcal{N}} IM_{nj,t-1}}{\sum_{n\in\mathcal{N}} X_{nj,t-1}}$ is the aggregate import shares of sector j, where $IM_{nj,t-1}$ are region-sector nj's imports and $X_{nj,t-1}$ are region n's expenditures on sector j goods. $\pi^{k,M}_{j,t-1}$ is sector j's shares on sector k inputs to the total material expenditures. $\hat{P}^F_{jt}$ is Foreign import cost changes, which I back out from the data and the model. The first term of the right-hand side captures the domestic components and the second term the foreign components of the input deflators.

Finally, the GDP deflator is implicitly defined as the ratio between nominal and real GDP changes:

$$\hat{P}^{GDP} = \frac{\hat{Y}^n_t}{\hat{Y}_t},$$

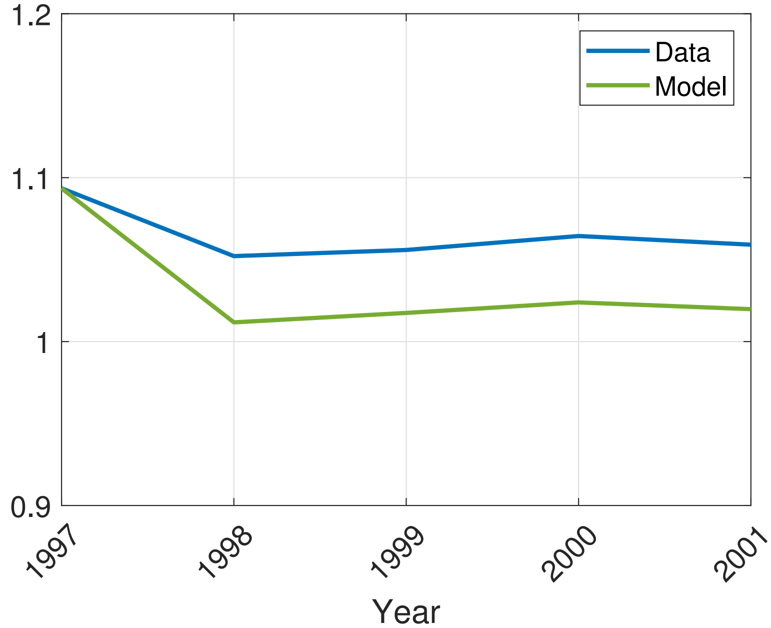
where nominal GDP is the sum of value-added across regions: $Y^n_t \equiv= \sum_{n\in\mathcal{N}} \sum_{j\in\mathcal{J}} \gamma^V_j GO_{njt}$.

D.7 Additional Figures and Tables

Table D8: Correlates of Migration Frictions

Dep.	Migration frictions					
Sample period	1997	1995-2006	1997	1995-2006	1997	1995-2006
	(1)	(2)	(3)	(4)	(5)	(6)
Log of distance	1.78***	1.76***			1.39***	1.39***
	(0.12)	(0.12)			(0.11)	(0.11)
Index for regional tension			11.27***	11.14***	5.33***	5.33***
			(1.34)	(1.32)	(0.64)	(0.64)
Origin FE	✓		✓		✓	
Dest. FE	✓		✓		✓	
Origin×Year FE		✓		✓		✓
Dest.×Year FE		✓		✓		✓
Adj. R^2	0.75	0.75	0.62	0.62	0.80	0.80
# Cluster 1	54.00	54.00	54.00	54.00	54.00	54.00
# Cluster 2	54	54	54	54	54	54
N	2862	34344	2862	34344	34344	34344

Notes. Panels A and B are the scatter plots between the log of the inferred migration frictions and log distance and the index for regional conflicts. Migration frictions are inferred from Equation (4.22) and demeaned by year. Standard errors are two-way clustered at origin and destination levels.



Growth in the Aggregate Capital Stock (%)

Figure D10. Non-Targeted Moment. Capital Accumulation. Data vs. Model

Notes. The figure plots growth in the aggregate real capital stock of the data and model, respectively.

