Trade Liberalization and the Great Labor Reallocation*

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Abstract

The extent to which a country can benefit from trade openness crucially depends on its ease of reallocating resources. However, we know little about the role of domestic frictions in shaping the effects of trade policy. I address this question by analyzing the impact of tariff reductions on the spatial allocation of labor in China, and how this impact depends on migration frictions that stem from China's household registration system (hukou). I first provide reduced-form evidence that input trade liberalization has induced significant spatial labor reallocation in China, with a stronger effect in regions with less hukou frictions. Then, I construct and estimate a quantitative spatial model with input-output linkages and hukou frictions to examine the general equilibrium effects of tariff reductions and perform counterfactuals. The quantitative exercise shows that trade liberalization increases China's welfare by 0.71%. Abolishing the hukou system leads to a direct welfare improvement of 1.56%, but it also leads to welfare losses to hukou holders from certain regions. Additionally, it increases gains from tariff reductions by 2% and alleviates its distributional consequences. In this process, I develop a novel measure of migration frictions associated with the hukou system.

JEL Classification: F11, F13, F16, R23, O15

Keywords: input trade liberalization, spatial labor reallocation, hukou frictions, migration

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1 Introduction

Trade liberalization is often argued to be an important driver of economic development, as it can raise a country's income through increasing specialization in sectors with a comparative advantage, providing access to cheap foreign inputs, and facilitating the adoption of new technologies. Prominent trade theories typically focus on long-run equilibrium, assuming that the reallocation of resources across economic activities is frictionless. Yet, in reality, factor adjustments tend to be slow, costly, and heterogeneous across firms, sectors, and space. The extent to which a country can gain from trade crucially depends on the ability of factors to move. In particular, there is increasing evidence that labor immobility can explain a great part of the negative consequences of trade on labor market outcomes.[1] Although the role of labor mobility for both aggregate and distributional impact of trade has long been emphasized, we still lack a rigorous understanding of how globalization affects to a country's internal labor adjustments, and how migration frictions shape the impact of tariff reductions on regional employment, income distribution, and aggregate welfare.

In this paper, I exploit China's liberalization episode after its accession to the WTO and the country's unique household registration system (hukou) to make three contributions to our understanding of the interaction between trade and migration frictions. First, I provide empirical evidence of input-liberalization-induced spatial labor reallocation and the presence of migration frictions caused by the hukou system. Then, I assess, in the context of a spatial general equilibrium model, the associated changes in welfare behind the observed labor adjustments. Finally, I quantify the impact of tariff reductions on regional disparities and aggregate welfare were the hukou system abolished. In this process, I also develop a novel measure of hukou frictions.

China offers a particularly suitable setting to study this subject for three reasons. First, the composition of industries differ significantly across Chinese prefectures, providing ample variation to identify the causal effects of trade policy on regional economic outcomes. Second, even though trade has been growing rapidly in China, its accession to the WTO was an inflection point: China's total trade in goods was about half trillion USD in 2000, and it surged to more than 4 trillion USD by the end of 2010. Interestingly, in the same period, China's internal migration also accelerated. From 1995 to 2000, about thirty million Chinese switched their living provinces. This number increased to nearly fifty million between 2000 and 2005, and further reached sixty million by 2010.[2] This rapid increase in internal migration not only coincides with China's accession to the WTO, but is also largely a consequence of workers moving from inland areas to coastal cities, which contributed the most to China's trade surge over the same period. This makes it natural for us to probe the relationship between international trade and domestic migration patterns.

The third and most important reason is that, unlike most policies that tend to affect *both* the

[1] See for instance, Autor et al. (2013), Topalova (2010), and Dix-Carneiro and Kovak (2017) for the case of the U.S., India, and Brazil, respectively.

[2] The numbers are calculated based on the 2000 and 2010 rounds of the population census and the 2005 round of the 1% population sampling survey.

movement of goods and people, China's hukou system offers a unique possibility to *cleanly* identify migration frictions from other types of domestic frictions. Introduced in the 1950s, the system has long been recognized as the most important factor restricting internal mobility in China. It ties people's access to various social benefits and public services to their residential status; as a result, the ease of obtaining a hukou has heavily influenced one's migration decisions. Notably, the stringency of the hukou system differs across provinces. This spatial heterogeneity provides an ideal setting for identifying the role of migration frictions in shaping the impact of trade on regional labor market outcomes.

Drawing on a rich dataset I assembled on China's regional economy, I first document four empirical patterns that suggest input-liberalization-induced labor reallocation across Chinese prefecture cities and the presence of hukou frictions. To this end, I develop a novel measure of migration frictions associated with the hukou system based on the hukou-granting probability of each region. Exploiting regional variation in exposure to *input tariff cuts* that stem from a region's initial difference in industry mix, I find that:

1. *Prefectures facing larger input tariff cuts experience a relative increase in employment, and the effect is stronger in provinces with less hukou frictions.* In my preferred specification, a prefecture at the 75th percentile of input tariff exposure experiences a 3.4 percentage points larger employment increase (or smaller decrease) than a prefecture at the 25th percentile. In a prefecture with the least hukou frictions, the effect of input tariff cuts is three times larger than the average effect. When taking into account both input and output channels, over 30 percent of the regional variation in employment changes can be attributed to trade liberalization.

2. *The total population and the working age population of prefectures react to input tariff cuts and their interaction with the hukou measure in a quantitatively similar way to that of employment.* This result implies that the observed regional employment changes are mainly driven by interregional labor adjustments.

3. *Prefectures facing larger input tariff cuts experience a relative increase in population inflows from other provinces, and more so if they have less restrictive hukou systems.* That is, by examining migration inflows directly, I further confirm the presence of trade-induced spatial labor reallocation and the importance of hukou frictions in shaping the impact of trade.

4. *While, on average, input tariff cuts do not result in an increase in the population holding local hukou, they do so in prefectures where hukou frictions are low.* This result suggests that despite labor mobility between prefectures, migrant workers can only obtain a local hukou in prefectures with less stringent hukou systems. It supports the validity of my hukou measure, and confirms the existence of hukou frictions.

I control for output tariff cuts and their interaction with the hukou friction measure throughout the empirical analysis. Prefectures that are more exposed to output tariff reductions experience a relative decrease in employment and attract fewer migration inflows, but the results are not always significant.

Next, I interpret the empirical results through the lens of a multi-sector quantitative spatial model. For this purpose, I extend the theoretical framework of Redding (2016) to explicitly model input-output linkages and hukou frictions. Falling trade costs allow firms to access cheaper intermediate inputs and hence produce less expensive final goods. As a result, demand for local production increases. Regions specialized in industries facing larger input tariff reductions are more positively affected, which pushes up wages and ends up attracting workers from elsewhere. With the presence of the hukou system, migrant inflows are limited in positively affected regions, meaning that a large fraction of the gains accrues to workers holding a local hukou. That is, the hukou system affects not only aggregate gains from trade, but also their distribution across otherwise identical workers. I also show that, despite the complex general equilibrium interactions, the welfare changes can be expressed in a parsimonious form. In particular, the *relative* welfare change between worker groups depends on only two sufficient statistics: (i) the change in the employment share by region for each worker group and (ii) the income elasticity of labor supply.

I proceed by calibrating the model in relative changes to identify the general equilibrium effects of tariff reductions. I do so with 30 Chinese provinces and a constructed rest of the world. The simulated regional employment changes qualitatively match well with the observed data. I find that trade liberalization increases China's welfare by 0.71%. However, this welfare gain is not shared equally across provinces. Individuals with a Beijing and Shanghai hukou experience welfare improvements of 1.72% and 1.50%, while individuals who hold a hukou from Jiangxi or Sichuan provinces gain only 0.53% and 0.58%, respectively. In general, trade liberalization amplifies regional inequalities. I further assess how much China would have gained from trade liberalization were the hukou system abolished. For this purpose, I estimate the income losses associated with hukou frictions. I find that in a province with median hukou frictions, migrant workers are willing to forgo 21% of their income to obtain a local hukou. Abolishing the system improves aggregate welfare by 1.56%. Starting from this new equilibrium, aggregate gains from tariff reductions increase by 2% and become more evenly distributed across provinces.

This paper is motivated by a growing literature on the global effects of China's trade and economic growth. Important works in this literature include Autor et al. (2013), Bugamelli et al. (2015), Balsvik et al. (2015), Giovanni et al. (2014) and Hsieh and Ossa (2011), among many others.[3] While the effects of the "rise of China" on other countries' economies have been widely examined, we know much less about the internal adjustments within China due to this rise. To what extent can China's economic transformation be explained by its integration into the global economy? Does labor market distortion prevent China from fully reaping the gains from trade reforms? In addition, calls for

[3] Autor et al. (2013) and Balsvik et al. (2015) empirically assess the impact of increased import competition from China on labor market adjustments in the United States and Norway, respectively; Bugamelli et al. (2015) find that increased import penetration from China restrains the price growth of products using Italian firm-level data; Giovanni et al. (2014) evaluate the global welfare impact of China's trade integration and technological change in a quantitative Ricardian-Heckscher-Ohlin model; Hsieh and Ossa (2011) investigate the spillover effects of China's productivity growth on other countries' real income in a quantitative multi-industry Melitz model.

reforming the hukou system began long before the year 2000, and reforming this system appears high on the agenda of the Chinese government today. This paper contributes to the ongoing debate by studying the system's interaction with trade liberalization and the counterfactual hukou abolishment. The quantitative framework developed in this paper can also be used to evaluate alternative reform policies.

In terms of focus, this paper contributes to a rich empirical literature on trade and local labor markets (see for example, Autor et al. (2013); Dauth et al. (2014); Dix-Carneiro and Kovak (2017); Kovak (2011, 2013); McLaren and Hakobyan (2010); and Topalova (2007, 2010)).[4] Though trade reforms lead to both negative and positive demand shocks, most reduced-form empirical work has focused on the downsides of increased import competition (Galle et al., 2017).[5] My paper is the first to analyze the impact of input trade liberalization on regional employment (controlling for import competition). Contrary to the existing literature documenting the limited impacts of trade on internal migration,[6] I find that input tariff reductions have caused significant spatial labor adjustments in China. My emphasis on migration policy in shaping the impact of trade policy is also novel.[7]

In terms of modeling techniques, this paper closely follows a recent but growing literature that develops spatial general equilibrium models to analyze the welfare consequences of aggregate shocks, while taking into account trade and mobility frictions within countries (for example, Caliendo et al. (2015); Galle et al. (2017); Monte et al. (2015); Redding (2016); and Bryan and Morten (2017)). In particular, I extend the work of Redding (2016) to highlight the importance of sectoral linkages and migration frictions when evaluating the impact of trade policies. An important work bringing Redding's (2016) framework to the context of China is Tombe and Zhu (2015). They assume that individuals have idiosyncratic productivity instead of amenity draws, and study how the reduction of trade and migration frictions, rather than the interaction between the two, has contributed to the aggregate productivity growth in China. Within this literature, Fan (2015) and Monte (2015) emphasize the interaction of trade and labor mobility, with the former focused on inequality across skill groups, and the latter on shock transmissions. In contrast, I focus on a particular form of institutional frictions (hukou) that affect migration, and ask the extent to which it affects both aggregate and distributional effects of trade.[8] Moreover, the regional responses studied in both papers are derived

[4]See Autor et al. (2016) for an overview.

[5]An exception is Dauth et al. (2014), who find that the rise of the East in the world economy caused substantial job losses in regions in Germany that are specialized in import-competing industries but job gains in regions specialized in export-oriented industries.

[6]In particular, Kovak (2011) finds that the most affected Brazilian states lost approximately 0.5% of their local population as a result of liberalization; Dix-Carneiro and Kovak (2017) find that the regional adjustment of formal employment occurs primarily through workers transitioning into and out of formal employment rather than migrating across space; and Autor et al. (2013) document no robust evidence for import shocks to local manufacturing causing reallocation of workers across commuting zones.

[7]In the empirical literature on trade and local labor markets, the most related papers are Goldberg and Pavcnik (2007) and Topalova (2007), which suggest that the poor are more likely to share the gains from trade liberalization in regions with flexible labor markets. Facchini et al. (2017) relate changes in internal migration rates to the reduction in trade policy uncertainty faced by Chinese exporters to the U.S. and find positive results. There is another growing literature investigating reallocation costs across sectors and firms (Artuç et al. (2010); Artuç and McLaren (2012); and Dix-Carneiro (2014), among others).

[8]Other works studying the interaction between trade and domestic geography include Coşar and Fajgelbaum (2013)

from counterfactual trade shocks. Instead, I look at an observed liberalization episode, thus I am able to guide the model construction with credibly identified empirical evidence and confirm its validity by comparing the observed regional response with the one generated by the model.

The rest of the paper is organized as follows. In the next section, I describe the empirical context, discuss the data, and present the empirical results. Section 3 presents the theoretical framework. In Section 4, I estimate and calibrate the key parameters of the model, quantify aggregate and distributional effects of tariff reductions, and explore the counterfactual scenario whereby the hukou system is abolished. Section 5 concludes.

2 Input Liberalization and Regional Hukou Frictions

In this section, I briefly explain the history of trade reforms and the hukou system in China, describe the data and measurement, and present four empirical patterns that demonstrate input-liberalization-induced spatial labor adjustments and the presence of hukou frictions. I provide a more detailed discussion of the empirical background, data construction, and a battery of robustness checks of the empirical results in Appendices B, D, and E, respectively.

2.1 Empirical Context

China's Trade Liberalization

Prior to the economic reforms of the early 1980s, the average tariff level in China was 56%.[9] This tariff schedule was introduced in 1950 and underwent almost no change for the following decades, partly due to the relative unimportance of trade policy in a centrally planned economy.[10] Starting in 1982, China engaged in a series of voluntary tariff cuts, driving down the simple average tariffs to 24% in 1996 (Li, 2013). However, the government also introduced pervasive and complex trade controls in the same period - import quotas, licenses, designated trading practices and other non-tariff barriers were widely used (Blancher and Rumbaugh, 2004).[11] In addition, the Chinese RMB depreciated by more than 60% in the 1980s, and further by 44% in 1994 to help firms export (Li, 2013). As a result, changes in tariff duties neither reflect the changes in actual protection faced by Chinese firms nor the accessibility of imported inputs.

and Fajgelbaum and Redding (2014), who show that the difference in domestic trade costs to international gates can lead to heterogeneous regional development after external integration; Monte et al. (2015) emphasize the role of commuting ties to estimate local employment elasticities; Ramondo et al. (2016) find that domestic trade costs are substantial impediments to scale effects.

[9] This is the 1982 unweighted average tariff documented by Blancher and Rumbaugh (2004).

[10] Under the planned economy, import and export quantities were government decisions rather than reflections of market supply and demand (Ianchovichina and Martin, 2001). During this period, trade in China was run by 10 to 16 foreign-trade corporations who were *de facto* monopolies in their specified product ranges (Lardy, 1991).

[11] There was also a substantial level of tariff redundancy resulting from various preferential arrangements. To name a few, imports for processing purposes, for military uses, by Special Economic Zones and in certain areas near the Chinese border were subject to waivers or reductions in import duties. According to Ianchovichina and Martin (2001), only 40% of imports were subject to official tariffs.

In 1996, to meet the preconditions of its WTO accession, the Chinese government engaged in substantial reforms that did away with the most restrictive non-tariff barriers. Trade licenses, special import arrangements, and discriminatory policies against foreign goods were reduced or eliminated to make tariffs the primary instruments of protection.[12] Phased tariff reductions started in 2001. In 2000, China's simple average applied tariff was 17%, with the standard deviation across the six-digit Harmonized System (HS6) products being 12%. By the end of 2005, the average tariff level was reduced to 6% and the standard deviation almost halved. The average tariff level stabilized after 2005.[13] Thus, I measure input trade liberalization based on the change in tariff rates between 2000 and 2005. Detailed discussions and robustness checks on the exogeneity of tariff changes can be found in Appendix E.

The Hukou System

A hukou is a household registration record that identifies a person as a resident of a particular area in China. It determines where citizens are officially allowed to live. China introduced its hukou system in the early 1950s to harmonize the old household registration systems across regions. The system was, however, soon repurposed for restricting internal migration. Despite a series of reforms since the 1980s to relax the system, it continues to serve as the primary instrument for regulating interregional migration. Discrimination against migrant workers on the basis of their hukou status is widespread. Individuals who do not have a local hukou in the place where they live are not able to access certain jobs, schooling, subsidized housing, healthcare and other benefits enjoyed by those who do. As a result, the ease of obtaining a local hukou still heavily influences one's migration decisions.

Importantly, as part of a contemporaneous reform devolving fiscal and administrative powers to lower-level governments, local governments have largely gained the authority to decide the number of hukou to issue in their jurisdictions. Since 1992, some provinces have introduced temporary resident permits for individuals with a legitimate job or business in one of their major cities, others grant hukou to highly skilled professionals or businessmen who make large investments in their region (Kinnan et al., 2015).[14] The stringency of these policies and general hukou issuing rules, however, differ significantly

[12] The share of all imports subject to licensing requirements fell from a peak of 46% in the late 1980s to less than 4% of all commodities by the time China entered the WTO. The state abolished import substitution lists and authorized tens of thousands of companies to engage in foreign trade transactions, undermining the monopoly powers of state trading companies for all but a handful of commodities. The transformation was similarly far-reaching on the export side (Lardy, 2005). The duty-free policy on imports for personal use by Special Economic Zones was gradually abolished in the 1990s; preferential duty in Tibet was abolished in 2001. Moreover, China also abolished, modified or added over a thousand national regulations and policies. At the regional level, more than three thousand administrative regulations and about 188,000 policy measures implemented by provincial and municipal governments were stopped (Li, 2011).

[13] All numbers are calculated using the simple average of Most Favoured Nation (MFN) applied tariffs at the HS6 level from the United Nations' (UN) Trade Analysis Information System (TRAINS).

[14] The most significant change is the introduction of two particular types of residential registration, the so-called temporary residential permit and the blue-stamp hukou. Unlike the regular hukou, these are not administered by the central government; instead, their design and implementation are up to local governments. While the temporary resident permit can be issued to anyone who has a legitimate job or business in the city, citizens who want a blue-stamp hukou are usually required to pay a one-time entry fee called the urban infrastructural construction fee, which varies between a few thousand RMB in small cities and 50,000 RMB in more "attractive" cities.

across regions. Despite a reform launched by the central government in 1997, which was largely an affirmation of existing local hukou policies and had mostly been put on hold since mid-2002 (Wang, 2004), there have been no substantial hukou reforms over the 2000-2010 period. I therefore exploit the heterogeneity in hukou-granting practices in 2000 to measure the migration costs associated with the hukou system for the 2000-2010 period. I provide a detailed description of the political economy of the hukou system, its main rationale and determinants in Appendix D.

2.2 Data and Measurement

To evaluate the impact of tariff reductions on regional economies in China, I construct a panel dataset of 337 Chinese prefecture-level divisions (prefectures in short). The core data tracks prefectures decennially from 2000-2010, with the 1990 value available for some variables. Table 1 contains descriptive statistics of the main variables that I use in Section 2, which I describe throughout this section. Appendix B provides details on the construction of these variables, as well as detailed information on other variables and datasets that are used in the paper.[15]

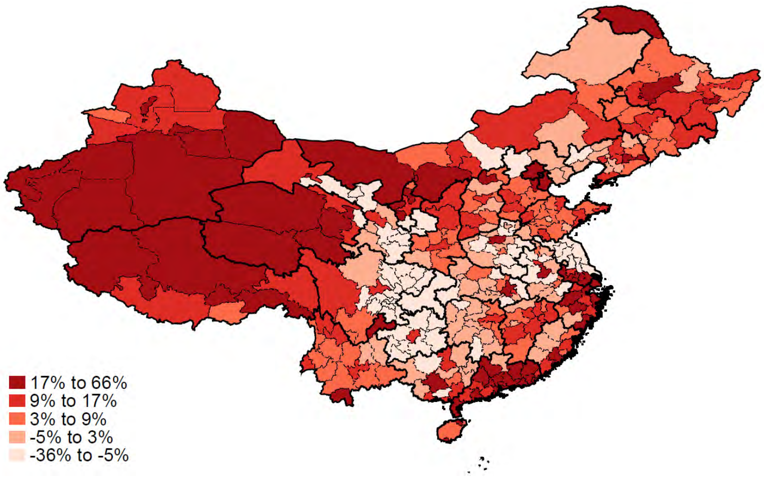
Local Labor Markets

Throughout the empirical analysis, local labor markets are defined as prefectures. A prefecture is an administrative division of China that ranks below a province and above a county. As the majority of regional policies, including the overall planning of public transportation, are conducted at the prefecture level (Xue and Zhang, 2001), I expect counties within the same prefecture to have strong commuting ties and be economically integrated. To account for prefecture boundary changes, I use information on the administrative division changes published by the Ministry of Civil Affairs of China to create time-consistent county groups based on prefecture boundaries in the year 2000. This results in 337 geographic units that I refer to as prefectures or regions, including four direct-controlled municipalities and 333 prefecture-level divisions that cover the entire mainland China. Compared to the commuting zones in the United States, the Chinese prefectures are about twice the size on average and 1.5 times the size when the 10 largest (but sparsely populated) prefectures in autonomous regions are excluded.

The empirical analysis in this paper studies 10-year changes in prefecture employment, total and working age populations, the most recent five-year migrant inflows from other provinces, and population holding local hukou in each prefecture. I collect these variables at the county level from the Tabulation on Population Census of China by County for the years 2000 and 2010, then aggregate them to prefectures based on the time-consistent county groups. Notably, the employment measure includes informal workers, the lion's share of which are migrants.[16] Figure 1 shows the prefecture em-

[15]The key data challenge is to consolidate different publications of the Chinese population census and to create crosswalks that are consistent across various data sources, the details of which are in Appendix B.

[16]According to Park et al. (2012), informal employment in China is defined either based on (i) whether or not the employer fails to provide all of the three most important types of social insurance that employers are expected to provide in China (i.e., pensions, health insurance, and unemployment insurance), or (ii) whether workers have a labor contract.



Notes: 10-year change in log prefecture employment. See text for details.

Figure 1: Regional Employment Changes

ployment changes in China between 2000-2010. I outline provinces in bold and prefectures in dashed lines. The darker prefectures experienced larger employment increases (or smaller decreases). Between 2000 and 2010, China underwent a significant change in its spatial distribution of employment, with some prefectures seeing over a 50% increase in local employment, while others facing more than a 30% decrease.

Regional Trade Shock Exposures

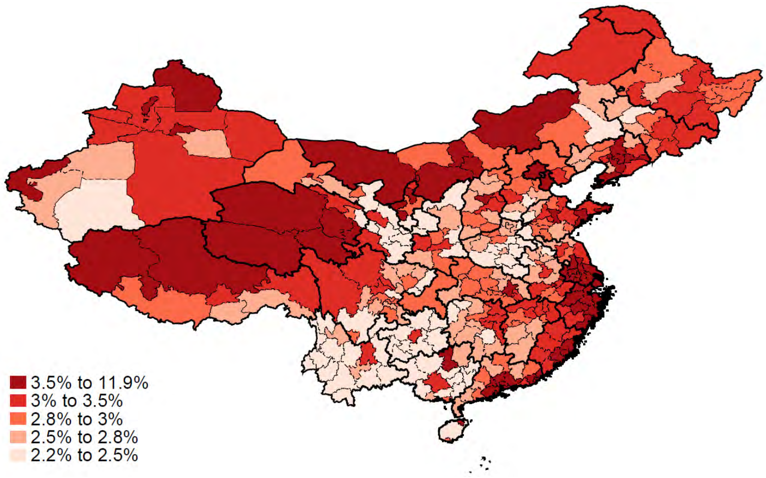
To construct the exposure of local labor markets to *input tariff reductions*, I combine data on regional industry employment with data on tariffs and industry cost shares. Data on regional employment by industry in the year 2000 is collected from the Tabulation on the 2000 Population Census published by each province. The original data is by county and by 92 two-digit 1994 Chinese Standard Industrial Classification (CSIC1994), which I aggregate to prefecture level.[17] I use the simple average of MFN applied tariffs at the HS6 product level from the UN's TRAINS database to calculate tariff changes. The cost share of each industry is constructed as its share of value in the output industry using the 2002 Chinese National IO table.[18] To utilize these various datasets, I also construct a common industry classification, which consists of 71 industries, including five agriculture and 28 non-traded industries.[19] The crosswalk between industry classifications is presented in Appendix B, Table A1.

Migrant workers contribute to 49.0% of the informal employment in China under the first definition and 65.7% under the second. The employment data from population census includes all informal workers, as long as they engaged in at least one-hour of paid job the week before the survey date or were on leave.

[17]The 2010 employment by industry has many missing values, so I perform all analyses at the regional rather than the region-industry level.

[18]Because trade liberalization began in 2001, I use the IO table of the closest year. I do so under the assumption that industries' cost structures adjust slowly to trade reforms. I do not use the 1997 IO table for two reasons: firstly, the 1997 IO table uses an industry classification which is less consistent with employment data; second, it might understate the importance of tradable inputs due to the Asian financial crisis.

[19]The common industry classification is created to achieve the maximum disaggregation between different classifica-



Notes: Prefecture exposure to input tariff cuts (2000-2005), with darker prefectures experiencing larger input tariff reductions. See text for details.

Figure 2: Regional Input Tariff Cuts

As standard in the literature, I measure input tariff cuts (ΔIT) as the input-cost weighted average of tariff reductions:

$$\Delta IT_s = \sum_{k \in K} \alpha_s(k) d\ln(1 + t_k),$$

where $\alpha_s(k)$ represents the cost share of industry s due to purchases from industry k, t_k is the tariff rate of industry k, and d represents the long-difference between 2000 and 2005. Following Kovak (2013) and Dix-Carneiro and Kovak (2017), I calculate the regional input tariff cuts (ΔRIT) as follows:

$$\Delta RIT_i = \sum_{s \in K} \delta_{is} \Delta IT_s,$$

where $\delta_{is} = \frac{L_{is} \frac{1}{\phi_s}}{\sum_{s \in K} L_{is} \frac{1}{\phi_s}}$, L_{is} is the initial amount of labor allocated to industry s in region i, and ϕ_s is one minus the wage bill share of the industry value added. In a specific-factor model with a constant returns production function, $\frac{1}{\phi_s}$ represents the labor demand elasticity (Kovak, 2013). The weight δ_{is} captures the intuition behind the construction of ΔRIT: a prefecture will experience a larger increase in employment if its workers are specialized in industries with large input tariff declines, and more so if these industries are elastic in labor demand. Nevertheless, my empirical results are robust to using weight that are based on employment only.

I present the results of this calculation in Figure 2, with darker prefectures facing larger input tariff cuts. Evidently, disparities in industry weights across regions generate substantial variations in their exposure to input trade liberalization. The three hubs of China's trade and economic growth, the Bohai Economic Rim, the Yangtze River Delta, and the Pearl River Delta are among the top beneficiaries of input trade liberalization. Western prefectures that are specialized in animal husbandry or basic

tions; the 2002 IO table consists of 122 industries and is coded similarly to the 1994/2002 Chinese Standard Industrial Classification (CSIC1994/CSIC2002). See Appendix B for more details.

food processing and manufacturing benefited greatly from tariff cuts in farming industries, and hence also experienced large decreases in regional input tariffs.

Similar to calculating the regional *input tariff cuts*, I compute regional *output tariff reductions* as a δ_{is}-weighted average of industry-specific tariff reductions over the 2000-2005 period. To calculate external tariff reductions, I first use the Chinese customs data for 2000 to compute prefecture exports and calculate the export share by destination country for each industry and prefecture. I then take the export-share weighted average of the tariff changes across destination countries to get prefecture-industry specific tariff reductions. In the last step, I compute the weighted average tariff changes across industries using δ_{is} for each prefecture. Appendix B provides descriptive statistics of these variables.

The Hukou Measure

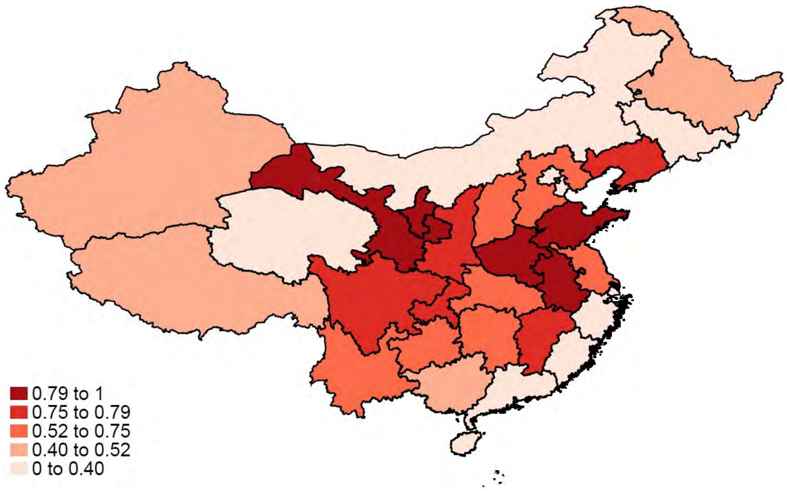
The primary dataset that I use to construct the hukou measure is the 0.095% random sampled data of the Population Census in 2000. The complete dataset covers the entire population of China, and the sample I obtained was randomly drawn at the household level, with a unique identifier linking individuals in the same household. The dataset contains rich individual-level information including one's hukou registration status and migration history in the last five years, from which I can infer the stringency of a prefecture's hukou system based on the likelihood of an individual obtaining a local hukou after settling in that prefecture. In reality, the likelihood of an individual acquiring or being granted a local hukou also depends on various individual characteristics. In order to draw out these effects, I calculate the hukou measure as follows: focusing on individuals who moved between 1995 and 2000 to a prefecture that is not their birthplace,[20] I regress a dummy equal to one if the individual had already obtained a local hukou before November 2000 (when the census was conducted) on age, age squared, gender, ethnicity (Han versus the other), marriage status (ever married), difference in log GDP per capita between the migrate-out and migrate-in provinces,[21] migrate-from-rural-areas dummy, migrate-within-province dummy, categorical variables for education and for the years of residence in the current city, and prefecture fixed effects. I then take a simple average of the estimated prefecture fixed effects by province and normalize it from zero to one to obtain the final measure.[22]

The hukou measure is an *inverse* indicator of migration frictions associated with the hukou system: it equals zero if a province has the most stringent hukou granting practice. Figure 3 presents the estimated calculation. Migrants in darker provinces have a greater chance of obtaining a local hukou than do migrants in lighter provinces. I also list the five most and least difficult provinces to obtain the local hukou. Consistent with common knowledge, Beijing, Shanghai and Guangdong are among

[20]In the early 1990s, most internal migration was state-planned, guaranteeing local hukou to migrants. I therefore focus on the most recent five years. The raw dataset contains 1,180,111 observations; since most people never migrate, the number of observations in my regressions is 62,289.

[21]I obtain GDP per capita data from the 2000 provincial statistical yearbooks. Notice that it is important to control for GDP differences, as a migrant from a more developed area might not be willing to switch and acquire a local hukou.

[22]I view the simple average as a useful benchmark measure, and I show that the empirical results in this paper are robust to alternative hukou measures in Appendix E.



Name	Value
5 provinces with the most frictions	
Beijing	0
Shanghai	0.03
Qinhai	0.05
Hainan	0.14
Guangdong	0.25
5 provinces with the least frictions	
Shandong	0.79
Anhui	0.83
Ningxia	0.98
Gansu	0.99
Henan	1

Notes: The measure of hukou frictions for each province, with lighter provinces having more stringent hukou systems in 2000. See text for details.

Figure 3: Province-level hukou Measure

the most difficult provinces to obtain a local hukou. In addition, there is no correlation between GDP per capita of a province and its hukou policy. For instance, Qinghai and Tibet also have very stringent hukou policies, which are more likely driven by limited farming land and political stability concerns.[23] Hukou stringency is not determined by the initial population density of a region either, with some densely populated provinces, such as Henan, having a rather liberal hukou system, while other densely populated regions like Beijing having a stringent system.

There are few papers that have tried to calculate hukou frictions, and almost all of them are based on city-level legislation (see, for example, Wu et al. (2010) and Kinnan et al. (2015)). In comparison, my approach has several advantages. First, because data covering hukou-related laws and regulations is limited, existing studies typically focus on a small number of cities or provinces. Second, the actual practice of local regulations may vary greatly across regions; sometimes new regulations are simply an affirmation of existing practices. In these circumstances, regulations will not necessarily reflect the *real* difficulty of obtaining a local hukou. Furthermore, in some provinces, hukou granting rules are not detailed (Kinnan et al., 2015), making quantifying the stringency of the system difficult. By looking at the hukou granting probability directly, I am able to circumvent these limitations.

Endogeneity problems may arise if the local government adjusts hukou policy in response to trade shocks. Though I cannot address this concern directly, the local government tends to tighten the hukou policy to save fiscal spending when inward migration increases. Kinnan et al. (2015) document no evidence that the local government issues more regulations tightening the hukou system if the province experiences an economic boom. In this case, the estimates of ΔRIT and its interaction with the hukou measure will be downward biased and hence can be viewed as a lower-bound result. Second, as mentioned in Appendix D, there were no significant regional hukou reforms in China after 2002, so

[23]Even in 2016, internal migration is still very restricted in Tibet, and the police constantly checks the identity of migrant workers.

Table 1: Descriptive Statistics (Main Variables)

Variable	Mean	Std. Dev.	Min.	Max.	N
Regional input tariff cuts, 2000-2005	0.03	0.01	0	0.12	337
Employment changes, 2000-2010	0.07	0.14	-0.36	0.66	337
Population changes, 2000-2010	0.07	0.12	-0.25	0.64	337
Working age population changes, 2000-2010	0.13	0.13	-0.26	0.64	337
Changes in migration inflows, 1995-2000 versus 2005-2010	0.95	0.49	-2.22	2.38	337
Hukou population changes, 2000-2010	0.48	0.13	0.07	1.25	337
Provincial hukou measure	0.60	0.24	0	1	337

Notes: This table provides descriptive statistics for main variables used in the empirical analyses. An exhaustive list of variables, along with their descriptive statistics, are provided in Table A2.

the endogenous hukou change should be less of a concern over the 2000-2010 period. I also compared the hukou measure constructed using the 2000 census with the one constructed using the 2005 1% population survey (mini census). I obtained the 10% random sample of the 2005 mini census data from the Sociology Department of the Remin University of China. This data contains less information at the individual level; hence I calculate the simple hukou granting probabilities for each province focusing on residents who mainly lived in other provinces five years ago, and who have left their hukou registration place at least once. Notice that I cannot exclude locally born individuals or those who have already obtained a local hukou before 2000 but have lived somewhere else due to data limitations, and this will lead to measurement error. However, when I compare this measure with the simple granting ratio calculated using the 2000 census, the Spearman correlation is 0.81, suggesting that the hukou system is stable over time.

2.3 Empirical Specification

Given the regional input tariff cuts and the hukou measure at hand, I estimate the following equations in the next subsection:

$$\Delta Y_i = \beta_1 \Delta RIT_i + D_p + \mathbf{X_1'}\gamma + \epsilon_i, \tag{1}$$

and

$$\Delta Y_i = \beta_2 \Delta RIT_i + \beta_3 \Delta RIT_i * Hukou_p + D_p + \mathbf{X_2'}\gamma + \epsilon_i, \tag{2}$$

where the second specification explores the heterogeneous regional effect of input tariff reductions depending on the hukou frictions. Here, ΔY_i is the decadal change of the log value of a regional outcome variable such as employment or total population; β_1 captures the regional effect of input trade liberalization on the variable of interest during the 2000-2010 period, while β_2 and β_3 represent the heterogeneous impact of input tariff reductions depending on hukou frictions; D_p are province fixed effects, and $\mathbf{X}$ represents a set of additional controls. In the main specification, $\mathbf{X}$ includes regional output tariff reductions, external tariff reductions, and the pre-liberalization level of the outcome variable to control for increased import competition, improved market access,[24] and possible mean convergence. $Hukou_p$ is the hukou friction measure; in the second equation, I also control for its interaction with external and output tariff reductions.

2.4 Empirical Results

In this subsection, I present four reduced-form empirical patterns that suggest input-liberalization-induced spatial labor adjustments and the presence of hukou frictions.

Pattern 1: Prefectures facing larger input tariff cuts experience a relative increase in employment, and the effect is stronger in provinces with less hukou frictions.

Table 2 presents the results of regressing employment changes on regional input tariff cuts. The standard errors are clustered at the provincial level, accounting for the possible covariance between the error terms across prefectures within the same province. Regressions are weighted by the log of beginning-period of employment. Columns (1)-(3) present the model without interactions. Column (1) represents the benchmark case without any controls, then I control for beginning-period log employment, regional output tariff reductions, and external tariff reductions in column (2). In column (3), I add province fixed effects to control for province-specific trends. Column (3) is the preferred specification, but in all three cases, the coefficient on ΔRIT is significant at the 1% level and has the expected positive sign. The estimate of 4.92 in column (3) implies that a prefecture facing a 1 percentage point regional input tariff cut experiences an almost 5 percentage points employment increase. The difference between regional input tariff cuts in regions at the 25th and 75th percentiles is 0.7 percentage points. Evaluated using the estimate in column (3), a region at the 75th percentile experiences a 3.4 percentage points larger employment increase than a region at the 25th percentile. Consistent with the existing literature, I find that regional output tariff reductions has a negative impact on employment, though at a smaller magnitude compared to the impact of input tariff cuts. The effect of external tariff reductions has the expected positive sign but is statistically insignificant.

Columns (4)-(6) add the interaction term between input trade liberalization and the hukou measure, probing whether input-liberalization-induced employment adjustments are more pronounced in provinces with relatively free hukou systems. Similar to the case without interactions, I first present baseline results in column (4) and then add additional controls in columns (5) and (6). Since I normalized my hukou measure to the unit interval, coefficients on ΔRIT directly reflect the impact of input tariff cuts in prefectures with the highest hukou frictions. In all three cases, the coefficient on the interaction term is positive and statistically significant. In the preferred specification in column (6), input tariff reductions have no impact on regional employment in the most hukou-stringent province. In contrast, in regions with the most relaxed hukou system, a 1 percentage point increase in input tariff cuts leads to a 16 percentage points relative increase in employment, which is much larger than

[24] External tariff reductions capture the positive impact of tariff reductions by China's trading partners after its WTO accession. However, this is less of a concern as most countries had already granted China MFN status before 2001.

Table 2: Effect of Input Tariff Cuts on Local Employment

	Main			With hukou interactions		
	(1)	(2)	(3)	(4)	(5)	(6)
Regional input tariff cuts (ΔRIT)	6.13***	6.78***	4.92***	0.03	2.75*	-0.06
	(1.45)	(0.89)	(1.44)	(1.80)	(1.42)	(1.53)
Regional input tariff cuts × Hukou				12.69***	8.09**	15.70***
				(3.74)	(2.96)	(4.45)
Regional output tariff change		-3.01***	-2.73***		-2.72***	-3.81***
		(0.61)	(0.67)		(0.83)	(0.92)
External tariff change		0.27	0.11		0.46	0.99*
		(0.31)	(0.20)		(0.57)	(0.50)
Initial employment		-0.01	-0.00		-0.01	-0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Regional output tariff change × Hukou					1.08	4.52**
					(1.45)	(2.04)
External tariff change × Hukou					-0.31	-1.34**
					(0.78)	(0.64)
Province fixed effects (31)			Yes			Yes
Observations	337	337	337	337	337	337
R-squared	0.27	0.46	0.66	0.43	0.52	0.70

Notes: The dependent variable is the 10-year change in log prefecture employment. The sample contains 333 prefectures and four direct-controlled municipalities. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

the 5 percentage points average found in column (3). I also find a weak relationship between the effect of output tariff reductions and hukou stringency, though the result is only significant when fixed effects are included. This is consistent with the fact that the hukou system is mostly designed to control for migration inflows. The interaction terms between external tariff change and hukou frictions, on the other hand, have the wrong sign. Calculated based on the specification in column (6), the partial R-squared of regional input tariff cuts, regional output tariff cuts and their interactions with the hukou measure is 0.35. This suggests that when taking into account both input and output channels, over 30 percent of the regional variation in employment changes could be accounted for by trade liberalization.

Pattern 2: The total population and the working age population react to input tariff cuts and their interaction with the hukou measure in a quantitatively similar way to that of employment.

It is possible that the observed changes in regional employment are due to intra- rather than inter-regional adjustments. A positively affected region may experience a decline in unemployment and an increase in labor force participation, both of which could lead to an increase in local employment. To ensure that it is the spatial reallocation of labor that drives pattern 1, I next look at how total and working age (15 to 64 years old) populations respond to input tariff reductions. If the observed employment changes are mainly due to intraregional adjustments, trade shocks should have no impact on the local population; whereas if the change is primarily due to interregional adjustments, the local population should react to trade shocks in a quantitatively similar way to that of employment.

Table 3 reports the results of regressing the regional change of log total and working age popu-

Table 3: Effect of Input Tariff Cuts on Local Population

	Total population		Working age population	
	(1)	(2)	(3)	(4)
Regional input tariff cuts (ΔRIT)	5.56***	1.54	4.33***	-1.00
	(1.08)	(1.23)	(1.46)	(1.50)
Regional input tariff cuts × Hukou		12.01***		16.43***
		(3.38)		(4.31)
Regional output tariff change	-2.78***	-2.83**	-2.20***	-2.83***
	(0.56)	(1.06)	(0.59)	(0.83)
Regional output tariff change × Hukou		1.62		3.53*
		(2.13)		(1.88)
External tariff change	0.10	0.73	0.16	1.10*
	(0.19)	(0.54)	(0.22)	(0.54)
External tariff change × Hukou		-0.96		-1.42*
		(0.74)		(0.76)
Initial population	0.02***	0.02**		
	(0.01)	(0.01)		
Initial working age population			0.00	-0.01
			(0.01)	(0.01)
Province fixed effects (31)	Yes	Yes	Yes	Yes
Observations	337	337	337	337
R-squared	0.62	0.65	0.58	0.63

Notes: The dependent variable is the 10-year change in log prefecture total population, and working age population (15 to 64 years old) for columns (1)-(2), (3)-(4) respectively. The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the regional output tariff change and external tariff change as controls; models with interaction terms further include the interaction between the hukou measure and other tariff changes as in column (6) of Table 1. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture population. *** p<0.01, ** p<0.05, * p<0.1.

lations on regional input tariff cuts, without and with interactions. I include the full set of controls and cluster standard errors at the provincial level. The results strongly support interregional labor reallocation: columns (1) and (3) show that both prefecture-level total and working age populations react positively and significantly to input tariff cuts, and the coefficients are quantitatively similar to that of employment. On average, a 1 percentage point increase in regional input tariff cuts leads to 5.56 and 4.33 percentage point increases in the total and working age population of a prefecture, respectively. In a prefecture with the least hukou frictions, a 1 percentage point increase in regional input tariff cuts leads to a 12.01 and 16.43 percentage point increase in the total and working age population, respectively. Hence, interregional labor reallocation appears to be the driving force behind the regional employment changes.

Pattern 3: Prefectures facing larger input tariff cuts experience a relative increase in population inflows from other provinces, and more so if they have less restrictive hukou systems.

Compared to indirectly inferring spatial adjustments in labor from regional population changes, it would be preferable to examine migration directly. However, the ideal measure, i.e., the decadal change in net migration inflows, is not available. Therefore, I instead look at the most similar variable available in the census: the number of migrants from other provinces in the past five years.

It is important to note that, compared to the ideal measure, this variable is likely to give an

Table 4: Effect of Input Tariff Cuts on Labor Inflows and Hukou Population

	Migrant inflows		Hukou population	
	(1)	(2)	(3)	(4)
Regional input tariff cuts (ΔRIT)	13.16**	-5.55**	1.25	-2.51
	(5.65)	(2.05)	(0.77)	(2.59)
Regional input tariff cuts × Hukou		61.99***		10.23**
		(15.41)		(4.65)
Regional output tariff change	-3.73	-2.92	-2.84***	-2.06
	(2.49)	(2.61)	(0.70)	(1.35)
Regional output tariff change × Hukou		3.14		-1.26
		(5.39)		(2.66)
External tariff change	0.72	-0.06	0.17	0.68*
	(1.23)	(3.76)	(0.12)	(0.36)
External tariff change × Hukou		1.10		-0.79
		(4.73)		(0.47)
Migrant inflow, 1995-2000	-0.12*	-0.18**		
	(0.07)	(0.08)		
Initial population with local hukou			-0.24***	-0.27***
			(0.03)	(0.04)
Province fixed effects (31)	Yes	Yes	Yes	Yes
Observations	337	337	337	337
R-squared	0.41	0.44	0.70	0.72

Notes: The dependent variable is the difference in log population that migrated from other provinces between 2005-2010 and 1995-1990 for columns (1) and (2), and the 10-year change in log prefecture population holding local hukou permit for columns (3) and (4). The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the full vector of control variables from column (3) of Table 1; models with interaction terms further include the interaction between the hukou measure and other tariff changes as in column (6) of Table 1. Prefecture birth and death rates are also controlled in columns (3) and (4). Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture population. *** p<0.01, ** p<0.05, * p<0.1.

insignificant estimate. Firstly, interregional migration occurs much more frequently within provinces than across them. Secondly, since this variable counts migrant inflows in five-year periods, I compare the number of migrants between 1995 and 2000 with those between 2005 and 2010. Since tariff reductions began in 2001, if their impact levels off quickly, I will not be able to find a significant result.