Table D9: Robustness. Migration Rate

Average outflow migration rate between 1997 and 2002 (%)					
Baseline	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
(1)	(2)	(3)	(4)	(5)	(6)
Panel A. $\sigma = 4,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$					
9.84	0	12.81	7.38	11.12	17.75
Panel B. $\sigma = 7,\ \theta = 2,\ 1/\nu = 0.7,\ \psi = 1$					
9.84	0	12.83	7.38	11.13	17.77
Panel C. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.5,\ \psi = 1$					
9.84	0	12.82	7.37	11.11	15.29
Panel D. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 0.5$					
9.84	0	12.82	7.38	11.12	17.75
Panel E. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1,$ *permanent reductions*					
9.83	0	12.78	7.42	11.12	17.69

Notes. The table reports the average outflow migration rates across regions between 1997 and 2002 in the baseline and counterfactual economies. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) with common decreases, common increases, and selective decreases by the median of the empirical distribution; and column (6) with reductions by the components predicted by the index of regional conflicts.

Table D10: Robustness. Aggregate Effects of Migration Frictions

	Baseline (data)	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. $\sigma = 4,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$						
Top five emp. shares	1.53	0.33	1.69	1.35	2.86	1.59
Top five export intensity	7.47	6.74	7.58	7.37	7.97	7.70
Overall export intensity	14.82	13.85	14.96	14.68	15.50	15.07
Panel B. $\sigma = 7,\ \theta = 2,\ 1/\nu = 0.7,\ \psi = 1$						
Top five emp. shares	1.53	0.23	1.71	1.35	2.96	1.62
Top five export intensity	7.53	6.45	7.69	7.39	8.36	7.82
Overall export intensity	14.93	13.45	15.15	14.74	16.08	15.26
Panel C. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.5,\ \psi = 1$						
Top five emp. shares	1.52	0.21	1.70	1.32	3.04	1.66
Top five export intensity	7.36	6.24	7.54	7.21	8.27	7.60
Overall export intensity	14.68	13.16	14.91	14.47	15.93	14.97
Panel D. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 0.5$						
Top five emp. shares	1.38	0.16	1.56	1.20	2.85	1.43
Top five export intensity	7.15	6.09	7.33	7.0	8.02	7.46
Overall export intensity	14.37	12.97	14.61	14.17	15.57	14.72
Panel E. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1,$ *permanent reductions*						
Top five emp. shares	1.49	0.21	1.69	1.29	2.79	1.57
Top five export intensity	7.52	6.42	7.73	7.32	8.31	7.90
Overall export intensity	14.92	13.43	15.19	14.67	16.01	15.34

Notes. The table reports the growth rate of the aggregate-level employment in the top five sectors and the aggregate export intensity of the top five and overall manufacturing sectors between 1997 and 2000. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) with common decreases, common increases, and selective decreases by the median of the empirical distribution; and column (6) with reductions by the components predicted by the index of regional conflicts. The numbers in the bracket are the level in 1997.

Table D11: Robustness. Regional Effects of Migration Frictions on Sectoral Reallocation

	Estimated $\hat{\beta}^{reg}$, 1997–2000, $\triangle \ln y_{nt} = \beta^{reg}\text{RegEX}_{nt_0} + \epsilon_{nt}$					
	Baseline (data)	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. $\sigma = 4,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$						
Top five emp.	5.37	3.39	5.61	5.11	8.80	5.84
Pop.	2.57	0	2.88	2.21	6.33	3.06
Top five emp. shares	2.02	2.16	2.01	2.03	1.74	2.0
Panel B. $\sigma = 7,\ \theta = 2,\ 1/\nu = 0.7,\ \psi = 1$						
Top five emp.	5.42	3.41	5.67	5.16	8.87	5.93
Pop.	2.63	0	2.96	2.26	6.45	3.21
Top five emp. shares	2.01	2.17	2.0	2.03	1.71	1.99
Panel C. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.5,\ \psi = 1$						
Top five emp.	5.39	3.37	5.64	5.09	9.04	5.83
Pop.	2.57	0	2.92	2.17	6.55	3.10
Top five emp. shares	2.02	2.15	2.0	2.03	1.74	2.0
Panel D. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 0.5$						
Top five emp.	5.32	3.39	5.58	5.06	8.82	5.81
Pop.	2.49	0	2.82	2.14	6.30	3.01
Top five emp. shares	2.02	2.15	2.01	2.04	1.76	2.0
Panel E. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1,$ *permanent reductions*						
Top five emp.	5.36	3.37	5.65	5.07	8.42	5.88
Pop.	2.55	0	2.88	2.20	5.87	3.05
Top five emp. shares	2.01	2.15	2.0	2.03	1.79	1.99