With the above concerns in mind, I regress the change in the log 5-year inflow of population from other provinces on regional input tariff reductions, without and with interactions. The results are presented in columns (1) and (2) of Table 4, respectively. Column (1) reports that a 1 percentage point increase in regional input tariff reduction leads to a 13.16 percentage points increase in migrant inflows from other provinces. Column (2) confirms that input tariff cuts lead to larger migrant inflows when the hukou system is less stringent. Both estimates are significant at the 5% level. Since migration is a flow rather than a stock variable, the magnitude of the estimates is much larger. In sum, pattern 3 provides additional support that regional input tariff cuts increase local employment through attracting labor from other locations, and this effect crucially depends on frictions caused by the hukou system.

Interestingly, I find that neither the regional output tariff reductions nor the external tariff changes have a significant effect on migrant inflows, nor does their impact heterogeneously depend on hukou frictions. These results further suggest that among various trade shocks associated with China's accession to the WTO, input tariff liberalization seems to have played a dominant role in shaping the labor reallocation in China.

Pattern 4: While, on average, input tariff cuts do not result in an increase in the population holding local hukou, they do so in prefectures where hukou frictions are low.

Columns (3) and (4) of Table 4 show how the number of individuals holding local hukou (hukou population) in a prefecture responds to input tariff reductions. In these regressions, I further control for prefecture birth and death rates to address two additional concerns. One is that input tariff cuts may generate different life expectancy across regions, which affects hukou population changes. The second concern is that it may generate different family planning behavior across regions (i.e., in positively affected areas families may be willing to have more children). The latter is going to impact hukou population via birth rate changes, as the children of local hukou holders are automatically granted local hukou.

If local hukou can be obtained costlessly, the hukou population should be highly correlated with total population in a given region, and hence react positively to input tariff reductions. The empirical results, however, point to the contrary: column (3) indicates that on average, reductions in regional tariffs do not cause significant changes in the hukou population. However, in prefectures with less stringent hukou systems, the hukou population does increase in positively affected regions. Column (4) indicates that, in a prefecture with the most free hukou system, a 1 percentage point increase in regional input tariff cuts leads to a 10.23 percentage points increase in the hukou population. The magnitude, however, is only two-thirds of the input-liberalization-induced increase in total population (column (2), Table 3). This implies that hukou frictions are substantial even in regions with the least stringent system. Since I construct the hukou measure based on the granting probabilities of each region, the positive coefficient on the interaction term provides an additional support of its validity.

In sum, the empirical patterns presented in this subsection suggest that input tariff reductions had a large effect on the reallocation of labor across Chinese regions. Importantly, this effect is heterogeneous depending on the hukou stringency of a region. In Appendix E, I show that my empirical results are not driven by various confounding factors including pre-liberalization trends, state-owned enterprise reforms, RMB appreciation, housing booms, economic agglomeration into provincial capitals, or the development of Special Economic Zones. Moreover, my results are also robust when I instrument tariff changes with their 1992 levels and when I use alternative hukou measures. Importantly, as a falsification test, I look at the effect of input tariff cuts on regional employment before the WTO accession, and find no impact.

3 A Spatial Model with Migration Frictions

In the previous section, I documented the significant impact of input liberalization on local employment through spatial labor reallocation. Moreover, this impact is even more pronounced in regions where hukou frictions are low. While interesting in its own right, the reduced-form evidence abstracts from various general equilibrium effects of trade reforms. Moreover, it is silent about aggregate implications, such as production and welfare effects, and cannot be used to analyze counterfactuals. To address these issues, I propose a quantitative spatial model in this section. To keep the model tightly linked to the empirical analysis, I avoid ingredients that have no direct counterparts in the empirical exercise when constructing the model. Also, without having a convincing parameter on agglomeration forces, I disallow additional agglomeration forces such as increasing returns to scale or heterogenous productivity draw of workers across locations, so that the simulated employment responses could be interpreted as lower-bound results. With these purposes in mind, the model builds on Eaton and Kortum (2002, henceforth EK) and Redding (2016), and features both trade and migration frictions. To take into account the empirical features, the model also incorporates specific factors, sector heterogeneity, input-output linkages and heterogeneous location preferences among workers. Then, in the section that follows, I use the model to quantify the impact of trade liberalization and the importance of hukou frictions.

3.1 Basic Environment

Production

I consider a world with N locations indexed by i, j, and K sectors indexed by s, k, each with a continuum of intermediate varieties indexed by $\nu \in [0,1]$. Three types of inputs are used for producing the varieties: labor, composite goods from all sectors, and local factor which I refer to as structures following Caliendo et al. (2015). The production technology of an intermediate variety ν in sector s of location i is:

$$q_{is}(\nu) = z_{is}(\nu) l_{is}(\nu)^{\alpha_{is}(L)} s_{is}(\nu)^{\alpha_{is}(S)} \prod_{k \in K} Q_{iks}(\nu)^{\alpha_{is}(k)}, \tag{3}$$

where $z_{is}(\nu)$ is the efficiency of producing variety ν, which is distributed Fréchet with a shape parameter θ_s and a level parameter T_{is}. Respectively, l_{is}, s_{is}, and Q_{iks} are labor, structures, and composite goods from sector k that are used for production in sector s, location i; $\alpha_{is}(L)$, $\alpha_{is}(S)$, and $\alpha_{is}(k)$ are the associated cost shares, with $\alpha_{is}(L) + \alpha_{is}(S) + \sum_{k \in K} \alpha_{is}(k) = 1$. Total supply of labor in location i is denoted as L_i, which depends on workers' residential choice (specified later). Total supply of structures, $S_i \equiv \sum_{s \in K} S_{is}$, is assumed to be fixed and immobile across regions. Rents from structures are redistributed equally to local residents.[25]

To produce the composite good Q_{is}, producers in location i source varieties of sector s from the lowest cost suppliers across locations. Production technologies in each sector are CES with the

[25] I implicitly assume that the local government owns structures such as land and natural resources, the rent of which is used to provide public services. In fact, structures like land and natural resources are nationally owned in China. Except for offshore petroleum resources, rents of rest accrue to local governments. Admittedly stylized, I view this as an important aspect of the Chinese economy, as those rents make up a sizable part of local governments' fiscal revenue. Nevertheless, the quantitative results change little when I instead follow the literature and assume there is a mass one of rentiers in each location and that rentiers consume local goods, contribute rents and consume a share of the global portfolio revenue to match the observed trade imbalances across locations (Caliendo et al., 2014, 2017).

elasticity of substitution $\sigma_s < \theta_s + 1$. Composite goods are then used for both final consumption and for producing intermediate varieties. Bilateral trade is subject to iceberg trade costs $\tilde{\tau}_{ijs}$ and ad-valorem flat-rate tariffs t_{ijs}; denote $\tau_{ijs} = (1 + t_{ijs})\tilde{\tau}_{ijs}$. Thus, τ_{ijs} units of a variety in sector s must be shipped from location i for one unit to arrive in location j, where $\tau_{ijs} > 1$ for $i \neq j$ and $\tau_{iis} = 1$. In the interest of brevity, I ignore tariff revenues for now and take it into account when performing quantitative exercises.

Within my empirical context, N locations can be viewed as $N-1$ Chinese regions and "the rest of the world". When s refers to a non-tradable sector, $\tilde{\tau}_{ijs} = \infty$ for $i \neq j$.

Worker Preferences

Consumer preferences over the composite goods are Cobb-Douglas with sector-specific shares β_s. The utility of worker ω holding a hukou from location h and residing in location i depends on her goods consumption, idiosyncratic amenity shocks $a_i(\omega)$, and migration frictions d_{hi}:

$$U_{hi}(\omega) = \frac{a_i(\omega) y_i(\omega)}{d_{hi} P_i}, \tag{4}$$

where the nominal income $y_i(\omega)$ and the local consumption price index P_i jointly determine the consumption level of worker ω. The idiosyncratic amenity shock $a_i(\omega)$ captures the idea that workers have heterogeneous preferences for living in different locations and are assumed to be drawn from a Fréchet distribution with a shape parameter $\kappa > 1$ and a level parameter A_i.

Living outside one's hukou area is costly. For a worker holding hukou from region h, $d_{hi}P_i$ units of her income have to be spent for one unit of consumption in region i.[26] I assume d_{hi} consists of both the hukou frictions (H_{hi}) and other types of resettling costs $\tilde{d}_{hi}$ such that $d_{hi} = H_{hi}\tilde{d}_{hi}$, where $\tilde{d}_{hi} > 1$ for $h \neq i$ and $\tilde{d}_{hh} = 1$. In reality, the hukou system does not discriminate against one's origin among the non-locals, therefore $H_{hi} = H_i > 1$ for $h \neq i$ and $H_{hh} = 1$. Labor is internationally immobile.

Each worker chooses the location that offers her the highest utility and supplies one unit of labor inelastically under perfect competition. The number of workers holding the hukou of a particular location h is assumed to be fixed and is denoted as $\bar{L}_h$.

[26] In reality, the costs of hukou have three main aspects. Firstly, not having a local hukou can entail additional costs of living due to institutional frictions: for instance, one can only take the university entrance examination, get married, apply for a birth permit, visa application, etc. in their hukou city. Secondly, workers without a local hukou may have lower bargaining power in the labor market and hence earn lower wages. Lastly, one may face a higher bar to access certain products, such as healthcare or education. In the last case, one may pay a higher price to access those goods (if possible), find private alternatives, or return to their hukou city to consume those goods. In either way, they raise the cost of living for non-hukou holders but require additional (and different) assumptions on how those goods are provided. Having no direct counterpart in empirical analysis nor guidance from real data, iceberg migration costs, with its brevity and straightforward interpretation, seems a reasonable case to start with. Alternatively, I can introduce a public sector following Caliendo et al. (2017) and Fajgelbaum et al. (2015) and assume that migrant workers pay a higher price to access local public goods. In that case, I get a larger correction of the distributional impact of trade when abolishing the hukou system; the result of which is available upon request.

3.2 Equilibrium

To solve the equilibrium, I first write the location-specific labor demand as a function of wages, which comes from the production side of the model, and then write the labor supply in each location also as a function of wages, which comes from workers' residential choice.

Given the heterogeneous location preferences and the existence of migration frictions, wages can differ across locations. However, with perfectly competitive labor markets and homogeneous workers in terms of their productivity, $w_i(\omega)$ must equalize across workers in a given region. The unit input cost to produce a variety in sector s of location i is therefore:

$$c_{is} = \iota_{is} w_i^{\alpha_{is}(L)} r_i^{\alpha_{is}(S)} \prod_{k \in K} P_{ik}^{\alpha_{is}(k)}, \tag{5}$$

where w_i is the wage, r_i is the rental rates of structures, and P_{ik} is the price of the composite goods in sector k in location i, and ι_{is} is a constant.[27] From EK we know that location i's share of expenditure on varieties from sector s, location j is given by:

$$\lambda_{jis} = \frac{T_{js} \left(\tau_{jis} c_{js}\right)^{-\theta_s}}{\sum_{n \in N} T_{ns} \left(\tau_{nis} c_{ns}\right)^{-\theta_s}}, \tag{6}$$

and the price of the composite good in sector s, location i is:

$$P_{is} = \eta_s \left(\sum_{j \in N} T_{js} (\tau_{jis} c_{js})^{-\theta_s} \right)^{-\frac{1}{\theta_s}}, \tag{7}$$

where $\eta_s \equiv \Gamma(\frac{\theta_s - \sigma_s + 1}{\theta_s})^{\frac{1}{1-\sigma_s}}$ and $\Gamma(.)$ is a Gamma function. The corresponding local price index is $P_i = \zeta \prod_{s \in K} P_{is}^{\beta_s}$, where $\zeta = \prod_{s \in K} \beta_s^{-\beta_s}$. Total revenue in each location equals total expenditure on goods produced in that location, for both consumption and intermediate usage. Thus:

$$R_{is} = \sum_{j \in N} \lambda_{ijs} \left(\beta_s Y_j + \sum_{k \in K} \alpha_{jk}(s) R_{jk} \right), \tag{8}$$

where Y_j is the total value added of location j. For each worker, her income equals wage plus the transferred rents from structures, which by assumption are equal across workers. I therefore have:

$$Y_i = y_i L_i = w_i L_i + r_i S_i. \tag{9}$$

Equalizing total wage payment to the total revenue that goes to workers yields the local labor demand:

$$L_i^D = \sum_{s \in K} \alpha_{is}(L) R_{is} / w_i. \tag{10}$$

[27]Specifically, $\iota_{is} = \alpha_{is}(L)^{-\alpha_{is}(L)} \alpha_{is}(S)^{-\alpha_{is}(S)} \prod_{k \in K} \alpha_{is}(k)^{-\alpha_{is}(k)}$.

Next, I turn to the labor supply. Given the distribution of amenities, the probability that a worker with hukou h chooses to live in location i is:

$$\pi_{hi} = \frac{A_i \left(\frac{y_i}{P_i d_{hi}}\right)^{\kappa}}{\sum_{j \in N} A_j \left(\frac{y_j}{P_j d_{hj}}\right)^{\kappa}}. \tag{11}$$

The shape parameter κ captures the (fundamental) income elasticity of labor supply. Higher κ implies more homogeneous location preferences across workers, hence a more sensitive labor supply to changes in real income or migration frictions. Given a finite value of κ, the relative labor supply to location i (in terms of h hukou holders) increases when the local amenity and real income levels increase, and decreases when migration frictions increase.

As the number of workers holding a hukou of a given location is fixed, by the law of large numbers, the total h workers residing in location i equals $\pi_{hi}\bar{L}_h$. Hence, the total labor supply in location i is:

$$L_i^S = \sum_{h \in N} \pi_{hi}\bar{L}_h. \tag{12}$$

Substituting equations (10) and (12) into the labor market clearing condition ($L_i^S = L_i^D$), I get:

$$\sum_{s \in K} \alpha_{is}(L) R_{is}/w_i = \sum_{h \in N} \pi_{hi}\bar{L}_h. \tag{13}$$

Finally, structure market clearing implies the equilibrium rental rates can be determined from equating the demand and supply of structures:

$$\sum_{s \in K} \alpha_{is}(S) R_{is} = S_i r_i. \tag{14}$$

I now formally define the equilibrium of the model.

Definition 1. *Given $\bar{L}_h$, S_{is}, τ_{ijs} and d_{hi}, an equilibrium is a wage vector $\{w_i\}_{i \in N}$, rental prices $\{r_i\}_{i \in N}$, residential choices $\{\pi_{hi}\}_{h \in N, i \in N}$, and goods prices $\{P_{is}\}_{i \in N, s \in K}$ that satisfy equilibrium conditions (5), (6), (7), (8), (9), (11), (13) and (14) for all i, h, s.*

Intuitively, given wage w_i and structure rents r_i , one can solve for the equilibrium price P_{is} and export shares λ_{ijs} using equations (5), (6) and (7). Labor demand L_i^D and sector output R_{is} can then be solved using equations (8), (9) and (10). Higher factor prices imply a higher factor supply but a lower factor demand. These two forces work against each other and pin down the equilibrium values of w_i and r_i.

3.3 Comparative Statics

Consider a change in tariffs and migration frictions. I proceed as in Dekle et al. (2008) and solve for the change of endogenous variables relative to their initial value. Using the $\hat{x} \equiv x'/x$ notation, I consider shocks $\hat{\tau}_{ijs}$ and $\hat{d}_{hi}$ while keeping all other parameters constant. The equilibrium equation system (5)-(9), (11), (13)-(14) can be rewritten as follows:

$$\hat{c}_{is} = \hat{w}_i^{\alpha_{is}(L)} \hat{r}_i^{\alpha_{is}(S)} \prod_{k\in K} \hat{P}_{ik}^{\alpha_{is}(k)}; \tag{15}$$

$$\hat{\lambda}_{jis} = \left(\frac{\hat{\tau}_{jis}\hat{c}_{js}}{\hat{P}_{is}}\right)^{-\theta_s}; \tag{16}$$

$$\hat{P}_{is} = \left(\sum_{j\in N} \lambda_{jis} \left(\hat{\tau}_{jis}\hat{c}_{js}\right)^{-\theta_s}\right)^{-\frac{1}{\theta_s}}; \tag{17}$$

$$R'_{is} = \sum_{j\in N} \lambda_{ijs}\hat{\lambda}_{ijs}(\beta_s Y'_j + \sum_{k\in K} \alpha_{jk}(s) R'_{jk}); \tag{18}$$

$$Y'_i = w_i L_i \hat{w}_i \hat{L}_i + r_i S_i \hat{r}_i; \tag{19}$$

$$\hat{\pi}_{hi} = \frac{\left(\hat{y}_i/\hat{P}_i\hat{d}_{hi}\right)^{\kappa}}{\sum_{n\in N} \pi_{hn} \left(\hat{y}_n/\hat{P}_n\hat{d}_{hn}\right)^{\kappa}}; \tag{20}$$

$$\frac{\sum_{s\in K} L_{is}\hat{R}_{is}}{\hat{w}_i} = \sum_{h\in N} \hat{\pi}_{hi} L_{hi}; \tag{21}$$

$$\hat{r}_i = \sum_{s\in K} \frac{\alpha_{is}(S) R_{is}\hat{R}_{is}}{\sum_{k\in K} \alpha_{ik}(S) R_{ik}}, \tag{22}$$

where $\hat{y}_i = \frac{Y'_i}{Y_i\hat{L}_i}$, $\hat{P}_i = \prod_{s\in K} \hat{P}_{is}^{\beta_s}$, and $L_{hi} \equiv \pi_{hi}\bar{L}_h$. As suggested by equations (15) and (17), a tariff reduction lowers the price of intermediates and in turn reduces the price of composite inputs. Equations (16) and (18) together indicate that this stimulates production and increases sectoral revenue. Notice that equation (21) can be rewritten as $\hat{w}_i\hat{L}_i = \sum_{s\in K} \frac{L_{is}}{L_i}\hat{R}_{is}$, suggesting that a region will experience a larger increase in total wages if its initial employment is more concentrated in sectors that are booming. This is the key mechanism that generates heterogeneous regional responses to sector-specific tariff changes.

3.4 Relative Change in Regional Real Wages and Employment

This subsection discusses the role of input-output linkages and specific factors in quantifying the effects of trade on regional real wages and employment. Given $\hat{\tau}_{ijs}$, I solve for $\frac{\hat{w}_i}{\hat{P}_i}$ as a function of sectoral prices P_{is}, structure rents r_i, and the share of expenditures on domestic goods λ_{iis} using equations (15) and (16):

$$\frac{\hat{w}_i}{\hat{P}_i} = \prod_{s\in K} \hat{\lambda}_{iis}^{-\frac{\beta_s}{\theta_s}} \prod_{s\in K} \hat{\lambda}_{iis}^{-\frac{\beta_s}{\theta_s}\frac{1-\alpha_{is}(L)}{\alpha_{is}(L)}} \prod_{k\in K, s\in K} \frac{\hat{P}_{ik}}{\hat{P}_{is}}^{-\beta_s\frac{\alpha_{is}(k)}{\alpha_{is}(L)}} \prod_{s\in K} \frac{\hat{r}_i}{\hat{P}_{is}}^{-\beta_s\frac{\alpha_{is}(S)}{\alpha_{is}(L)}}. \tag{23}$$

This decomposition shows that all general equilibrium effects on real wages can be summarized by the change in the share of domestic expenditure in each sector (λ_{iis}), the relative rental price of structures ($\frac{r_i}{P_{is}}$), and the relative price of aggregated inputs from other sectors ($\frac{P_{ik}}{P_{is}}$). The four multiplicative terms on the right-hand side of equation (23) capture the idea that real wages in a given region increase if: (i) consumption goods produced elsewhere become relatively cheaper; (ii) intermediate inputs from one's own sector become relatively cheaper; (iii) the relative price of inputs from other sectors decreases; and (iv) the relative rental price of structures decreases. Without taking into account structures, the last term drops out and I get the same expression as in Caliendo and Parro (2015), which emphasizes the importance of sectoral linkages.

Given equation (23), the relative change in real income can be expressed as:

$$\frac{\hat{y}_i}{\hat{P}_i} = \frac{\hat{w}_i}{\hat{P}_i}\left(b_1 + \sum_{s\in K} b_{2s}\frac{\hat{L}_{is}}{\hat{L}_i}\right), \tag{24}$$

where $b_1 = \frac{L_i}{L_i+\sum_{s\in K}\frac{\alpha_{is}(S)}{\alpha_{is}(L)}L_{is}}$, and $b_{2s} = \frac{\frac{\alpha_{is}(S)}{\alpha_{is}(L)}L_{is}}{L_i+\sum_{s\in K}\frac{\alpha_{is}(S)}{\alpha_{is}(L)}L_{is}}$. Equation (24) sheds light on the impact of inter-sectoral labor adjustments on changes in real income. When employment changes are the same across sectors, the relative changes of real income is proportional to changes in real wage. However, if the employment increases are more concentrated in those sectors that use structures relatively more intensively, rents of structures (in real terms) increase more than real wages, as does real income.

Recall that the relative change in regional employment is characterized by $\hat{L}_i = \sum_{h\in N}\hat{\pi}_{hi}\frac{L_{hi}}{L_i}$. Substituting for $\hat{\pi}_{hi}$ from equation (20), I get:

$$\hat{L}_i = \sum_{h\in N}\frac{\bar{L}_h}{L_i}\frac{\left(\hat{y}_i/\hat{P}_i\right)^{\kappa}\pi_{hi}}{\sum_{j\in N}\pi_{hj}\left(\hat{y}_j/\hat{P}_j\right)^{\kappa}}. \tag{25}$$

The general equilibrium interactions in the model are too complex to allow for a closed-form solution for the effect of tariff cuts on regional employment. Thus, to link the quantitative results with my empirical analysis, I discuss two extreme cases where labor is either perfectly mobile or immobile. With *perfect labor mobility* (absence of the hukou and other migration frictions), the residential choices of workers do not depend on their hukou origin: π_{hj} is the same in all hukou regions, which I denote as π_j. In this case, equation (25) collapses to $\hat{L}_i = \Psi\left(\hat{y}_i/\hat{P}_i\right)^{\kappa}$, where $\Psi = \sum_{j\in N}\pi_j\left(\hat{y}_j/\hat{P}_j\right)^{\kappa}$. In this case, the relative increase in regional employment is proportional to the relative increase in real income $\hat{y}_i/\hat{P}_i$. In the case of *prohibitive hukou frictions*, regional employment will not respond to trade shocks. Generally speaking, the more mobile the labor is, the more elastic is the response of the regional labor supply.

3.5 Welfare Effects

Using equations (4) and (11), the expected utility for workers holding hukou h can be written as:

$$U_h = \Gamma(1 - \frac{1}{\kappa}) \left(\sum_{j \in N} A_j \left(\frac{y_j}{P_j d_{hj}} \right)^{\kappa} \right)^{\frac{1}{\kappa}}. \tag{26}$$

Intuitively, the expected utility depends positively on real income $\frac{y_j}{P_j}$ and the general amenity level A_j, and negatively on migration frictions d_{hj}. With Fréchet distribution, the expected utility of workers holding hukou h conditional on living in location j is the same across all locations. A better location directly raises the utility a worker can derive from that location, but it also attracts workers with lower amenity draws. The Fréchet distribution of amenities makes sure that these two effects exactly cancel each other.

In general U_h differs across h. When the hukou system is the only source of migration frictions, removing it leads to $U_h = \Gamma(1 - \frac{1}{\kappa}) \left(\sum_{j \in N} A_j \left(\frac{y_j}{P_j} \right)^{\kappa} \right)^{\frac{1}{\kappa}}$, which is the same across all worker types. In other words, the hukou system can introduce welfare gaps among otherwise identical workers. Workers holding hukou from h have higher utility if h (i) is more attractive (i.e., high $A_h(\frac{y_h}{P_h})^{\kappa}$), and (ii) has a more stringent hukou system (i.e., high H_h). Since $H_h > 1$ and $H_{hh} = 1$, being a local citizen (in terms of hukou) enables local workers to enjoy local characteristics relatively more compared to non-locals. Therefore, the more attractive a location, the greater the welfare of local citizens. At the same time, the higher the H_h, the more difficult it is for non-locals to move in to arbitrage away the "local premium", therefore the wider the utility gap between local and migrant workers.

Given a trade shock (holding migration frictions constant), the change in expected utility for workers with hukou h is given by:

$$\hat{U}_h = \underbrace{\prod_{s \in K, k \in K} \hat{\lambda}_{iik}^{-\beta_s \tilde{\alpha}_{isk}/\theta_k}}_{price\ effects} \underbrace{\prod_{s \in K, k \in K} \hat{\tilde{L}}_i^{-\beta_s \alpha_{ik}(S) \tilde{\alpha}_{isk}}}_{labor\ supply} \underbrace{(b_1 + \sum_{s \in K} b_{2s}(\frac{\hat{L}_{is}}{\hat{L}_i}))}_{sectoral\ reallocation} \underbrace{\hat{\pi}_{hi}^{\frac{-1}{\kappa}}}_{regional\ reallocation}, \tag{27}$$

where $\tilde{\alpha}_{isk}$ is the $\{s, k\}^{th}$ element of matrix $(1 - \Omega)^{-1}$, with the $(s, k)^{th}$ element of Ω given by $\Omega_{s,k} = \alpha_s(k)$; $\hat{\tilde{L}}_i \equiv \sum_{s \in K} \frac{\frac{\alpha_{is}(S)}{\alpha_{is}(L)} L_{is} \hat{L}_{is}}{\sum_{k \in K} \frac{\alpha_{ik}(S)}{\alpha_{ik}(L)} L_{ik}}$. The right-hand side of the expression in (27) is decomposed into four parts. The first part is the formula for the welfare effects of trade shocks as in Arkolakis et al. (2012) for an economy with input-output linkages. It captures the impact of cost reductions on consumer welfare due to an increased access to imported products (for both consumption and production). The second component captures the wage effects of changes in labor supply. An increased labor supply raises consumption prices and lowers wages, hence reducing the welfare of workers in a given region. Mirroring the empirical specification, the wage effects of labor supply also depend on the initial labor distribution across industries adjusted by wage bill shares in each industry. The third term captures the income effect associated with rent changes due to labor reallocation across sectors within a region.

As shown in Appendix A, the combination of the first three components is simply another expression for the relative change in real income $\frac{\hat{y}_i}{\hat{P}_i}$ in location i. The last term summarizes the gains from regional reallocation. Given a relative increase in real income in location i, a decrease in π_{hi} implies that other locations must have become even more attractive, as otherwise people would rather stay in their initial location. Therefore, it must be that the expected utility of type h workers increases more than the real income in region i.

The last term, $\hat{\pi}_{hi}^{\frac{-1}{\kappa}}$, distinguishes between individual gains from trade and regional gains from trade. As shown in Redding (2016), without migration frictions, people will migrate to equalize gains across worker types even though, regional income changes may be different; but with migration frictions this will not be the case.

Equation (27) also allows me to express the relative change in expected utility across worker types in a parsimonious way. Consider workers holding hukou h relative to the ones with hukou h', their relative gains from trade are:

$$\frac{\hat{U}_h}{\hat{U}_{h'}} = \left(\frac{\hat{\pi}_{hi}}{\hat{\pi}_{h'i}}\right)^{\frac{-1}{\kappa}}, \ \forall i, \tag{28}$$

where $\frac{\hat{\pi}_{hi}}{\hat{\pi}_{h'i}}$ characterizes how attractive outside options are compared to living in location i, for workers holding h hukou relative to those holding h' hukou. If, following a trade shock, a region experiences larger labor outflows of h compared to h' workers, it must be because that the former can reap greater gains from trade by migrating to other regions. The shape parameter κ governs the heterogeneity of worker preferences. A small κ implies a higher degree of worker heterogeneity, suggesting that it is more difficult to move people around. Therefore, given the value of $\frac{\hat{\pi}_{hi}}{\hat{\pi}_{h'i}}$, the smaller the κ, the larger the relative welfare change that it implies.

4 Quantifying the Regional Effects of Trade Liberalization

In this section, I calibrate the model in relative changes to quantify the trade, employment, and welfare effects of tariff reductions, and to assess the role of hukou frictions in shaping these effects. The data needed are tariff changes, cost shares, consumption shares, beginning-of-period sector output R_{is}, bilateral trade shares λ_{ijs}, bilateral labor flows L_{hi}, elasticities θ_s, κ, and hukou frictions. All variables except for θ, κ, and hukou frictions, can be directly observed from the data.

4.1 Taking the Model to the Data

I take the model to the data for the pre-liberalization year 2000. This subsection provides a summary of the sources, and the construction of all parameters except for the hukou frictions, which will be discussed in more detail in the following subsection.

Regions, sectors, and labor markets I calibrate the model to 31 regions, including 30 Chinese provinces and a constructed rest of the world, and 71 industries (same as the ones used in Section 2). I aggregate China's regional data to the provincial level due to the limited information available on labor distribution (L_{hi}) and wages (w_i). Tibet is also excluded from the analysis due to lack of data on trade flows between Tibet and other regions in China. As it will be clear from the quantitative results, calibrating the model at the province level (rather than at the prefecture level) tends to underestimate both the distributional consequences of trade and the benefits of eliminating migration frictions. Therefore, the corresponding quantitative results can be viewed as conservative estimates of the actual effects.

Tariff changes and elasticities I take tariff changes directly from the empirical analysis. The income elasticity of labor supply $\kappa = 2.54$ is taken from Tombe and Zhu (2015). Using alternative values of κ does not meaningfully change the quantitative results.[28] Sectoral trade elasticity θ_s is calculated based on the method developed by Caliendo and Parro (2015). I provide estimation details in Appendix C. In quantitative exercises that follow, I take tariff revenue into account and assume it is redistributed equally to all citizens of a country.

Production data In line with the empirical analysis, I calculate the cost shares $\alpha_{is}(L)$, $\alpha_{is}(S)$, and $\alpha_{is}(k)$ for Chinese provinces using the 2002 Chinese National IO table. By doing so, I implicitly assume that the production structure is the same across all provinces.

I construct labor compensation $w_i L_{is}$ by sector and province for the year 2000 by multiplying provincial wages from the 2000 China Statistical Yearbook with sectoral employment from the 2000 population census. Then using the cost shares, I compute province-specific output and structure rents for each sector. Finally, I deflate all three variables with a sector-specific constant so that the aggregated national output by sector equals the observed data.

For the rest of the world, I set the cost structure of each sector to that of the United States. For this, I use the 2002 Standard Make and Use Tables from the Bureau of Economic Analysis (BEA) and concord it to the industry classification. To construct labor compensation for each sector, I first obtain the labor compensation data for the rest of the world from the OECD Inter-Country Input-Output (ICIO) Tables for 34 aggregated sectors classified according to the International Standard Industrial Classification (ISIC). Then, I split the data into the 71 industries by assuming that the share of each industry's labor compensation in aggregated sectors to which they belong is the same as that of the United States. The structure compensation $r_i S_i$ and output R_{is} are then computed using this data on labor compensations and cost shares.

Bilateral trade flows Trade flows between each Chinese province and the rest of the world across non-service sectors are calculated based on the Chinese customs data for 2000.[29] The inter-provincial trade flows, as well as the international trade flows in service sectors, are calculated based on the production data and the 2002 Chinese Regional IO Tables. These tables report both inter-provincial trade as well as trade between Chinese provinces and the rest of the world, for eight aggregated sectors. I first calculate each province's export share to a certain region (including itself) for these aggregated sectors. Next, for each of the 71 disaggregated sector and province, I set export shares

[28] These Results are available upon request.

[29] Non-service sectors are sectors that have positive trade flows reported in the Chinese customs data. Service sectors are sectors in which the Chinese national IO table documents positive trade flows but the Chinese customs data do not.

equal to that of the aggregated sector to which it belongs. Then the trade flows of a disaggregated sector are calculated as its regional output times the export shares. When computing inter-provincial trade flows in non-service sectors, international trade flows are partialled out first.

In the model, I assume that trade is balanced, thus income equals expenditure. When taking the model to the data, I follow Caliendo and Parro (2015) and calculate all counterfactuals holding China's aggregate trade deficits as a share of world GDP constant at its 2000 level.

Share of final goods expenditure For Chinese provinces, I compute consumption shares directly using the 2002 Chinese National IO table. For the constructed rest of the world, the share of income spent on goods from different sectors is calculated as:

$$\beta_{row,s} = \frac{\sum_{i \in N}(R_{is} - \sum_{k \in K} \alpha_{ik}(s) R_{ik}) - \sum_{i \neq row} \beta_{is} Y_{is}}{Y_{row,s}},$$

where *row* stands for the constructed rest of the world.

Initial labor distribution Within China, I obtain data on population distribution from the Tabulation on the 2000 Population Census of China (National Tabulation). This measure is recorded as the number of individuals holding hukou from province h and living in province j in 2000, based on which I calculate π_{hi}. By doing so I implicitly assume that the initial distribution of labor is the same as the distribution of population. I set the migration between Chinese provinces and the rest of the world to zero.

4.2 Estimating Hukou Frictions

Hukou friction H_i is a critical parameter for understanding the complementarity between labor and trade policies. It is also of great policy interest given China's ongoing hukou reforms. I propose a ratio-type estimation following Caliendo et al. (2014) and Head and Ries (2001), among others, to parameterize the migration costs associated with the hukou system. Consider two regions, i and h. Take the ratio of workers with hukou h living in i to workers with hukou h living in h, and vice versa. Using equation (11) to calculate each expression and then multiplying them, I get:

$$\frac{L_{hi}}{L_{hh}} \frac{L_{ih}}{L_{ii}} = (d_{ih} d_{hi})^{-\kappa}. \tag{29}$$

Amenities, prices, and income terms are canceled out, and I end up with a relation between bilateral labor flows and migration costs. I parameterize d_{hi} as a function of hukou frictions, distance, relocation costs due to other source of regional differences, and a stochastic error term. More specifically, it takes the following form:

$$\ln d_{hi} = \psi_0 + \psi_l \ln Hukou_i + \psi_d \ln dist_{hi} + \psi_{cb} D_{c.b} + D_{r_h r_i} + \epsilon_{hi}, \tag{30}$$

where $Hukou_i$ is the hukou measure used for empirical analysis in Section 2 (before normalization). It captures migration frictions associated with the hukou system. Here, $dist_{hi}$ is the great-circle distance between province capitals, and $D_{c.border}$ is a dummy indicating if provinces h and i share a common border. Both variables capture migration frictions associated with geographic distance. I also include economic-region pair fixed effects $D_{r_h r_i}$ to control for migration frictions due to regional differences in culture and economic development.[30] The last three controls together correspond to $\tilde{d}_{hi}$ in the model.

Taking logarithms of equation (29) and using equation (30) to substitute $\ln d_{hi}$, I obtain:

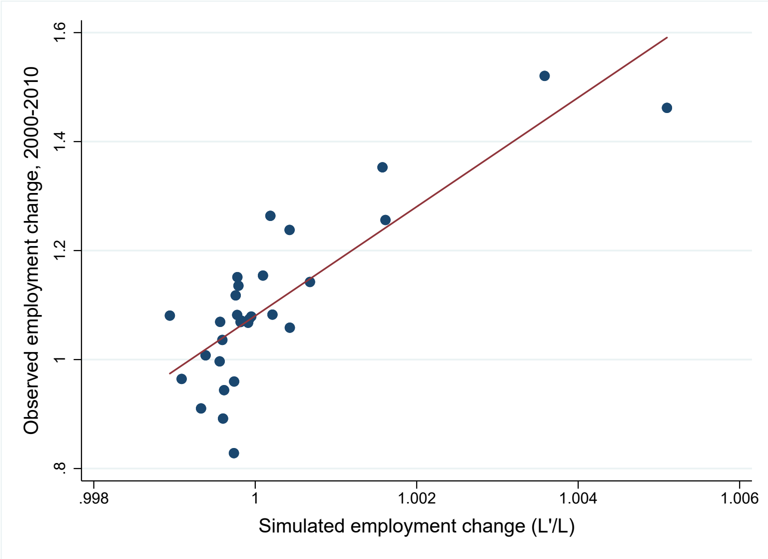
$$\ln(\frac{L_{hh}L_{ii}}{L_{hi}L_{ih}}) = 2\kappa\psi_0 + \kappa\psi_l \ln Hukou_i + \kappa\psi_l \ln Hukou_h + 2\kappa\psi_d \ln dist_{hi} + 2\kappa\psi_{cb}D_{c.b} + 2\kappa D_{r_h r_i} + \tilde{\epsilon}_{hi}, \quad (31)$$

where $\tilde{\epsilon}_{hi} = \kappa(\epsilon_{hi} + \epsilon_{ih})$. I estimate equation (31) using OLS, and get an R-squared of 0.64 and an estimated coefficient on hukou granting probability ($\kappa\psi_l$) of 1.11, which is positive and significant at the 5% level. When $\kappa = 2.54$, the elasticity of migration costs with respect to the hukou granting probability is $\psi_l = 0.44$. The median hukou granting probability estimated in the data is 0.59, which suggests a hukou-related migration cost $H = 1.26$, i.e., the additional living cost for migrant workers in a province with median hukou frictions is about 21% of their income. The estimated coefficient changes little when I further control for ethnic and industry similarities between regions; these results are presented in Appendix C. To my knowledge, this is the first attempt in the literature to quantify the cost of hukou system. Existing case studies indicate that individuals are willing to pay between 15% to 30% of their income to obtain a local hukou. Using Chinese Household Income Project Survey (CHIPS), Chen et al. (2010) also find that if hukou restrictions were removed in 2002, average consumption of migrants would rise by 20.8% even after controlling for the impact of remittances. Although not directly comparable, my estimates are in line with these studies.

4.3 Quantitative Exercises

I quantify the economic effects of tariff reductions and the role of hukou frictions by performing two different but equally informative counterfactual exercises. In the first counterfactual exercise, I introduce Chinese tariff change from 2000 to 2005 into the model and fix hukou frictions to their 2000 level. This counterfactual measures the general equilibrium effects of China's tariff reductions conditional on there being no changes in migration costs. In the second counterfactual, I measure the impact of tariff reductions when hukou frictions are eliminated. To this end, I first calculate the effects of abolishing the hukou system (by setting $\hat{d}_{hi} = 1/{H_i}^{\psi_l}$ for $h \neq i$) and compute the post hukou-abolishment equilibrium. I then evaluate the effects of tariff reductions starting from this new equilibrium. By comparing the results of the two counterfactuals, I am able to quantify the relevance of hukou frictions in shaping the impact of trade liberalization. The second exercise also sheds light on the importance of the hukou system in directly affecting the welfare workers holding different hukou.

[30]There are eight economic regions in China: the northeast (Liaoning, Jilin, Heilongjiang), the northern coast (Beijing, Tianjin, Hebei, Shandong), the eastern coast (Shanghai, Jiangsu, Zhejiang), the southern coast (Fujian, Guangdong, Hainan), the Yellow River region (Shaanxi, Shanxi, Henan, Inner Mongolia), the Yangtze River region (Hubei, Hunan, Jiangxi, Anhui), the southwest (Yunnan, Guizhou, Sichuan, Chongqing, Guangxi) and the northwest (Gansu, Qinghai, Ningxia, Tibet, Xinjiang).



Notes: This figure plots the actual provincial employment changes (L'/L) from 2000 to 2010 against the employment changes predicted by the model. Correlation: 0.83; regression coefficient: 100.12; t: 7.76; R-squared: 0.68.

Figure 4: Calibrated and Observed Employment Changes

Regional Effects of Tariff Reductions

I first evaluate the validity of the theoretical framework by comparing the simulated provincial employment changes with the actual data in Figure 4. The simulated regional employment changes qualitatively match well with the observed data, with a correlation of 0.83 and an R-squared of 0.68. However, it predicts a much smaller employment change than suggested by the reduced form analyses. This disconnect is partly due to the level of aggregation: calibrating the model to 30 provinces abstracts from variations within provinces and hence implicitly assumes more homogeneous regional trade shocks.[31] Moreover, since over two thirds of the internal migration in China was across prefecture cities within the same province, the model also implies much higher migration costs as most of the individuals live in their own province. In this sense, we can interpret the simulated employment changes as lower-bound results.[32]

Table 5 presents the regional effects of tariff reductions when hukou frictions are left unchanged. I set the nominal wage of the rest of the world as the numeraire. I list the five provinces with the biggest and smallest increases in employment for propositional convenience; the full results are available upon request. The table shows that the five provinces with the largest increases in employment are Beijing, Shanghai, Guangdong, Tianjin, and Fujian, with Beijing experiencing an increase in employment of 0.51% and Shanghai of 0.36%. The five provinces with the largest migration outflows are Hubei,

[31]In the case of China, more than half of the regional variation in exposure to trade shocks are within province.

[32]Admittedly, many other factors shape the employment and welfare response of trade shocks; the level of aggregation turns out to be a key factor driving the magnitude of those changes. Unfortunately, data on the number of hukou holders by prefecture cities is unavailable. Without this information, I am not confident about the credibility of estimated labor distribution across prefecture cities. Therefore, I perform the quantitative exercises at the province level, and view my results as conservative estimates.

Table 5: Regional Adjustments to Tariff Reductions

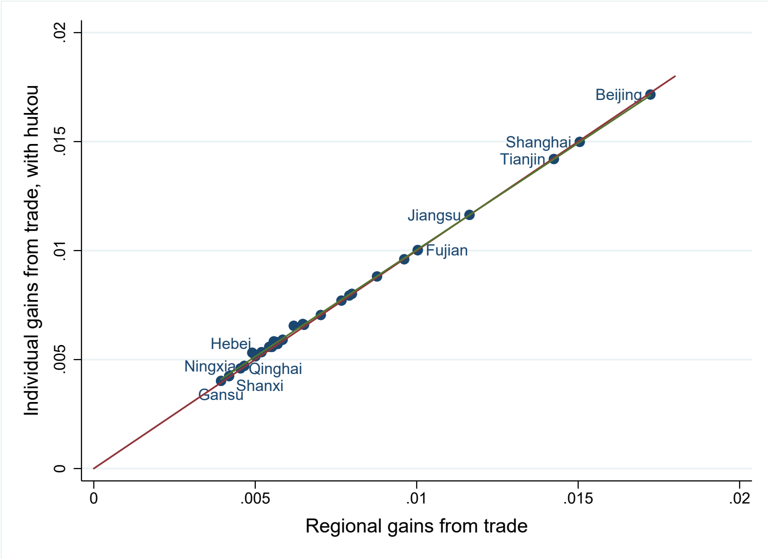
Province	(1) Employment	(2) Real wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	0.51%	1.82%	2.75%	-2.01%	7.39%	3.44%	1.72%
Shanghai	0.36%	1.60%	2.22%	-1.80%	4.92%	4.20%	1.50%
Guangdong	0.16%	0.95%	1.26%	-1.73%	5.15%	7.34%	0.96%
Tianjin	0.16%	1.44%	1.72%	-1.92%	5.88%	4.83%	1.42%
Fujian	0.07%	0.96%	1.10%	-1.64%	4.97%	7.42%	1.00%
with the largest emp. decrease							
Hubei	-0.04%	0.49%	0.40%	-1.52%	4.97%	5.44%	0.58%
Hunan	-0.06%	0.47%	0.35%	-1.45%	6.29%	5.39%	0.58%
Sichuan	-0.07%	0.48%	0.34%	-1.51%	3.98%	5.16%	0.58%
Anhui	-0.09%	0.52%	0.33%	-1.48%	4.33%	5.41%	0.65%
Jiangxi	-0.11%	0.39%	0.19%	-1.39%	3.99%	5.72%	0.53%
Weighted average							0.71%
Standard deviation							0.24%

Notes: This table presents the counterfactual percentage changes in regional employment, real wage, real GDP (total value added divided by local consumption price index), consumption price index, exports, and imports when Chinese tariff structure changed from its 2000 to 2005 level, holding hukou frictions constant. The nominal wage of the constructed rest of the world is the numeraire.

Hunan, Sichuan, Anhui, and Jiangxi.

Column (2) shows that real wages increase in all provinces and that they are positively correlated with changes in employment. When comparing changes in real wages and employment, two patterns stand out. First, regional employment reacts less to trade shocks than do wages (regressing employment changes on wage changes yields coefficient of 0.47), indicating substantial internal migration frictions in China. Second, the region with a larger real wage increase is not necessarily the region with a greater increase in employment. To see this, compare Fujian with Guangdong. The latter has a smaller rise in real wage in equilibrium but its labor inflows rise twice as much. This suggests that migration frictions differ significantly across Chinese regions.