Notes. The table reports the estimated coefficients of β^{reg} from the regression model $\triangle \ln y_{nt} = \beta^{reg}\text{RegEX}_{nt_0} + \epsilon_{nt}$ where RegEX_{nt_0} is the standardized regional export intensity defined in Equation (3.1) and dependent variables are the growth of regional employment in the top five sectors, population, and employment shares in the top five sectors. Column (1) reports the results for the baseline. Column (2) reports the counterfactual results with no migration; columns (3), (4), and (5) with common decreases, common increases, and selective decreases by the median of the empirical distribution; and column (6) with reductions by the components predicted by the index of regional conflicts. The numbers in the bracket are the level in 1997. These results are based on the calibrated values reported in Table 5.

Table D12: Robustness. Real GDP Growth after the Devaluation

	Cumulative real GDP growth (%)					
	Baseline	No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflicts
Years since the devaluation	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. $\sigma = 4,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$						
0 year	-10.37	-10.33	-10.39	-10.36	-10.37	-10.44
1 year after	-2.22	-2.26	-2.24	-2.22	-2.16	-2.29
2 years after	0.18	-0.03	0.18	0.16	0.31	0.14
3 years after	-0.26	-0.61	-0.24	-0.30	-0.11	-0.30
Panel B. $\sigma = 7,\ \theta = 2,\ 1/\nu = 0.7,\ \psi = 1$						
0 year	-11.16	-11.15	-11.18	-11.15	-11.14	-11.21
1 year after	-3.93	-4.01	-3.93	-3.93	-3.83	-3.95
2 years after	-1.13	-1.37	-1.12	-1.16	-0.96	-1.14
3 years after	-2.99	-3.33	-2.96	-3.02	-2.79	-3.01
Panel C. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.5,\ \psi = 0.5$						
0 year	-11.17	-11.16	-11.18	-11.16	-11.14	-11.19
1 year after	-3.91	-4.0	-3.91	-3.92	-3.79	-3.92
2 years after	-1.04	-1.30	-1.03	-1.07	-0.84	-1.03
3 years after	-2.83	-3.19	-2.81	-2.88	-2.60	-2.83
Panel D. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 0.5$						
0 year	-11.17	-14.15	-11.18	-11.16	-11.14	-11.21
1 year after	-3.99	-4.05	-4.0	-4.0	-3.87	-4.01
2 years after	-1.22	-1.40	-1.21	-1.24	-1.01	-1.23
3 years after	-3.11	-3.36	-3.08	-3.14	-2.86	-3.14
Panel E. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$, *permanent reductions*						
0 year	-11.16	-11.15	-11.17	-11.15	-11.13	-11.19
1 year after	-3.90	-3.99	-3.90	-3.90	-3.79	-3.91
2 years after	-1.07	-1.32	-1.05	-1.11	-0.89	-1.06
3 years after	-2.80	-3.14	-2.76	-2.85	-2.59	-2.80

Notes. This table reports the cumulative real GDP growth after the devaluation relative to 1997.

Table D13: Robustness. Aggregate Welfare Effects of Migration Frictions

Aggregate welfare changes, $\widehat{AggWel}^{c}_{t_0}$ (%)				
No migration	Decrease med. (common)	Increase med. (common)	Decrease med. (selective)	No regional conflict
(1)	(2)	(3)	(4)	(5)
Panel A. $\sigma = 4,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1$				
-1.93	0.71	-0.56	0.40	2.12
Panel B. $\sigma = 7,\ \theta = 2,\ 1/\nu = 0.7,\ \psi = 0.5$				
-1.87	0.72	-0.57	0.43	2.14
Panel C. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.5,\ \psi = 0.5$				
-2.41	0.96	-0.74	0.57	1.92
Panel D. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 0.5$				
-1.96	0.70	-0.58	0.41	2.11
Panel E. $\sigma = 7,\ \theta = 1.3,\ 1/\nu = 0.7,\ \psi = 1,$ *permanent reductions*				
-13.14	3.82	-3.09	1.97	11.22

Notes. This table reports the aggregate welfare effects of the counterfactual migration friction changes relative to the baseline. The aggregate welfare effects are defined as the weighted average of the regional welfare effects (Equation (4.24)), where the weights are given by the initial population in 1997.