Column (3) of Table 5 presents changes in provincial real GDP (adjusted for the local price index). Every region gains from tariff reductions, but the level at which each region gains differs significantly. Moreover, the most positively affected provinces are those that were the most developed before the introduction of tariff reductions, implying that trade liberalization has exacerbated regional inequality in China. Column (4) presents changes in the local consumption price index. Beijing, Tianjin, and Shanghai experienced the largest price decrease, suggesting that they are the top beneficiaries of cheaper foreign goods. Columns (5) and (6) present the total changes in exports and imports, and show that both increased in all provinces, with some provinces experiencing a larger increase in total exports than imports. There are two main economic forces behind these changes in trade flows. The first is related to industry composition. When sectors with limited regional importance experience



Notes: This figure plots individual welfare changes in terms of hukou provinces (individual gains from trade) against the changes in provincial real income per capita (sum of the first three components of welfare gains of equation (27), i.e., regional gains from trade). The green line is the linear fit and the red is the 45 degree line. Correlation: 1.00; regression coefficient: 0.97; t: 178.04; R-squared: 0.999.

Figure 5: Individual and Regional Gains from Trade

substantial tariff cuts, limited import competition is introduced but a broad range of use sectors may benefit. This boosts local exports more than imports. The other subtler force works through trade diversion. Cheaper intermediates directly lower production costs in all regions in China. For a Chinese province, it therefore becomes optimal to source more intermediates locally and from other Chinese provinces. This also suppresses growth in imports from the rest of the world.

The last column of Table 5 presents the change in welfare for individuals holding hukou from a given province. With the presence of tariff revenues, the welfare effects cannot be directly decomposed following equation (27) as changes in tariff revenues also affects real income; therefore, I instead calculate changes in welfare as $ln(\hat{U}_h) = ln(\frac{\hat{y}_h}{\hat{P}_h}) - \frac{1}{\kappa}ln(\hat{\pi}_{hh})$. As suggested by the last column of Table 5, all Chinese regions (in terms of people's hukou status) gain from tariff reductions, but the distribution of the gains is uneven. Individuals with a Beijing and Shanghai hukou experience welfare improvements of 1.72% and 1.50% respectively, while individuals holding a hukou from Sichuan or Jiangxi province only gain 0.58% and 0.53% - approximately 70% less. The hukou-population-weighted average welfare increase is 0.71%, with the (hukou-population-weighted) standard deviation being 0.24%.

Recall that the labor reallocation term $\frac{1}{\kappa}ln(\hat{\pi}_{hh})$ disentangles individual gains from regional gains (changes in regional real income) from trade. When labor is perfectly mobile, workers may choose to move to different places due to idiosyncratic amenity draws, but the welfare changes should be equal across individuals due to migration; when labor is perfectly immobile, the labor reallocation term equals zero, and hence individual gains from trade equal the real income increase of the individual's hukou province. To explore to which extent internal migration has alleviated the uneven welfare gains, Figure 5 plots individual welfare changes in terms of their hukou (individual gains from trade) against the changes in provincial real income per capita (regional gains from trade). The relationship is strikingly linear with the data points lying around the 45 degree reference line. This suggests that the redistribution of wealth via migration is limited: while we can see large changes in real income, most of the gains in booming areas accrue to local hukou holders due to the high costs of migration.

Effects of Tariff Reductions Given the Elimination of Hukou Frictions

Next, I look at to what extent the effects of tariff reductions can be influenced by the elimination of hukou frictions. To that end, I first use the hukou frictions estimated in the previous subsection to quantify the regional effect of abolishing the hukou system.

Table 6 presents the regional adjustments that take place following the abolishment of the hukou system. I report the five provinces that experience the most significant expansions or contractions. Beijing, Shanghai, and Guangdong are the top migrant-receiving provinces, with an employment increase of more than 10%. Jiangxi, Sichuan, Anhui, Hunan, and Guangxi are the provinces with the largest migrant outflows. The large migrant outflows in Guangxi and Jiangxi are (among other factors) due to their geographic proximity to Guangdong while for Anhui, these outflows are due to its proximity to Shanghai. In the case of Hunan and Sichuan, locals may face less migration frictions for other reasons, such as their strong historical ties with Guangdong. This is also reflected in the fact that their regional employment reacts strongly to tariff reductions (Table 5). In expanding provinces, increased labor supply lowers real wages and boosts local GDP; because of the increased economic size, more intermediates can now be sourced locally with a cost advantage, hence the local consumption price decreases.

There are two forces that govern changes in trade flows. A province experiencing expansion requires more intermediate inputs, which implies an increase in both exports and imports; at the same time, increased economic size also means the region gains a cost advantage in producing a wider range of intermediates, suggesting an increase in exports and a decrease in imports. These two forces work in the opposite direction in contracting provinces. Therefore, exports should always rise while the changes in imports are ambiguous in provinces with worker inflows; the opposite is true in provinces with worker outflows. The calibration exercise shows that imports in all top expanding provinces decrease, suggesting the latter force prevails. On the other hand, imports increase in some contracting provinces but decrease in others.

In the last column of Table 6, I present the individual welfare changes. Although increased regional employment hurts local hukou holders by bidding up structure rents and lowering wages, relaxations in the hukou system make it easier for individuals to move to provinces where they have higher amenity draws, which always improves welfare. Therefore, while individuals holding hukou from provinces with worker outflows benefit from hukou reforms unambiguously, those with hukou from migrant-receiving provinces may not necessarily lose. As shown in the last column of Table 6, the top expanding provinces' hukou holders do experience significant welfare losses. However, out of the 17 provinces

Table 6: Regional Effects of Hukou Abolishment

Province	(1) Employment	(2) Real wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	19.16%	-5.45%	33.58%	-1.27%	16.58%	-2.41%	-5.59%
Shanghai	18.48%	-5.25%	32.40%	-1.18%	14.33%	-2.79%	-5.23%
Guangdong	13.31%	-3.61%	23.63%	-1.08%	12.38%	-2.37%	-3.43%
Tianjin	5.28%	-1.41%	9.21%	-0.25%	4.09%	-0.86%	-1.15%
Xinjiang	4.69%	-0.74%	8.78%	-0.34%	4.50%	-0.87%	-0.45%
with the largest emp. decrease							
Guangxi	-3.50%	1.62%	-5.41%	0.32%	-5.22%	-0.43%	3.38%
Hunan	-4.77%	1.80%	-7.77%	0.84%	-8.39%	0.75%	3.81%
Anhui	-5.09%	2.36%	-7.88%	0.68%	-6.48%	0.15%	4.47%
Sichuan	-5.40%	2.01%	-8.85%	1.07%	-8.00%	1.28%	4.29%
Jiangxi	-6.22%	2.05%	-10.31%	0.87%	-8.36%	0.54%	4.74%
Weighted average							1.56%
Standard deviation							2.19%

Notes: This table presents the counterfactual percentage changes in regional employment, real wage, real GDP (total value added divided by local consumption price index), consumption price index, exports, imports, and hukou population's welfare when hukou frictions are reduced to zero in all provinces, holding tariffs constant. The nominal wage of the constructed rest of the world is the numeraire.

that experience employment increases, their hukou holders' welfare only decreases in six. The average gains across provinces is 1.56%, which is twice as high as the gains from trade reforms.

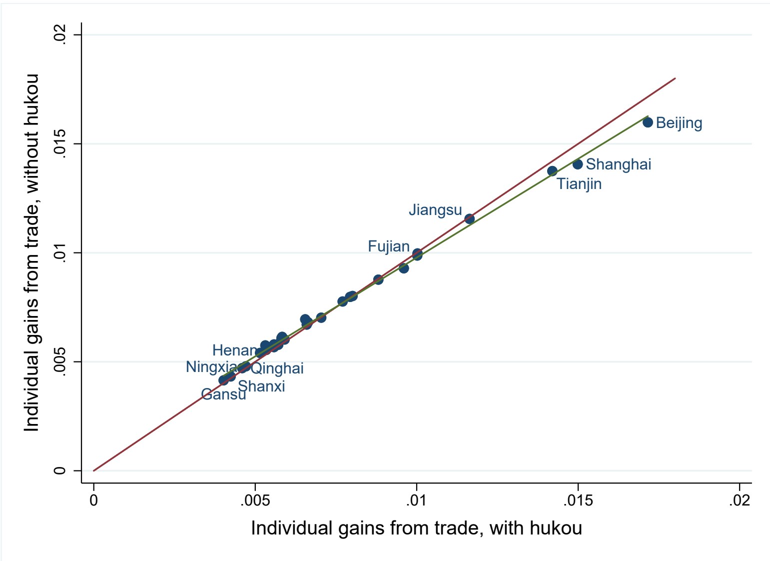
I now evaluate the extent to which hukou frictions shape the effects of tariff reductions. Starting from the post hukou-abolishment equilibrium, I repeat the first quantitative exercise by shocking the system with tariff changes. Table 7 presents the regional effects for the five provinces with the biggest and smallest increases in employment. Comparing the results with those in Table 5, we observe that regional employment reacts more strongly to trade shocks with the elimination of hukou frictions, while real wages react less. For instance, the change in Beijing employment increases by more than 50%, while the change in its real wage declines by 6%. The absolute changes, however, are still small. One plausible explanation is the data aggregation: calibrating the initial labor distribution at the province level overestimates the initial migration frictions, therefore abolishing hukou seems to have only a marginal effect in shaping the impact of trade since the model still suggests very high migration frictions in levels even after abolishing hukou.

The last column of Table 7 presents the changes in welfare of hukou holders of a given province. Comparing the results to those in Table 5, we can see that the top five beneficiaries are still hukou holders from Beijing, Shanghai, Tianjin, Jiangsu, and Fujian. However, they gain less due to the larger increase in migrant inflows. One the other hand, provinces with net migration outflows also experience an increase in their regional employment response to trade shocks, and this is associated with larger welfare improvements.

Table 7: Regional Adjustments to Tariff Reductions, without Hukou Frictions

Province	(1) Employment	(2) Real wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	0.79%	1.71%	3.20%	-2.03%	7.85%	3.44%	1.60%
Shanghai	0.51%	1.50%	2.45%	-1.80%	5.08%	4.16%	1.41%
Tianjin	0.25%	1.39%	1.86%	-1.92%	5.96%	4.86%	1.37%
Guangdong	0.21%	0.92%	1.33%	-1.73%	5.09%	7.26%	0.93%
Fujian	0.10%	0.95%	1.16%	-1.64%	4.91%	7.41%	0.99%
with the largest emp. decrease							
Hebei	-0.08%	0.43%	0.27%	-1.56%	4.12%	8.42%	0.54%
Hunan	-0.10%	0.49%	0.29%	-1.44%	6.09%	5.41%	0.61%
Sichuan	-0.11%	0.50%	0.28%	-1.51%	3.85%	5.25%	0.61%
Anhui	-0.15%	0.54%	0.24%	-1.47%	4.15%	5.44%	0.69%
Jiangxi	-0.17%	0.42%	0.09%	-1.38%	3.82%	5.75%	0.57%
Weighted average							0.72%
Standard deviation							0.22%

Notes: This table presents the counterfactual percentage changes in regional employment, real wage, real GDP (total value added divided by local consumption price index), consumption price index, exports, and imports when Chinese tariff structure changed from its 2000 to 2005 level after eliminating hukou frictions, holding tariffs constant. The nominal wage of the constructed rest of the world is the numeraire.



Notes: This figure plots individuals' welfare changes from tariff reductions in terms of hukou provinces (individual gains from trade) with hukou abolishment against the changes without hukou abolishment. The green line is the linear fit and the red is the 45 degree line. Correlation: 0.999; Regression coefficient: 0.90; t: 101.55; R-squared: 0.997.

Figure 6: Individual Gains from Trade, with and without Hukou Frictions

The last two rows of column (7) of Table 7 report the weighted average and the standard deviation of welfare increases. Average gains from trade increase by about 2%, from 0.71% in the case with hukou frictions to 0.72%. Compared to Monte et al. (2015), who shows that allowing commuting across US counties improves the gains from a 20% reduction in domestic trade costs by 0.8%, the additional gains from trade due to hukou friction elimination is sizable. In addition, calibrating the model at the prefecture city level would likely produce larger estimates. Therefore, we can interpret the 2% gains from trade due to hukou abolishment as a lower bound estimate.

The standard deviation of welfare gains across worker types decreases from 0.24% to 0.22%. Freer migration leads to greater employment increases in more positively affected regions, and the opposite in less positively affected regions. This narrows the spatial wage gap, meaning that individuals who stay in contracting regions are less negatively affected. In addition, freer migration makes individuals migrate to booming areas to improve their welfare. Both effects lead to more evenly distributed gains. Figure 6 plots individual gains from tariff reductions without hukou frictions to those with hukou frictions; the plot is flatter than the 45 degree line, suggesting that the elimination of hukou frictions alleviates the distributional effects of trade.

5 Conclusion

This paper shows that trade liberalization can lead to significant spatial labor adjustment within a country, and internal migration frictions are important in shaping the impact of trade. In the context of China, I first document four empirical patterns that suggest input-liberalization-induced labor reallocation across prefectures, and the presence of migration frictions caused by the hukou system using a rich dataset on Chinese regional economies and a novel measure on hukou frictions. Then, guided by the empirical findings, I setup a quantitative spatial model with input-output linkages and hukou migration frictions to estimate the welfare impact of trade liberalization and the importance of the hukou system. The model yields tractable equations to study the regional and welfare responses to trade shocks, and a parsimonious expression linking the distributional effect of trade to the observed change in spatial labor reallocations. Given the structure of the model, I am able to quantify the cost of the hukou system and disentangle it from other migration costs. I find that tariff reductions improve China's aggregate welfare by 0.71% but magnify regional disparities. Abolishing the hukou system leads to a sizable improvement in aggregate welfare but has a strong distributional impact. Additionally, it increases the gains from trade and alleviates its negative distributional consequences. My results shed light on the benefits of eliminating migration frictions, and the importance of taking these frictions into account when evaluating both aggregate and distributional consequences of trade reforms.

This paper contributes to a growing body of literature that examines the role of domestic frictions in shaping the impact of trade liberalization, as well as the literature on trade and local labor markets. Existing literature suggests that migration frictions are pervasive in many countries, but this paper is the first that examines domestic *migration policy.* While my focus was on China, according to the 2013 World Population Policies (United Nations, 2013), 60 percent of governments in the world desired a major change in their countries' spatial labor distribution, and 80 percent of which had policies to influence internal migration. This paper's exercises could also inform migration policy and motivate research on other countries, possibly taking into account the interaction between migration friction and other household characteristics.

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Appendix A Theory Appendix

Expenditure shares and prices

The efficiency of a location j in producing an intermediate good ν in sector s is the realization of a random variable $z_{js}(\nu)$ that is drawn from a Fréchet distribution with a shape parameter θ_s and a level parameter T_{js}, specifically; $F_{js}(z_{js}(\nu) < z) = e^{-T_{js}z^{-\theta_s}}$. Let $\Pr(p_{jis} \leq p) = G_{jis}(p)$ be the probability that the price at which country j supplies a variety of sector s to location i is less than or equal to p. Since such a price is given by $\frac{\tau_{jis}c_{js}}{z_{js}(\nu)}$, this is equivalent to $z_{js}(\nu) \geq \frac{\tau_{jis}c_{js}}{p}$. Hence, $G_{jis}(p) = 1 - F_{js}(\frac{\tau_{jis}c_{js}}{p})$. Let p_{is} be the lowest price at which country i can buy a variety, i.e. $p_{is} \equiv min\{p_{1is}, p_{2is}, ..., p_{Nis}\}$. Then, p_{is} is distributed according to:

$$\begin{aligned} \Pr(p_{is} \leq p) &= 1 - \prod_{j \in N} \Pr(p_{jis} \geq p) \\ &= 1 - \prod_{j \in N} \left(1 - G_{jis}\left(p\right)\right), \end{aligned} \tag{A1}$$

using $G_{jis}(p) = 1 - F_{js}(\frac{\tau_{jis}c_{js}}{p})$ gives:

$$\begin{aligned} 1 - \prod_{j \in N} (1 - G_{jis}(p)) &= 1 - \prod_{j \in N} e^{-T_{js}(\frac{\tau_{jis}c_{js}}{p})^{-\theta_s}} \\ &\equiv 1 - e^{-\Theta_{is}p^{\theta_s}}, \end{aligned} \tag{A2}$$

where $\Theta_{is} = \sum_{j \in N} T_{js}(\tau_{jis}c_{js})^{-\theta_s}$. Therefore, the probability that country j provides a variety at the lowest price p to country j is simply:

$$\Pr(p_{jis} = p, P_{nis} \geq p \, for \, n \neq j) = T_{js}(\frac{\tau_{jis}c_{js}}{p})^{-\theta_s} \frac{\theta_s}{p} e^{-\Theta_{is}p^{\theta_s}}. \tag{A3}$$

The probability that location j is the least-cost supplier of variety ν can then be computed by integrating over equation (A3) for all possible p's:

$$\begin{aligned} \lambda_{jis} &= \int_0^\infty T_{js}(\frac{\tau_{jis}c_{js}}{p})^{-\theta_s} \frac{\theta_s}{p} e^{-\Theta_{is}p^{\theta_s}} dp \\ &= \frac{T_{js}(\tau_{jis}c_{js})^{-\theta_s}}{\Theta_{is}} \int_0^\infty \Theta_{is} e^{-\Theta_{is}p_s^\theta} dp_s^\theta \\ &= \frac{T_{js}\left(\tau_{jis}c_{js}\right)^{-\theta_s}}{\sum_{n \in N} T_{ns}\left(\tau_{nis}c_{ns}\right)^{-\theta_s}}. \end{aligned} \tag{A4}$$

Denote $\Pr(p_{is} \leq p) = 1 - e^{-\Theta_{is}p_s^\theta} \equiv G_{is}(p)$. If country i buys a good from location j it means that j is the least-cost supplier. If the price at which location j sells this good in location i is p', then this probability is $\prod_{n \neq j}(1 - G_{nis}) \equiv e^{-\Theta_{is}^{-j}p'^{\theta_s}}$. Thus, the probability that location j selling a good at price p' is the least-cost supplier in i is simply $e^{-\Theta_{is}^{-j}p'^{\theta_s}} dG_{jis}(p')$. Integrating this probability over all prices $p' \leq p$ and using $G_{jis}(p') = 1 - F_{js}(\frac{\tau_{jis}c_{js}}{p'})$, I get:

$$\begin{aligned} \int_0^p e^{\Theta_{is}^{-j}p'^{\theta_s}} dG_{jis}(p') &= \int_0^p T_{js}(\frac{\tau_{jis}c_{js}}{p'})^{-\theta_s}\frac{\theta_s}{p'}e^{T_{js}(\frac{\tau_{jis}c_{js}}{p'})^{-\theta_s}}e^{\Theta_{is}^{-j}p'^{\theta_s}}dp' \\ &= \frac{T_{js}(\tau_{jis}c_{js})^{-\theta_s}}{\Theta_{is}}\int_0^p \Theta_{is}e^{-\Theta_{is}p_s'^{\theta}}dp_s'^{\theta} \\ &= \lambda_{jis}(1 - e^{-\Theta_{is}p_s^{\theta}}) \equiv \lambda_{jis}G_{is}(p). \end{aligned} \tag{A5}$$

Thus, conditional on j being the least-cost supplier in i, the price distribution of goods that j actually sells in i is $\frac{\lambda_{jis}G_{is}(p)}{\lambda_{jis}} = G_{is}(p)$, which does not depend on j. This is a special result of the Fréchet distribution: locations that are more distant, have higher costs or lower T_{js} sell a smaller range of goods, but the average price they charge is the same across different locations. This implies that the share of spending by location i on goods from location j, sector s, is the same as the probability λ_{jis}.

I next derive the expression for the sectoral price index. The composite good is produced by using all varieties from that sector using a CES production technology with elasticity of substitution $\sigma_s < \theta_s + 1$. Therefore, $P_{is}^{1-\sigma_s} = \int_0^\infty p_{is}(\nu)^{1-\sigma_s}d\nu$. Hence:

$$P_{is}^{1-\sigma_s} = \int_0^\infty p^{1-\sigma_s}dG_{is}(p) = \int_0^\infty p^{1-\sigma_s}e^{-\Theta_{is}p_s^{\theta}}d\Theta_{is}p_s^{\theta}. \tag{A6}$$

Defining $x = \Theta_{is}p^{\theta_s}$, the above equation can be rewritten as:

$$P_{is}^{1-\sigma_s} = \int_0^\infty (x/\Theta_{is})^{\frac{1-\sigma_s}{\theta_s}}e^{-x}dx = \Theta_{is}^{\frac{\sigma_s-1}{\theta_s}}\Gamma(1 + \frac{1-\sigma_s}{\theta_s}), \tag{A7}$$

where $\Gamma(.)$ is a Gamma function. Using $\Theta_{is} = \sum_{j\in N} T_{js}(\tau_{jis}c_{js})^{-\theta_s}$, the price of the composite good in sector s, location i, is:

$$P_{is} = \eta_s\left(\sum_{j\in N} T_{js}(\tau_{jis}c_{js})^{-\theta_s}\right)^{-\frac{1}{\theta_s}}, \tag{A8}$$

where $\eta_s \equiv \Gamma(\frac{\theta_s-\sigma_s+1}{\theta_s})^{\frac{1}{1-\sigma_s}}$. This concludes the proof.

Labor distribution and expected utilities

The indirect utility of worker ω holding a hukou from location h and residing in location i is $U_{hi}(\omega) = \frac{a_i(\omega)y_i}{d_{hi}P_i}$. The amenity of living in location i is the realization of a random variable a that is drawn from Fréchet with a shape parameter κ and a level parameter A_i; specifically, $F_i(a_i(\omega) < a) = e^{-A_i a^{-\kappa}}$. Let $\Pr(U_{hi} \leq u) = G_{hi}(u)$ be the probability that the utility of living in location i is lower than or equal to u. Since such a utility is given by $\frac{a_i(\omega)y_i}{d_{hi}P_i}$, this is equivalent to $a_i(\omega) \leq \frac{ud_{hi}P_i}{y_i}$. Let U_h be the highest utility a worker with hukou h can obtain, i.e. $U_h \equiv max\{U_{h1}, U_{h2}, ..., U_{hN}\}$. Then U_h is distributed according to:

$$\Pr(U_h \leq u) = \prod_{j\in N}\Pr(U_{hj} \leq u), \tag{A9}$$

using $\Pr(U_{hj} \leq u) = e^{-A_j(\frac{ud_{hj}P_j}{y_j})^{-\kappa}}$, I get:

$$\Pr(U_h \leq u) = e^{u^{-\kappa}\sum_{j\in N} -A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}}. \tag{A10}$$

The probability that location i gives the highest utility for a worker of type h, π_{hi}, is then the integration of the probability that location i provides the highest utility u over all possible u's:

$$\begin{aligned}
\pi_{hi} &= \int_0^{\infty} e^{u^{-\kappa}\sum_{j\in N} -A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa} \kappa u^{-\kappa-1} du \\
&= \frac{A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}}{\sum_{j\in N} A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}} \int_0^{\infty} -e^{-u^{-\kappa}\sum_{j\in N} A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}} d\left(u^{-\kappa}\sum_{j\in N} A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}\right) \\
&= \frac{A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}}{\sum_{j\in N} A_j(\frac{y_j}{P_j d_{hj}})^{\kappa}}.
\end{aligned} \tag{A11}$$

The number of workers with hukou h is large enough, hence by the law of large numbers, π_{hi} is also the share of h workers who choose to live in location i.

The expected utility for workers holding hukou h is therefore:

$$\begin{aligned}
U_h &= \int_0^{\infty} ud\left(\Pr(U_h \leq u)\right) = \int_0^{\infty} ud\left(e^{-A_i(\frac{ud_{hi}P_i}{y_i})^{-\kappa}}\right) \\
&= \int_0^{\infty} e^{-A_i(\frac{ud_{hi}P_i}{y_i})^{-\kappa}} \sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa} \kappa u^{-\kappa} du.
\end{aligned} \tag{A12}$$

Defining $x = \sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa} u^{-\kappa}$, then:

$$dx = \sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}(-\kappa u^{-\kappa-1}), u = \left(\frac{\sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}}{x}\right)^{\frac{1}{\kappa}}.$$

Hence:

$$\begin{aligned}
U_h &= -\int_{\infty}^{0} \left(\frac{\sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}}{x}\right)^{\frac{1}{\kappa}} e^{-x} dx \\
&= -\left(\sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}\right)^{\frac{1}{\kappa}} \int_{\infty}^{0} x^{-\frac{1}{\kappa}} e^{-x} dx \\
&= \Gamma\left(1 - \frac{1}{\kappa}\right)\left(\sum_{i\in N} A_i(\frac{y_i}{P_i d_{hi}})^{\kappa}\right)^{\frac{1}{\kappa}},
\end{aligned} \tag{A13}$$

where Γ stands for the Gamma function. This concludes the proof.

Relative changes in real wage, income and welfare

Recall that equation (16) implies $\frac{\hat{c}_{is}}{\hat{P}_{is}} = \hat{\lambda}_{iis}^{-\frac{1}{\theta_s}}$; therefore, using equation (15) I obtain:

$$\begin{aligned}\hat{w}_i^{\alpha_{is}(L)} &= \hat{\lambda}_{iis}^{-\frac{1}{\theta_s}} \hat{P}_{is} \hat{r}_i^{-\alpha_{is}(S)} \prod_{k \in K} \hat{P}_{ik}^{-\alpha_{is}(k)} \\ &= \hat{P}_{is}^{\alpha_{is}(L)} \hat{\lambda}_{iis}^{-\frac{1}{\theta_s}} \left(\frac{\hat{r}_i}{\hat{P}_{is}}\right)^{-\alpha_{is}(S)} \prod_{k \in K} \left(\frac{\hat{P}_{ik}}{\hat{P}_{is}}\right)^{-\alpha_{is}(k)} .\end{aligned} \tag{A14}$$

Using $\hat{P}_i = \prod_{s \in K} \hat{P}_{is}^{\beta_s}$, $\frac{\hat{w}_i}{\hat{P}_i}$ can be written as $\prod_{s \in K} (\frac{w_i}{\hat{P}_{is}})^{\beta_s}$. Therefore $\frac{\hat{w}_i}{\hat{P}_i}$ can be written as:

$$\begin{aligned}\frac{\hat{w}_i}{\hat{P}_i} &= \prod_{s \in K} (\frac{w_i}{\hat{P}_{is}})^{\beta_s} \\ &= \prod_{s \in K} \left(\hat{\lambda}_{iis}^{-\frac{1}{\theta_s}} \left(\frac{\hat{r}_i}{\hat{P}_{is}}\right)^{-\alpha_{is}(S)} \prod_{k \in K} \left(\frac{\hat{P}_{ik}}{\hat{P}_{is}}\right)^{-\alpha_{is}(k)} \right)^{\frac{\beta_s}{\alpha_{is}(L)}} \\ &= \prod_{s \in K} \hat{\lambda}_{iis}^{-\frac{\beta_s}{\theta_s}} \prod_{s \in K} \hat{\lambda}_{iis}^{-\frac{\beta_s}{\theta_s}\frac{1-\alpha_{is}(L)}{\alpha_{is}(L)}} \prod_{k \in K, s \in K} \frac{\hat{P}_{ik}}{\hat{P}_{is}}^{-\beta_s \frac{\alpha_{is}(k)}{\alpha_{is}(L)}} \prod_{s \in K} \frac{\hat{r}_i}{\hat{P}_{is}}^{-\beta_s \frac{\alpha_{is}(S)}{\alpha_{is}(L)}} .\end{aligned} \tag{A15}$$

Using equations (19) and (A15), the relative change in real income $\frac{\hat{y}_i}{\hat{P}_i}$ can be expressed as:

$$\begin{aligned}\frac{\hat{y}_i}{\hat{P}_i} &= \frac{Y_i'}{Y_i \hat{P}_i \hat{L}_i} \\ &= \frac{w_i L_i \hat{w}_i \hat{L}_i + r_i S_i \hat{r}_i}{(w_i L_i + r_i S_i) \hat{P}_i \hat{L}_i} \\ &= \frac{\hat{w}_i}{\hat{P}_i} \left(\frac{w_i L_i}{w_i L_i + r_i S_i} + \frac{r_i S_i \hat{r}_i}{(w_i L_i + r_i S_i) \hat{w}_i \hat{L}_i} \right) .\end{aligned} \tag{A16}$$

Noting $w_i L_i = \sum_{s \in K} w_i L_{is}$ and $r_i S_{is} = \frac{\alpha_{is}(S)}{\alpha_{is}(L)} w_i L_{is}$, $\hat{r}_i = \sum_{s \in K} \frac{\frac{\alpha_{is}(S)}{\alpha_{is}(L)} L_{is} \hat{w}_i \hat{L}_{is}}{\sum_{k \in K} \frac{\alpha_{ik}(S)}{\alpha_{ik}(L)} L_{ik}}$. Therefore, $\frac{\hat{y}_i}{\hat{P}_i}$ simplifies to:

$$\frac{\hat{y}_i}{\hat{P}_i} = \frac{\hat{w}_i}{\hat{P}_i} \left(b_1 + \sum_{s \in K} b_{2s} \frac{\hat{L}_{is}}{\hat{L}_i} \right), \tag{A17}$$

where $b_1 = \frac{L_i}{L_i + \sum_{s \in K} \frac{\alpha_{is}(S)}{\alpha_{is}(L)} L_{is}}$ and $b_{2s} = \frac{\frac{\alpha_{is}(S)}{\alpha_{is}(L)} L_{is}}{L_i + \sum_{s \in K} \frac{\alpha_{is}(S)}{\alpha_{is}(L)} L_{is}}$.

Next, I compute the change in the expected utility for workers with hukou h, holding hukou frictions d_{hi} constant. Using equation (26) I obtain:

$$\hat{U}_h = \left(\sum_{i \in N} \pi_{hi} (\frac{\hat{y}_i}{\hat{P}_i})^{\kappa} \right)^{\frac{1}{\kappa}} . \tag{A18}$$

Using equation (20), the above equation can be expressed as:

$$\begin{aligned}\hat{U}_h &= \left(\frac{\hat{y}_i}{\hat{P}_i}\right)\hat{\pi}_{hi}^{-\frac{1}{\kappa}} \\ &= \frac{\hat{w}_i}{\hat{P}_i}\left(b_1 + \sum_{s\in K} b_{2s}\frac{\hat{L}_{is}}{\hat{L}_i}\right)\hat{\pi}_{hi}^{-\frac{1}{\kappa}}.\end{aligned} \tag{A19}$$

Equation (A19) indicates that the relationship between the change in the welfare of a worker group and the change in real income of a region depends on how labor is adjusted spatially (as is captured by $\hat{\pi}_{hi}$). Denote $\hat{\hat{L}}_i \equiv \sum_{s\in K}\frac{\frac{\alpha_{is}(S)}{\alpha_{is}(L)}L_{is}\hat{L}_{is}}{\sum_{k\in K}\frac{\alpha_{ik}(S)}{\alpha_{ik}(L)}L_{ik}}$. Taking the log of equation (A14) and using $\hat{r}_i = \hat{w}_i\hat{\hat{L}}_i$ to write $\ln(\frac{\hat{w}_s}{\hat{P}_{is}})$ as a function of $\ln(\hat{\lambda}_{iis})$, $\ln(\hat{L}_{is})$, and $\ln(\frac{\hat{w}_k}{\hat{P}_{ik}})$, I obtain:

$$\ln(\frac{\hat{w}_s}{\hat{P}_{is}}) = -\frac{1}{\theta_s}\ln(\hat{\lambda}_{iis}) - \alpha_{is}(S)\ln(\hat{\hat{L}}_i) + \sum_{k\in K}\alpha_{is}(k)\ln(\frac{\hat{w}_k}{\hat{P}_{ik}}). \tag{A20}$$

Writing the expressions for all $\ln(\frac{\hat{w}_s}{\hat{P}_{is}})$ in matrix form, I solve $\ln(\frac{\hat{w}_s}{\hat{P}_{is}})$ as a function of $\ln(\hat{\lambda}_{iis})$ and $\ln(\hat{\hat{L}}_i)$:

$$\ln(\frac{\hat{w}_s}{\hat{P}_{is}}) = -\sum_{k\in K}\tilde{\alpha}_{isk}\left(\frac{1}{\theta_k}\ln(\hat{\lambda}_{iik}) + \alpha_{ik}(S)\ln(\hat{\hat{L}}_i)\right), \tag{A21}$$

where $\tilde{\alpha}_{isk}$ is the $\{s,k\}^{th}$ element of matrix $(1-\Omega)^{-1}$, with the $\{s,k\}^{th}$ element of Ω given by $\Omega_{s,k} = \alpha_s(k)$. Using $\ln(\frac{\hat{w}_s}{\hat{P}_i}) = \sum_{s\in K}\beta_s\ln(\frac{\hat{w}_s}{\hat{P}_{is}})$ and equation (A19), I obtain equation (27), which characterizes the change of expected utility of workers with hukou h. This concludes the proof.

Appendix B Data Appendix

This appendix provides detailed information (supplementary to Section 2) on data and measures used in the empirical part of this paper (both Section 2 and Appendix E).

Local labor markets

I choose *prefecture-level divisions* as my measure of local labor markets. A prefecture-level division is an administrative division ranking below a *province* and above a *county* in China's administrative structure. The majority of regional policies, including the overall planning of public transportation, are conducted at the prefecture level (Xue and Zhang, 2001). I therefore expect counties within the same prefecture city to have stronger commuting ties and better economic integration.[33]

[33] I treat each direct-controlled municipality (*Zhixiashi*) as a local labor market (the four direct-controlled municipalities, Beijing, Tianjin, Shanghai, and Chongqing are provincial level administrative divisions). In addition, I combine direct-controlled county-level divisions (*Shen Zhixia Xingzheng Danwei*) with prefectures they used to belong to before becoming independent administrative units. Direct-controlled county-level divisions are counties that are directly administrated by the provincial government. There are four provinces that had direct-controlled county-level divisions in 2000: Henan (Jiyuan), Hubei (Xiantao, Qianjiang, Tianmen, and Shennongjia), Hainan (17 county-level divisions including Zhanzhou, Qiongshan, Wenchang etc.) and Xinjiang (Shihezi). By 2012, Zhanzhou was established as a prefecture

The number of prefecture-level divisions is relatively stable over time,[34] although some divisions did experience significant changes in their administrative boundaries. I use information on administrative division changes published by the Ministry of Civil Affairs of China to create time-consistent county groups based on prefecture boundaries from the year 2000. Prefecture-level employment is then defined as the total employment of a county group. If between 2000 and 2010 a county was split between several counties that belonged to different prefectures in 2010, I aggregate and assign those counties to the same prefecture. This results in 337 geographic units that I refer to as prefectures or regions, including four direct-controlled municipalities and 333 prefecture-level divisions that cover the entire mainland China.

Industries

I work with 71 industries classified based on the two-digit Chinese Standard Industrial Classification for 1994 (CSIC1994). This classification includes 5 agricultural industries, 5 mining and quarrying industries, 29 manufacturing industries, 3 energy supply industries, 37 service industries, a wholesale and retail trade industry, and a construction industry. I select the number of industries to achieve the maximum level of disaggregation at which I can collect Chinese production, employment and trade data. I report the industry list as well as the crosswalks from it to the two-digit CSIC1994, the Chinese 2002 Input-Output industry classification, and to the four-digit ISIC Rev.3 (International Standard Industrial Classification of All Economic Activities, Rev.3) in Table A1. More details on industry construction can be found in the description of the data on *cost shares*.

Population census

Many variables used in this paper are constructed using various publications of the Chinese Population Census from the years 1990, 2000, and 2010. The long form of the census, which covers 10% of total population of China, asks respondents detailed information on their current living address, employment status, hukou, and affiliation (among others). Data on current address and affiliation are then coded at county and three-digit industry level, respectively. The complete data is unfortunately not publicly available. Instead, the National Bureau of Statistics of China (NBS) publishes several datasets after each round of the census. These are the Tabulation on Population Census of China (National Tabulation), the Tabulation on Population Census of China by County (Tabulation of Population Census by County, starts from 2000) and the Tabulation on Population Census released by each province. Each tabulation has a different focus. The national tabulation provides most information at the aggregate level. The county tabulation has more disaggregated geographic information but aggregated information in other categories. The degree of aggregation of the provincial tabulations varies across provinces and years; this tabulation also has more missing data and discrepancies compared

city while Qianghai became part of Haikou city, and Xinjiang province established another three new direct-controlled counties. My empirical results are robust to the exclusion of those counties.

[34] The number of prefectures is 336, 333, and 334 for the years 1990, 2000, and 2010, respectively.

Table A1: Industry Aggregation and Concordance

Aggregated industry	Industry name	CSIC1994 two-digit	NBS IO2002	ISIC Rev.3
1	Farming	1	1001	111,112,113,130
2	Forestry	2,12	2002,2003	200
3	Animal Husbandry	3	3004	121,122,150,8520
4	Fishery	4	4005	500
5	Agricultural Services	5	5006	140
6	Coal Mining and Dressing	6	6007	1010,1020,1030
7	Extraction of petroleum and Natural Gas	7	7008	1110,1120
8	Mining and Dressing of Ferrous Metals	8	8009	1310
9	Mining and Dressing of Nonferrous Metals	9	9010	1200,1320
10	Mining and Dressing of Other Minerals	10,11	10011,10012	1410,1421,1422,1429
13	Food Processing	13	13013,13014,13015,13016,13017,13018	1511,1512,1513
14	Food Production	14	13019	1514-1549
15	Beverages	15	15020,15021	1551,1552,1553,1554
16	Tobacco	16	16022	1600
17	Textiles	17	17023,17024,17025,17026,17027	1711,1712,1721,1722,1723,1729,1730
18	Garments and Other Fiber Products	18	18028	1810,1920
19	Leather, Furs, Down and Related Products	19	19029	1820,1911,1912
20	Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products	20	20030	2010,2021,2022,2023,2029
21	Furniture Manufacturing	21	21031	3610
22	Papermaking and Paper Products	22	22032	2101,2102,2109
23	Printing and Record Medium Reproduction	23	23033	2211,2212,2213,2219,2221,2222,2230
24	Cultural, Educational and Sports Goods	24	24034,24035	3692,3693,3694
25	Petroleum Processing and Coking	25	25036,25037,37068	2310,2320,2330
26	Raw Chemical Materials and Chemical Products	26	26038,26039,26040,26041,26042,26043,26044	2411,2412,2413,2421,2422,2424,2429
27	Medical and Pharmaceutical Products	27	27045	2423
28	Chemical Fiber	28	28046	2430
29	Rubber Products	29	29047	2511,2519
30	Plastic Products	30	30048	2520
31	Nonmetal Mineral Products	31	31049,31050,31051,31052,31053	2610,2691,2692,2693,2694,2695,2696,2699
32	Smelting and Pressing of Ferrous Metals	32	32054,32055,32056,32057	2710
33	Smelting and Pressing of Nonferrous Metals	33	33058,33059	2720,2732
34	Metal Products	34	34060	2811,2812,2813,2892,2893,2899
35	Ordinary Machinery	35	35061,35062,35063	2731,2891,2911,2912,2913,2914,2915,2919
36	Equipment for Special Purposes	36,39	36064,36065	2921-2929,3311
37	Transport Equipment	37	37066,37067,37069,37071	3410-3599,5020
40	Electrical Equipment and Machinery	40	39072,39073,39074	3110,3120,3130,3140,3150,3190
41	Electronic and Telecommunications Equipment	41	40075,40076,40077,40078,40079,40080	3210,3220,3230
42	Instruments, Meters, Cultural and Office Machinery	42	41081,41082	3000,3312,3313,3320,3330
43	Other Manufacturing	43	42083,42084,43085	2930,3691,3699,3710,3720
44	Production and Supply of Electric Power, Steam and Hot Water	44	44086	4010,4030
45	Production and Supply of Gas	45	45087	4020
46	Production and Supply of Tap Water	46	46088	4100
47	Construction	47,48,49	47089	4510,4520,4530,4540,4550
52	Railway Transport	52	51090,51091	6010
53	Other Transport	53,57,58	52092	6023,6301,6303
54	Pipeline Transport	54	56097	6030
55	Waterway Transport	55	54094	6110,6120
56	Air Transport	56	55095,55096	6210,6220
59	Storage	59	58098	6302
60	Postal and Telecommunications Services	60	59099	6411,6412
61	Wholesale and Retail Trade	61,62,63,64,65	63102	5010,5030-5259
67	Catering Trade	67	67104	5520
68	Finance	68	68105	6511,6519,6591,6592,6599,6711,6712,6719
70	Insurance	70	70106	6601,6602,6603,6720
72	Real Estate	72,73,74	72107	7010,7020
75	Public Services	51,75	53093,79114,80115	6021,6022,9000,9233
76	Residential Services	76	82116	5260,7494,9301,9302,9303,9309,9500
78	Hotels	78	66103	5510
79	Leasing Services	79	73108	7111,7112,7113,7121,7122,7123,7129,7130
80	Commercial services	80,84	74109,74110	6304,6309,7411-7414,7430-7493,7495,7499
81	Recreational Services	81	92122	9249
82	Information and Consultative Services	82	60100	6420
83	Computer Application Services	83	61101	7210,7220,7230,7240,7250,7290
85	Health Care	85	85118	8511,8512,8519
86	Sports	86	91121	9241
87	Social Welfare and Social Security	87	86119	8531,8532
89	Education	89	84117	8010,8021,8022,8030,8090
90	Culture and Arts	90,91	88120	9211,9212,9213,9214,9219,9220,9231,9232
92	Scientific Research	92	75111	7310,7320
93	Polytechnic Services	50,93	76112,78113	7421,7422
94	Others	94,95,96,97,99	93123	7511-7530,9111-9199,9900

to the other tabulations. Unless noted otherwise, tabulations are obtained from the China Statistical Yearbooks Database (CSYD). Besides the tabulations mentioned above, I also used the 1%, 1%, and 0.095% micro sample of the complete census data for the years 1982, 1990, and 2000 respectively, which are all long-form data. I obtain the data from the Integrated Public Use Microdata Series (IPUMS) (for the years 1982 and 1990). The microdata allows richer interactions between variables as they are identified at the individual level. However, it does not report individuals' residing county, making it impossible to calculate time-consistent prefecture employment. Another limitation of the data is its limited sample size, especially for 2000. I therefore choose to collect aggregate variables from census tabulations when possible, rather than inferring them from the micro sample.

Employment

To compute *prefecture employment*, I first collect employment information by county. I take data for the years 2000 and 2010 from the Tabulation of Population Census by County. For the year 1990, the county-level employment is reported in the Tabulation published by provinces. The tabulations of 21 provinces (out of 30)[35] and part of Hainan are available in CSYD. For the remaining provinces, I collect and digitize the employment data based on paper-based publications of the 1990 tabulations. These are available at Peking University's Institute of Sociology and Anthropology Library.

Industrial employment by county in 2000 is collected from the Tabulation of Population Census published by each province. The data is reported in 92 two-digit CSIC1994 divisions. The original data was collected from China Data Online; it is also available in the CSYD.[36] For both sets of data, I compared the values with those recorded in other tabulations (when available) at various aggregations, and corrected mis-recorded values. I also made sure when aggregating to different levels that the data match the aggregated data reported in the tabulations.[37] I then sum the employment by county group to get the prefecture data. NBS reports 1990 employment after sample adjustment (except for Jilin province), but not for the years 2000 or 2010. The long form of the census is said to be randomly sampled to cover 10% of the total population. In reality, however, sampling rates vary across regions. To avoid potential bias, I exploit the fact that the population above the age of 15 is reported both in the full sample and in the long form. I proceed as follows: first, I collect data by county and then calculate the sum to get the above-age population of the prefecture, from both the full sample and the long form. I then use the ratio of the two to proxy for the sampling rates of each prefecture. The

[35] Chongqing was part of Sichuan province in 1990.

[36] Unfortunately, I cannot construct a panel of employment by prefecture and sector. Both the national and county tabulations report employment at aggregated industries (one-digit Chinese Standard Industrial Classification; 20 sectors). Most of the employment data published by provincial administrators are by disaggregated industries (two-digit), but with inconsistencies. In 2010, Shandong only reported employment by two-digit industry by province, Chongqing reported employment by one-digit industry, and Hainan was missing data for some industries; in 1990, Liaoning reported employment by one-digit industry, and Sichuan, Shanxi, and Hunan provinces had missing data for some industries and counties.

[37] For cases when there are mis-recorded values, I cross-check the number from the provincial tabulation (when available), which also provides county-level employment for most provinces and most years; if this is not possible, I adjust the county's employment to be the prefecture employment minus the the sum of employment of other counties in that prefecture.

rates turn out to vary quite a bit across prefectures, from 7.52% to 13.52% for 2000, and 7.29% to 11.50% for 2010. I finally divide the reported employment by the constructed sampling rates to get the prefecture employment for the years 2000 and 2010. Unfortunately, I do not find similar data to construct sampling rates for 1990. I therefore simply divide the 1990 employment of the Jilin province by 10%. By doing so, I complete the final step necessary for obtaining the employment data used in my empirical analysis.

Population measures

The data on prefecture *above-age population, total population, hukou population, and the number of migrants from other provinces in the past five years* are obtained from the Tabulation of Population Census by County. The original data are county-specific. I clean, adjust and aggregate those variables to the prefecture level following the same procedure as for the employment data.

Cost shares

China became a member of the WTO on 11 December 2001. I therefore use the IO table of the closest year, 2002, to identify the cost shares of Chinese industries. That is, I implicitly assume that industry cost structures adjust slowly to trade liberalization. The 2002 IO industries are classified in a system close to the two-digit CSIC1994, with a slightly different aggregation. For instance, some mining and manufacturing IO divisions correspond to three-digit CSIC industries, while the "Wholesale" division corresponds to several two-digit CSIC classifications. I therefore construct a common industry code between IO2002 and CSIC1994 by slightly aggregating both classifications. In the end, I map 122 IO and 92 CSIC divisions to 71 more aggregated industries. I then aggregate the IO table to 71 industries and compute the cost shares.

Tariffs

I use the simple average MFN applied tariffs at the HS6 product level from the UN's TRAINS database to calculate tariff changes. To concord tariffs from HS6 to my constructed industry classification, I first construct a many-to-one crosswalk from ISIC Rev.3 to the constructed classification and then use the crosswalk from HS6 to ISIC Rev.3 published by the World Integrated Trade Solution (WITS) to link HS6 to the classification. The final crosswalk concords HS6 products to 43 aggregated industries, spanning from agriculture to residential services. In the last step, I apply the crosswalk to the tariff data, and then take the simple average to obtain the aggregated industry tariffs used in the empirical analysis.

Input tariffs cuts are calculated as the input-cost weighted average of tariff reductions. To construct *external tariff reductions*, I first compute the prefecture-export-weighted average of tariff reductions that China faced from its trading partners over the 2000-2005 period for each industry and each prefecture. I then take the δ_{is} weighted average of this variable to get the final prefecture measure of external tariff reductions. Exports by industry, prefecture, and destination market are obtained by aggregating firm-level exports from the 2000 Chinese customs data. The Chinese customs trade data covers the universe of all Chinese import and export transactions by month; it contains values (in US dollars) of imports and exports at the 8-digit HS classification (about 7,000 product categories). The data is at the transaction level and contains firm information such as ownership (domestic, private, foreign, and state-owned), trade regime (processing versus non-processing), and firm location. These allow me to construct bilateral trade flows between Chinese prefectures and other countries. I exclude intermediary trade following Fan et al. (2015) when calculating export shares; the empirical results are also robust to the exclusion of processing exports or exports by state-owned enterprises.

The hukou measure

The main dataset I use to construct the province-specific *hukou measure* is the 0.095% randomly sampled data of the Population Census in 2000. The complete data covers the entire population of China, with 10% of the population chosen randomly to fill the long form of the census. The 0.095% sample I obtained consists only of long form respondents and was randomly drawn at the household level. It covers individual information on age, gender, ethnicity, education, marriage, employment, migration history, birth and hukou province (if not in current resident city), hukou registration status (residing here and registered here, or residing here but registered elsewhere, etc.), type (rural versus urban) and residency (prefecture), among others. The dataset also contains a unique identifier linking individuals in the same households. In particular, for individuals who have moved to their current city in the last five years, the dataset reports the year they moved, the county they migrated from, their reasons for migrating, and the type of place they moved from (city, town or village).

Using this micro sample, I construct the following control variables used in the hukou regressions: *age* (age and age squared), dummy variables on *gender*, *ethnicity* (Han versus the other), *marriage status* (ever married), *migrate within province*, *migration type* (moved from rural versus urban), categorical variables for *education* and for the *years of residence* in the current city. I also control for the *difference in log GDP per capita* between the migrate-out and migrate-in provinces. The data on GDP per capita by province is collected from the provincial statistical yearbooks. I focus on individuals who moved between 1995 and 2000 to a prefecture that is not their birthplace, and regress a dummy variable equal to one if the individual had already obtained a local hukou before November 2000 (when the census was conducted) in the prefecture where she resides on the above-mentioned controls and prefecture dummies. I then take a simple average of the estimated prefecture fixed effects by province and normalize it from zero to one to obtain my hukou measure.

Other controls

To construct *real exchange rate change by prefecture*, I first compute industry-specific real exchange rates as trade-weighted averages of real exchange rates between China and its trading partners. To get the real exchange rate, I first collect countries' nominal exchange rates with respect to the US

Table A2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Regional input tariff cuts, 2000-2005	0.03	0.01	0	0.12	337
Regional output tariff cuts, 2000-2005	0.12	0.02	0	0.20	337
Destination tariff cuts, 2000-2005	0.01	0.03	-0.13	0.15	337
Employment changes, 2000-2010	0.07	0.14	-0.36	0.66	337
Employment in 2000	14.24	0.91	10.55	16.73	337
Population changes, 2000-2010	0.07	0.12	-0.25	0.64	337
Population in 2000	14.89	0.86	11.47	17.18	337
Working age population changes, 2000-2010	0.13	0.13	-0.26	0.64	337
Working age population in 2000	14.45	0.89	10.76	16.88	337
Hukou population changes, 2000-2010	0.48	0.13	0.07	1.25	337
Hukou population in 2000	16.77	0.91	13.27	19.29	337
Changes in migration inflows, 2000-2005 versus 2005-2010	0.95	0.49	-2.22	2.38	337
Total migration inflows, 2000-2005	12.42	1.30	9.97	16.99	337
Birth rates, 2000	10.70	3.42	2.57	22.30	337
Death rates, 2000	5.65	1.19	0.92	11.58	337
Employment changes, 1990-2000	0.11	0.18	-0.27	1.54	337
Employment in 1990	14.12	0.95	10.34	16.75	337
SOEs employment, 2000	10.80	1.20	5.35	13.76	332
SOEs employment share changes, 2000-2009	-1.09	0.76	-6.22	0.81	337
Prefecture-level exchange rates exposure, 2000-2010	0.01	0.02	-0.05	0.13	337
Share of employment in construction industry, 2000	0.03	0.02	0.001	0.09	337
Share of employment in real estate industry, 2000	0.00	0.00	0	0.03	337
Prefecture-level GDP per capita, 2000	6.46	0.72	4.20	9.50	285
Provincial hukou measure	0.60	0.24	0	1	337
For hukou estimation					
Hukou granting dummy (obtained local hukou=1)	0.29	0.45	0	1	62260
Provincial GDP per capita, 1995	8.65	0.49	7.53	9.79	31
Rural-urban dummy (rural=1)	0.66	0.47	0	1	62260
Gender dummy (male=1)	0.5	0.5	0	1	62260
Marriage dummy (married=1)	0.58	0.50	0	1	62260
Ethnicity dummy (Han=1)	0.93	0.25	0	1	62260
Migration time	3.62	1.37	0	5	62260
Education (9 categories)	4.45	1.57	0	9	60010
Age	26.28	12.18	0	95	62260

Notes: This table provides the descriptive statistics for variables used in the empirical analyses and for the construction of the hukou measure. All level variables are in logs, except birth rates, death rates, migration time, age (age and age squared), dummy variables and the categorical variable education.

dollar from Penn World Table 8.1 and compute the nominal exchange rate between China and other countries, and then deflate the data using CPI indices from the World Bank. I then take the change in log real exchange rate from 2000 to year 2010 for each industry, and calculate regional exchange rate shocks as δ_{is} weighted averages.

Employment at state-owned Enterprises (SOEs) is calculated as the total employment of *industrial* SOEs in each prefecture. I collect the data from the NBS survey of above-scale industrial firms (the NBS Annual Surveys of Industrial Firms), which provides extensive firm-level information including their ownership and location. The NBS survey is particularly well suited for my analysis as all state-owned industrial firms are covered in the survey. I sum SOE employment by county for the years 2000 and 2009. I choose not to use data from 2010 as it contains erroneous information on employment statistics (Brandt et al., 2014). To aggregate the county level SOE employment to the prefecture level, I construct a crosswalk from 2009 county to the time-consistent prefectures. One potential limitation is that the survey covers industrial firms only (mining and quarrying, manufacturing, production and supply of electric power, gas and water). However, this is less of a concern for my study, as the majority of SOE layoffs occurred in the manufacturing and mining industries such as textiles, weapons and ammunitions, and coal mining and dressing (Li et al., 2001).

The *regional employment shares of the construction* and *real estate industries* are computed using employment data by prefecture and industry from the year 2000; *pre-decade employment trend* is computed as the difference of log employment between 2000 and 1990, using the prefecture employment panel I constructed. The *great-circle distance* between provincial capitals is constructed using the 2010 China Administrative Regions GIS Data from ChinaMap.

Table A2 presents the descriptive statistics of variables used in the empirical analyses of Section 2 and Appendix E in this paper.

Appendix C Calibration Appendix

Estimating trade elasticities

I calculate sectoral trade elasticity θ_s based on the method developed by Caliendo and Parro (2015). Consider three countries indexed by i, j, and n and denote location i's total expenditure on varieties from sector s, location j as X_{jis}. Substituting equation (6) into $\frac{X_{ijs}}{X_{ins}}\frac{X_{jns}}{X_{njs}}\frac{X_{nis}}{X_{jis}}$, I get:

$$\frac{X_{ijs}}{X_{ins}}\frac{X_{jns}}{X_{njs}}\frac{X_{nis}}{X_{jis}} = \left(\frac{\tau_{ijs}}{\tau_{ins}}\frac{\tau_{jns}}{\tau_{njs}}\frac{\tau_{nis}}{\tau_{jis}}\right)^{-\theta_s}. \tag{A22}$$

Caliendo and Parro (2015) show that if iceberg trade costs $\tilde{\tau}$ satisfy $\ln(\tilde{\tau}_{ijs}) = v_{is} + v_{js} + v_{ijs} + \epsilon_{ijs}$, where $v_{ijs} = v_{jis}$ and ϵ_{ijs} is orthogonal to tariffs t_{ijs}, all components of $\tilde{\tau}$ except ϵ_{ijs} cancel out, and the log trade ratio can be expressed as:

$$ln\left(\frac{X_{ijs}}{X_{ins}}\frac{X_{jns}}{X_{njs}}\frac{X_{nis}}{X_{jis}}\right) = -\theta_s ln\left(\frac{1+t_{ijs}}{1+t_{ins}}\frac{1+t_{jns}}{1+t_{njs}}\frac{1+t_{nis}}{1+t_{jis}}\right) + \epsilon_{ijns}, \tag{A23}$$

where $\epsilon_{ijns} = \theta_s\left(\epsilon_{jis} - \epsilon_{ijs} + \epsilon_{ins} - \epsilon_{jns} + \epsilon_{njs} - \epsilon_{nis}\right)$ and is orthogonal to tariffs.

I estimate θ_s sector by sector using specification (A23) for the year 2000. I collect data on trade flows and tariffs for 104 countries. Note that to construct the dependent variable, bilateral trade flows between three countries all have to be non-zero. Since I am estimating θ_s for more disaggregated industries compared to Caliendo and Parro (2015), the number of observations is limited by the number of positive sectoral trade inflows between countries. I am also restricted by the information

Table A3: Trade Elasticity Estimates

		Main	Full sample			99% sample			97.5% sample		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
No.	Industry name	θ_s	θ_s	s.e.	N	θ_s	s.e.	N	θ_s	s.e.	N
1	Farming	0.52	0.52	(0.14)	15157	0.52	(0.14)	15156	0.52	(0.14)	15154
2	Forestry	3.37	3.37	(0.38)	5346	3.37	(0.38)	5346	3.38	(0.38)	5343
3	Animal Husbandry	0.02	0.02	(0.55)	2668	0.02	(0.55)	2668	0.01	(0.55)	2650
4	Fishery	1.30	-1.55	(0.85)	2140	-1.55	(0.85)	2140	-1.57	(0.85)	2136
6	Coal Mining and Dressing	0.55	0.55	(25.01)	86	0.55	(25.01)	86	0.55	(25.01)	86
7	Extraction of petroleum and Natural Gas	3.15	-6.67	(29.71)	22	-6.67	(29.71)	22	-6.67	(29.71)	22
8	Mining and Dressing of Ferrous Metals	3.15	-		8	-		8	-		8
9	Mining and Dressing of Nonferrous Metals	20.41	20.41	(17.81)	523	20.41	(17.81)	523	20.41	(17.81)	522
10	Mining and Dressing of Other Minerals	5.75	5.75	(1.06)	6133	5.75	(1.06)	6133	5.75	(1.06)	6131
13	Food Processing	3.90	3.9	(0.22)	13518	3.9	(0.22)	13517	3.9	(0.22)	13516
14	Food Production	2.03	2.03	(0.29)	4643	2.03	(0.29)	4642	2.01	(0.29)	4631
15	Beverages	4.48	-0.15	(0.43)	1481	-0.15	(0.43)	1481	-0.11	(0.43)	1461
16	Tobacco	0.54	0.54	(0.44)	232	0.54	(0.44)	232	0.49	(0.44)	230
17	Textiles	6.07	6.06	(0.28)	19947	6.07	(0.28)	19935	6.08	(0.28)	19924
18	Garments and Other Fiber Products	1.47	1.42	(0.26)	17909	1.47	(0.26)	17875	1.53	(0.26)	17825
19	Leather, Furs, Down and Related Products	7.16	7.16	(0.42)	11267	7.16	(0.42)	11267	7.14	(0.42)	11256
20	Timber Processing, etc.	10.71	10.71	(0.45)	10200	10.71	(0.45)	10198	10.69	(0.45)	10167
21	Furniture Manufacturing	0.33	0.33	(0.73)	10619	0.33	(0.73)	10615	0.31	(0.73)	10573
22	Paper-making and Paper Products	8.61	8.61	(0.45)	11777	8.61	(0.45)	11776	8.62	(0.45)	11775
23	Printing and Record Medium Reproduction	3.87	3.88	(0.46)	14726	3.87	(0.46)	14725	3.91	(0.47)	14685
24	Cultural, Educational and Sports Goods	0.95	0.95	(0.52)	9031	0.95	(0.52)	9031	0.94	(0.52)	9014
25	Petroleum Processing and Coking	13.50	13.5	(4.20)	2588	13.5	(4.20)	2588	13.5	(4.20)	2584
26	Raw Chemical Materials and Chemical Prod.	5.88	5.88	(0.35)	23710	5.88	(0.35)	23708	5.89	(0.35)	23676
27	Medical and Pharmaceutical Products	4.48	-3.77	(0.90)	11753	-3.77	(0.90)	11753	-3.78	(0.90)	11751
28	Chemical Fiber	7.56	7.56	(1.42)	3080	7.56	(1.42)	3080	7.48	(1.42)	3079
29	Rubber Products	4.48	-4.77	(0.53)	11792	-4.77	(0.53)	11792	-4.77	(0.53)	11780
30	Plastic Products	4.48	-0.91	(0.33)	18716	-0.92	(0.33)	18709	-0.92	(0.33)	18705
31	Nonmetal Mineral Products	3.76	3.77	(0.40)	14325	3.76	(0.40)	14322	3.76	(0.40)	14319
32	Smelting and Pressing of Ferrous Metals	5.37	5.37	(0.63)	9238	5.37	(0.63)	9238	5.38	(0.63)	9236
33	Smelting and Pressing of Nonferrous Metals	8.47	8.47	(0.84)	8796	8.47	(0.84)	8796	8.44	(0.84)	8794
34	Metal Products	1.96	1.95	(0.39)	18515	1.96	(0.39)	18475	1.96	(0.39)	18467
35	Ordinary Machinery	4.48	-2.25	(0.49)	17188	-2.25	(0.49)	17185	-2.27	(0.49)	17160
36	Equipment for Special Purposes	1.15	1.15	(0.50)	17728	1.15	(0.50)	17727	0.83	(0.51)	17706
37	Transport Equipment	0.18	0.19	(0.28)	13580	0.18	(0.28)	13579	0.19	(0.28)	13560
40	Electrical Equipment and Machinery	1.64	1.52	(0.43)	19632	1.64	(0.43)	19601	1.65	(0.43)	19598
41	Electronic and Telecommunications Equipment	2.34	2.34	(0.37)	18349	2.34	(0.37)	18348	2.21	(0.37)	18287
42	Instruments etc.	5.02	5.1	(0.46)	19775	5.02	(0.46)	19757	5.03	(0.46)	19644
43	Other Manufacturing	2.91	2.91	(0.34)	17096	2.91	(0.34)	17093	2.91	(0.34)	17089
76	Residential Services	4.07	-1.35	(2.78)	891	-1.35	(2.78)	891	-1.31	(2.81)	890
90	Culture and Arts	4.07	4.07	(1.32)	3252	4.07	(1.32)	3252	3.91	(1.35)	3218
93	Polytechnic Services	4.07	-		404	-		404	-		403

on effectively applied tariff rates. Similar to Caliendo and Parro (2015), I impute the value of some countries to increase the sample size. If a country does not have effectively applied tariff data available in 2000, I impute this value with the closest value (in terms of date) available, searching up to four previous years, up to 1996. When effectively applied tariffs are not available in any of these years, I use the MFN tariffs of 2000. Data on trade flows is taken from the UN's Comtrade database for 2000. Values are recorded in US dollars for commodities at the HS6 product level, which I aggregate up to 43 tradable industries using concordance tables developed in this paper. Data on tariffs are taken from TRAINS for 1996-2000 and are at the HS6 level of disaggregation, and were aggregated up to 43 tradable industries using an import weighted average. The total number of observations is 407,923, with 9,487 observations per sector on average.

Table A3 presents the estimated θ_s and heteroskedastic robust standard errors using the full, 99%, and 97.5% sample. The 99% and 97.5% samples were constructed by dropping small trade flows following Caliendo and Parro (2015). The coefficients have the correct sign in most cases and the magnitude of the estimates varies considerably across industries.[38] Two industries, mining and dressing of ferrous metals and polytechnic services, have no variation on bilateral tariffs to identify the θ_s (if the tariff data only vary by importing countries, the log tariff ratio equals zero). I use the estimates for the 99% sample as the estimates for calibration; for negative and empty estimates, I replace them by the mean estimate of other industries in the same one-digit CSIC sector. I present in column (1) the final set of θ_s that are used for the quantitative exercises.

Estimating hukou frictions

Table A4 provides the regression results of equation (31) and robustness checks. Column (1) reports the benchmark estimates used for estimating hukou frictions in Section 4.2. As expected, migration flows are positively correlated with the hukou measure, meaning that people will move less between provinces with large hukou frictions. Two provinces also tend to have larger bilateral migration inflows if they share a common border or have a short bilateral distance.

In column (2), I further control for bilateral ethnic distance to take account of any migration frictions due to the regional difference in ethnic mix. Following Conley and Topa (2002), I calculate the bilateral ethnic distance as the Euclidean distance between the vector of percentages of two ethnic groups (Han versus the other) of two provinces. I use the 1% random sampled data of the 3rd Population Census in 1982 to construct this measure to avoid any simultaneity bias. If two regions have the same ethnic composition, this variable equals zero. The negative coefficient on this measure confirms that migration flows will be limited if two provinces are very different in minority population shares.

In column (3), I also control for bilateral industry distance using the 1% micro sample of the 1982 census data. This measure is calculated as the Euclidean distance between the vector of employment shares over 328 industry categories. I expect this measure to capture the reallocation frictions due to the regional difference in industry mix. Interestingly, the variable is positively correlated with migration flows, suggesting that workers are more likely to migrate to a region specialized in different industries. This might be because workers move to realize their comparative advantages. The estimated coefficient nevertheless is not statistically significant.

In all cases, the coefficient on the (not normalized) hukou measure is significant at the 5% level and has the expected positive sign. The magnitude of the estimated coefficients barely changes with

[38]The negative estimates are mainly driven by countries hit by the Asian financial crisis and China.

Table A4: Estimating Hukou Frictions

	Main	Robustness	
	(1)	(2)	(3)
$\log(Hukou_p * Hukou_i)$	1.11**	1.03**	1.11**
	(0.45)	(0.45)	(0.47)
Distance	-1.12***	-0.88***	-0.89***
	(0.20)	(0.23)	(0.23)
Common Border	2.26***	2.36***	2.37***
	(0.23)	(0.23)	(0.23)
Ethnic Distance		-0.63**	-0.62**
		(0.27)	(0.27)
Industry Distance			0.61
			(1.00)
Observations	930	930	930
R-squared	0.64	0.64	0.64

Notes: This table presents the regression results of equation (31) and robustness checks. Column (1) reports the benchmark estimation used for constructing hukou frictions in Section 4.2. In column (2), (3) I further control for the bilateral distance in ethnic groups and industry mix. In all specifications, pair fixed effects among 8 economic-regions are included. *** p<0.01, ** p<0.05, * p<0.1.

additional controls. Therefore I use the benchmark estimate to calculate income costs associated with frictions.

Solving the model in relative changes

In this subsection, I present a step-by-step description on how to solve the model. Consider changes in trade policy from τ to τ' and hukou policy from d to d'.

- Step 1: Guess a vector of changes in regional employment $\hat{\boldsymbol{L}} = (\hat{L}_1, \hat{L}_2, ..., \hat{L}_N)$, and a vector of changes in structure rents $\hat{\boldsymbol{r}} = (\hat{r}_{11}, ..., \hat{r}_{1K}, ..., \hat{r}_{NK})$.

- Step 2: Use the left hand side of equilibrium condition (21), i.e. $\frac{\sum_{s\in K} L_{is}\hat{R}_{is}}{\hat{w}_i} = \hat{L}_i$, to solve for wage changes $\hat{w}_i$ in each region.

- Step 3: Use equilibrium conditions (15) and (17), and information on λ_{ijs} to solve for changes in price in each region and each sector, $\hat{P}_{is}$, and changes in input cost, $\hat{c}_{is}$ which are consistent with $\hat{\boldsymbol{r}}$ and $\hat{w}_i$. Then solve for changes in local price index, $\hat{P}_i$, using $\hat{P}_i = \prod_{s\in K} \hat{P}_{is}^{\beta_s}$ and data on β_s.

- Step 4: Use equilibrium condition (16), the shock $\hat{\tau}_{ijs}$, estimates of θ_s, and $\hat{c}_{is}$, $\hat{P}_{is}$ calculated from step 3 to solve for changes in expenditure share $\hat{\lambda}_{ijs}$.

- Step 5: Use the guess of $\hat{\boldsymbol{r}}$ and $\hat{\boldsymbol{L}}$, $\hat{w}_i$, and data on $w_i L_i$ and $r_i S_i$ to solve for Y_i' using equation (19).

- Step 6: Given Y_i', $\hat{\lambda}_{ijs}$, and information on β_s, $\alpha_{jk}(s)$ and λ_{ijs}, use equilibrium condition (18) to solve for R_{is}'.

- Step 7: Compute $\hat{R}_{is}$ using R_{is}' and the initial value of R_{is}. Verify if equation (22) holds. If not, adjust the guess of $\hat{\boldsymbol{r}}$ and proceed to step 1 again until equilibrium condition (22) is obtained. This step yields endogenously determined $\hat{r}_i(\hat{\boldsymbol{L}})$, as well as other endogenous variables that are consistent with $\hat{\boldsymbol{L}}$, which I denote as $\hat{x}(\hat{\boldsymbol{L}})$ for variable $\hat{x}$.

- Step 8: Use $\hat{y}_i = \frac{Y_i'}{Y_i \hat{L}_i}$ and $Y_i'(\hat{\boldsymbol{L}})$ to solve for $\hat{y}_i(\hat{\boldsymbol{L}})$. Substitute $\hat{y}_i(\hat{\boldsymbol{L}})$, $\hat{P}_i(\hat{\boldsymbol{L}})$ derived from step 7, and the hukou policy shock $\hat{d}_{hi}$ into the right hand side of equilibrium condition (21) and obtain changes in labor supply in each region. Write it in vector form.

- Step 9. Verify if the vector of changes in labor supply equals $\hat{\boldsymbol{L}}$. If not, adjust the guess of $\hat{\boldsymbol{L}}$ and proceed to step 1 again until they equalize.

Appendix D Hukou Reforms in Detail

A hukou is a household registration record required by law in China. It officially identifies a person as a resident of an area in China and determines where citizens are officially allowed to live. China introduced its hukou system in the early 1950s to harmonize the old household registration systems across regions. However, under the centrally planned economy, economic resources were mostly devoted to urban areas, as the government hoped to extract China's agricultural economic surplus to fuel urban industrialization. This uneven allocation of resources lead to a massive influx of migrants into the main cities, which in turn led to a massive unemployment in the urban areas and threatened agricultural production in rural areas (Kinnan et al., 2015). As a result, the hukou system was soon re-purposed to restrict both interregional and rural-to-urban migration. In 1958, the Standing Committee of the National People's Congress adopted the Household Registration Regulations. According to the regulation, citizens could only apply to move after the registration authority has granted them the local hukou. From then on, China entered an era with strict migration controls, with the hukou being at the centre of the migration control system.

By the end of the 1950s, free migration became extremely rare. Migrant workers would be required six passes in order to work in provinces other than their own; rural-to-urban migrants, in addition to the above restrictions, would have to first acquire an urban hukou, the annual quota of which was 0.15% to 0.2% of the non-agricultural population of each locale (Cheng, 2007). Under the central planning system, coupons for consumption goods, employment, housing, education, healthcare and other social benefits were entirely allocated based on local hukou; urban dwellers without local hukou would be fined, arrested and deported. Thus it was also impossible for people to work and live outside their authorized domain (Cheng and Selden, 1994).

In the early 1980s, China latched onto a labor-intensive, export-oriented development strategy that created an increasingly large labor demand in cities. Accordingly, migration policy began to relax over time. In 1984, the State Council allowed rural population to reside in villages with self-sustained staples. In the following year, the Ministry of Public Security of China allowed people to migrate freely conditional on applying for a temporary residential permit upon arrival. In 1993, China officially ended the food rationing system and since then internal migration was no longer limited by hukou-based consumption coupons. Gradually, the distinction between rural and urban hukou also became less important (Bosker et al., 2012). The rural-to-urban migration quotas were officially abolished in 1997; for many cities and towns, the rural/urban distinction of the hukou type was also eliminated (Chan, 2009).

Nevertheless, the hukou system continues to serve as the primary instrument for regulating inter-regional migration. Certain cities have limited capacity to large quantities of labor due to historical or environmental issues, so they still want to keep migration under a tight control; some regions close to the country border or have lots of ethnic minority groups are also sensitive to migration inflows, mostly for stability concerns. In addition, without fiscal transfers from the central government, prefectures, in general, have very little incentive to provide public services to migrant workers. Because of these various reasons, discrimination against migrant workers by their hukou status is still widespread. Individuals who do not have a local hukou in the place where they live are not able to access certain jobs, schooling, subsidized housing, healthcare and other benefits enjoyed by those who do. As a result, the ease of obtaining a local hukou still heavily influences one's migration decisions.

Importantly, as part of a contemporaneous reform devolving fiscal and administrative powers to lower-level governments, local governments have largely gained the authority to decide the number of hukou to issue in their jurisdictions. Since 1992, some provinces introduced temporary resident permits for anyone who has a legitimate job or business in one of their major cities, and some grant hukou to high-skilled professionals or businessmen who make large investments in their region (Kinnan et al., 2015).[39] The stringency of these policies and general hukou issuing rules, however, differ significantly across regions. For instance, it is famously difficult to obtain a hukou in Beijing or Shanghai, while Dongguan, a coastal city in Guangdong province, offers relatively generous granting rules to attract low-skilled migrants for its booming manufacturing sectors. It is this heterogeneity in hukou-granting practices that provides variation for the hukou friction measure.

The above-mentioned practices led to a formal hukou reform launched by the central government in 1997. The major aspects of the reform included officially abolishing the rural-to-urban migration quotas and approving the selective migration policies in cities. After an experimental period, a national implementation of the reform began in 2001. However, this reform, which is largely an affirmation of

[39]The most significant change is the introduction of two particular types of residential registration, the so-called temporary residential permit and the blue-stamp hukou. Unlike the regular hukou, these are not administered by the central government; instead, their design and implementation are up to local governments. While the temporary resident permit can be issued to anyone who has a legitimate job or business in the city, citizens who want a blue-stamp hukou are usually required to pay a one-time entry fee called the urban infrastructural construction fee, which varies between a few thousand in small cities and 50,000 Chinese RMB in more "attractive" cities.

local policies that were already in practice, has been mostly put on hold since mid-2002 for stability concerns (Wang, 2004). According to Chan and Buckingham (2008), it only had a marginal impact in facilitating internal migrations. Despite the general increase in the number of migrants in the country over the last quarter century, the annual number of hukou migrants recorded by the Ministry of Public Security remained stable between 1992 to 2008 (Chan, 2013). In 2011, "a hukou reform" was re-mentioned in China's Five-Year Plan, but the exact plan only started to take shape in 2014.

Appendix E Empirical Appendix

Confounding factors

In this subsection, I show that the empirical results presented in Section 2 are not driven by potential confounding factors including pre-liberalization trends, SOE reforms, currency appreciation, housing booms, agglomeration into regional capitals, and the development of Special Economic Zones. I focus on *pattern* 1 here, and the remaining robustness checks are available upon request.

Tables A5 and A6 report the results without and with interaction terms, respectively. In all regressions, the full set of benchmark controls are also included; these yield similar estimated coefficients, thus I do not report them to save space. Column (1) of Table A5 reports the result in column (3) of Table 2 for comparison. In column (2), in addition to the set of controls used before, I include pre-liberalization employment growth to control for unobserved determinants of a prefecture's development in the long run. The estimated coefficient has the expected sign but is not statistically significant; the coefficient on ΔRIT remains the same. In column (3), I control for regional shifts in the employment share of SOEs between 2000 and 2009, to take into account the massive layoffs from the late 1990s that were due to SOE reforms. The estimation results suggest that SOE reforms had a negative but not statistically significant impact on regional employment; the estimated coefficient on ΔRIT remains almost the same.

In columns (5) and (6) I control for the beginning-period share of regional employment in the construction and real estate sectors, respectively, to take into account the possible correlation between real estate booms and trade shocks. In column (7), I include capital dummies in case the results are driven by the development of major cities. In all three cases, the estimate of the additional control coefficient is significant and has the expected positive sign, while that of ΔRIT is affected marginally. In column (8), I drop prefectures which contain Special Economic Zones. The estimated coefficient on ΔRIT stays almost the same, suggesting my empirical results are not driven by preferential trade policies granted to certain regions.

Table A6 reports the same exercise with interaction terms. When including each additional control, its interaction with the hukou measure is also included. Column (1) repeats the result in column (6) of Table 2 for comparison. Similarly, when I include additional controls or drop Special Economic Zones, the estimates of the interaction between ΔRIT and hukou frictions is in line with the benchmark case.

In column (1) of Table A7, I report the result of regressing employment changes on regional input

Table A5: Effect of Input Tariff Cuts on Local Employment: Robustness I

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional input tariff cuts (ΔRIT)	4.92***	4.14**	4.96***	2.95**	4.17***	3.26**	4.23***	4.80***
	(1.44)	(1.65)	(1.46)	(1.11)	(1.39)	(1.27)	(1.37)	(1.42)
Pre-liberalization employment trend		0.08						
		(0.08)						
Changes in state-owned employment shares			-0.00					
			(0.01)					
Real exchange rate				1.39**				
				(0.59)				
Initial share of employment, construction					1.00**			
					(0.46)			
Initial share of employment, real estate						10.36***		
						(3.11)		
Capital dummy							0.09***	
							(0.03)	
Drop Special Economic Zones								Yes
Province fixed effects (31)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	337	330
R-squared	0.66	0.67	0.66	0.68	0.67	0.69	0.69	0.70

Notes: The dependent variable is the 10-year change in log prefecture employment. The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the full vector of control variables from column (3) of Table 1. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

tariff cuts while controlling for pre-liberalization trends, SOE reforms, RMB appreciation, housing booms, province-capital dummies using a sample without Special Economic Zones. Standard controls used in baseline regressions are also included. Including the full set of controls leads to a lower coefficient on ΔRIT, but it remains positively significant. Column (2) reports the results with interaction terms. When including all control variables, the estimate of the interaction between ΔRIT and the hukou friction measure is in line with the benchmark case and remains statistically significant at the 5% level.

Exogeneity of tariff changes

The empirical analysis in this paper relies on the variation in tariff changes across industries. In order to draw any causal implications of input trade liberalization, tariff changes must be unrelated to counterfactual industry employment growth. As discussed in Kovak (2013), such a correlation may arise if trade policymakers impose smaller tariff cuts to protect weaker industries, or if larger industries can lobby for smaller tariff cuts (Grossman and Helpman, 1994).

There are a number of reasons to believe that these concerns are less important in the case of China. Viewing WTO membership as a way to lock China on a path of deepening economic reform and openness, the Chinese government had more desire to open rather than protect its domestic industries (Woo, 2001). Additional supporting evidence comes from examining the relationship between tariff cuts and pre-liberalization employment. If policymakers did allow “stronger” industries to bear larger tariff cuts, industries with higher employment *growth* between 1990 and 2000 would have experienced greater tariff reductions; if large industries lobbied more or were more likely to be protected due to

Table A6: Effect of Input Tariff Cuts on Local Employment: Robustness II

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional input tariff cuts (ΔRIT)	-0.06	-1.98	0.43	-1.40	-0.44	-0.41	0.19	-1.13
	(1.53)	(1.75)	(1.66)	(1.91)	(1.54)	(1.38)	(1.42)	(1.31)
Regional input tariff cuts × Hukou	15.70***	18.42***	14.76***	15.43***	16.94***	12.40**	13.57***	15.64***
	(4.45)	(4.35)	(4.46)	(5.24)	(5.54)	(5.06)	(4.71)	(4.27)
Pre-liberalization employment trend		0.01						
		(0.13)						
Changes in state-owned employment shares			-0.04					
			(0.03)					
Real exchange rate				1.38				
				(1.30)				
Initial share of employment, construction					0.52			
					(1.42)			
Initial share of employment, real estate						3.79		
						(5.61)		
Capital dummy							0.02	
							(0.06)	
Drop Special Economic Zones								Yes
Province fixed effects (31)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	337	330
R-squared	0.70	0.73	0.71	0.71	0.70	0.73	0.72	0.70

Notes: The dependent variable is the 10-year change in log prefecture employment. The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the full vector of control variables from column (6) of Table 1. When including each additional control, its interaction with the hukou measure is also included - none of the estimates are statistically significant and therefore are not reported. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

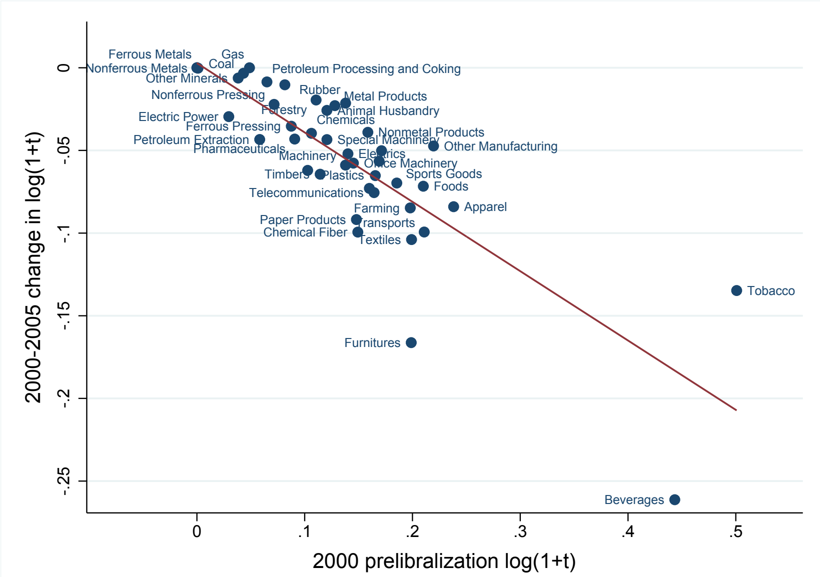
employment concerns, industries with larger employment (in *levels*) in 2000 would have experienced lower tariff cuts. However, I find only marginal and statistically insignificant correlation between tariff changes and pre-WTO industry employment in both *changes* and *levels*: the simple correlations are 0.13 and 0.16, respectively.

Following the approach of Goldberg and Pavcnik (2005), Figure 7 shows that industries with high tariffs in 2000 experienced the largest tariff cuts, with the correlation between the 2000 tariff levels and the change in tariffs being -0.84. The fact that the pre-WTO tariff levels largely determined the tariff changes after China's WTO accession implies that the primary goal of policymakers was to reduce tariff rates in general and to smooth cross industry variations. This further rules out the industry protection and political economy concerns.

Most importantly, even after rounds of voluntary tariff reductions, the Chinese tariff structure in 2000 remained similar to that of 1992,[40] with a correlation of 0.93. On the other hand, the *bound* duties after joining the WTO were largely imposed externally, benchmarking the tariff levels of other WTO members. Unlike in many other developing countries, there is almost no gap between China's *bound* and *applied* duties, and the binding coverage is 100%. This implies that the pre-liberalization tariffs of China were based on a protection structure that was set a decade earlier while post-liberalization tariffs were externally set. Therefore, it is highly unlikely that tariff reductions between 2000 and 2005 are correlated with counterfactual industry employment changes.

Despite evidence of the exogeneity of tariff changes to industry performance, I provide a robustness check of my empirical results by instrumenting tariff changes with tariff rates from the year 1992.

[40]The year 1992 is the earliest year that the Chinese tariff data at the HS6 level is available.



Notes: This figure plots log tariff changes over the 2000-2005 period against the log 2000 tariff levels. The sectoral tariff is calculated based on the simple average of MFN applied tariff rates at the HS6 product level from the TRAINS database. Correlation: -0.84; regression coefficient: -0.43; standard error: 0.044; t: -9.60.

Figure 7: Tariff Changes and Pre-liberalization Tariff Levels

Specifically, I construct an instrument following the formula of ΔRIT but replace the 2000-2005 tariff changes with the 1992 tariff levels. Similarly, I instrument regional output tariff changes using the 1992 tariff rates as well. Column (3) of Table A7 reports the two-stage least squares (2SLS) estimation without interaction terms. Instrumenting tariff changes with pre-liberalization tariff levels leads to a slightly higher estimate on ΔRIT, and the results remain statistically significant. In column (4), I include interaction terms and instrument them with the interaction between the instrument for ΔRIT and the hukou measure. The 2SLS estimates with interaction terms confirm the results discussed in the paper as well.

Falsification test

To verify that my results are not due to spurious correlation, I perform a simple falsification analysis by regressing pre-liberalization employment changes (1990-2000) on regional input tariff cuts, while using the employment share from the year 1990 to compute ΔRIT. The industry classification was more aggregated in 1990, hence I calculate regional tariff cuts based on 61 industries. The 1990 regional employment by sector is missing for some prefectures. To ensure data quality, I work with 287 prefecture cities that have employment information for all industries. The OLS results are presented in columns (5) and (6) of Table A7. Regional input tariff cuts have no statistically significant impact on pre-liberalization employment; the interaction term has the wrong sign when it is included. Notably, these results are not driven by different levels of industrial aggregation or decreased sample size: when I use the same sample of prefectures, regressing 2000-2010 employment changes on ΔRIT, which is

Table A7: Additional Robustness Checks

	All controls		2SLS		dEmp, 90-00	
	(1)	(2)	(3)	(4)	(5)	(6)
Regional input tariff cuts (ΔRIT)	1.92*	-0.31	5.05***	1.00	12.45	27.60**
	(1.09)	(1.44)	(1.25)	(1.91)	(8.24)	(12.74)
Regional input tariff cuts × Hukou		10.43**		12.62**		-36.55*
		(4.12)		(6.13)		(19.14)
Changes in state-owned employment shares	-0.01	-0.01				
	(0.01)	(0.02)				
Real exchange rate	0.92*	0.76				
	(0.49)	(0.77)				
Initial share of employment, real estate	5.71**	-9.51*				
	(2.63)	(4.92)				
Capital dummy	0.06**	-0.02				
	(0.03)	(0.05)				
Pre-liberalization employment trend	0.06	-0.08				
	(0.07)	(0.11)				
Drop Special Economic Zones	Yes	Yes				
Province fixed effects (31)	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.			41.01	7.28		
Observations	330	330	337	337	287	287
R-squared	0.70	0.75	0.66	0.70	0.39	0.48

Notes: The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the full vector of control variables from column (3) of Table 1; models with interaction terms further include the interaction between the hukou measure and other tariff changes as in column (6) of Table 1. In columns (3) and (4), I instrument tariff changes with the tariff levels from 1992. In columns (5) and (6), I replace the dependent variable with the decade-change in employment before liberalization. In even columns, the interaction terms of the hukou measure and control variables are also included. The estimates on the interaction between the hukou measure and the controls are statistically insignificant in most of the cases and therefore are not reported. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

calculated based on the 61 industries, I get positive and significant estimates.[41]

Validity of the hukou measure

Finally, Table A8 presents estimation results of the impact of ΔRIT on regional employment, with a series of alternative hukou friction measures. Columns (1) and (2) address the concern that migrants may not be willing to obtain a local hukou in some prefectures. If this is the case, the small value of the hukou measure may reflect migrants' reluctance to apply for local hukou rather than stringent hukou granting policies. This issue is partly taken care of by including the GDP per capita difference between migrants' move-in and move-out province, as people who moved to more developed regions are more willing to obtain a local hukou. In columns (1) and (2), I provide additional robustness checks by constructing the hukou measure using a subsample of my data. In column (1), I focus only on migrants with local family ties, namely migrants who live with family members who already have local hukou. In this case, I expect migrants to be more likely to settle permanently and hence prefer to have local hukou as well. In column (2), I construct the hukou measure using only migrants with rural origins. The majority of migrants moved to urban areas during my sample period, and in the year 2000 urban hukou were strictly preferred by most Chinese people. I would therefore expect

[41]The estimation results are in line with the benchmark results and are available upon request.

Table A8: Alternative Hukou Friction Measures

Hukou measures	Family ties (1)	Rural origin (2)	Inverse s.d. weighted (3)	Exclude outliers ($mig.pop < 30$) (4)	Simple ratio (5)	Province FE (6)	Prefecture-level measures (7)
Regional input tariff cuts (ΔRIT)	-2.37	0.19	-0.02	-1.26	0.13	3.47***	0.74
	(2.89)	(1.83)	(1.42)	(2.07)	(2.27)	(1.06)	(3.07)
Regional input tariff cuts × Hukou	21.56**	15.64**	16.52***	15.78**	12.73**	8.58**	17.53
	(8.67)	(5.84)	(4.49)	(5.87)	(5.64)	(3.27)	(13.86)
Province fixed effects (31)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	337
R-squared	0.70	0.69	0.71	0.69	0.69	0.69	0.67

Notes: The sample contains 333 prefectures and four direct-controlled municipalities. All regressions include the full vector of control variables from column (6) of Table 1. Robust standard errors in parentheses are adjusted for 31 province clusters. Models are weighted by the log of beginning-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

rural migrants to always be willing to obtain a local hukou if the application process is costless. The estimation results are unaffected in both cases; the coefficient on the interaction term in column (1) shows a slight increase.

Columns (3) and (4) address the concern that prefecture-fixed effects are not precisely estimated for prefectures with very few migration inflows. In column (3), I construct the provincial hukou friction measure as the inverse-standard-error weighted average of prefecture fixed effects (FE) instead of the simple average. The idea is to give fewer weights to prefecture hukou frictions that are not precisely estimated. In column (4), I drop prefectures with less than 30 migrants when constructing the hukou measure. The estimation results are quantitatively in line with the benchmark case presented in column (6), Table 2; and the interaction term is statistically significant in both cases.

Columns (5) to (7) address the concern that the positive and statistically significant estimates on the interaction term are driven by the specific construction process of the hukou measure. In column (5), I run the regression with a hukou measure constructed using simple hukou granting probabilities (without adjusting for individual characteristics). Next, I regress the hukou-granting dummy on individual characteristics and province fixed effects (instead of prefecture fixed effects), and then normalize the estimates on the province fixed effects as my measure of hukou frictions. Column (6) presents the employment effects of ΔRIT and its interaction with the new hukou measure. The estimation results confirm the sign and statistical significance for both alternative hukou measures. In column (7), I normalize the prefecture fixed effects from zero to one as the hukou friction measure. In this case, the hukou granting probability of some prefectures is not consistently estimated due to limited migrant inflows. Column (7) shows that the coefficient on the interaction terms lose statistical significance when using prefecture-level hukou friction measures, but it has the correct sign and is quantitatively similar to the benchmark case.