DISCUSSION PAPER SERIES

DP14490

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INTERNATIONAL TRADE AND REGIONAL ECONOMICS

ISSN 0265-8003

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Discussion Paper DP14490
Published 14 March 2020
Submitted 13 March 2020

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www.cepr.org

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JEL Classification: F14, F15, F16

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

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Acknowledgements
This project has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program (grant agreement 715147).

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February 19, 2020

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*First draft: March 2015. I am grateful to Richard Baldwin, Nicolas Berman, Arnaud Costinot, Rodrigo Adao, Pol Antràs, David Autor, Andy Bernard, Tibor Besedes, Loren Brandt, Lorenzo Caliendo, Kerem Coşar, David Dorn, Peter Egger, Aksel Erbahar, Benjamin Faber, Luisa Gagliardi, Gordon Hanson, Beata Javorcik, Ruixue Jia, Victor Kümmritz, Justin Yi Lu, Enrico Moretti, Andreas Moxnes, Rahul Mukherjee, Marc Muendler, Marcelo Olarreaga, Ugo Panizza, Frédéric Robert-Nicoud, Stela Rubinova, Kjetil Storesletten, Lore Vandewalle, Johanna Vogel, Yikai Wang, Zi Wang, Shang-Jin Wei and Xing Yang for their valuable comments and suggestions at various stages of the development of this paper. I also thank the Economics faculty of the Massachusetts Institute of Technology (MIT) for their hospitality during my visit as a doctoral researcher, as well as the Sociology Department of Peking University and Renmin University of China for providing me access to part of the data. This project has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program (grant agreement 715147).

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1 Introduction

Trade liberalization is often argued to be an important driver of economic development because it can raise a country's income by increasing specialization in sectors in which the country has 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. However, 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 considerable share of the negative consequences of trade on labor market outcomes.[1] Although the role of labor mobility in both the aggregate and distributional impacts of trade has long been emphasized, we lack a rigorous understanding of how globalization affects a country's internal labor adjustments and how migration frictions shape the impact of tariff reductions on regional employment, the 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 where the hukou system was abolished. In doing so, 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 differs significantly across Chinese prefectures, providing ample variation to identify the causal effects of trade policy on regional economic outcomes. Second, although trade has been growing rapidly in China, the country's accession to the WTO was an inflection point: China's total trade in goods was approximately one-half trillion USD in 2000, and it had surged to more than 4 trillion USD by the end of 2010. In the same period, China's internal migration also accelerated. From 1995 to 2000, approximately thirty million Chinese changed their province of residence. 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 is 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, making it a natural choice to probe the relationship between international trade

[1] See, for instance, Autor et al. (2013), Topalova (2010), and Dix-Carneiro and Kovak (2017) for the cases of the US, 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.

and domestic migration patterns.

Most important, unlike most policies that tend to affect the movement of *both* goods and people, China's hukou system offers a unique possibility to cleanly identify migration frictions separate 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 a person's access to various social benefits and public services to her residential status; as a result, the ease of obtaining a hukou substantially influences 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 empirical patterns that suggest input-liberalization-induced labor reallocation across Chinese prefecture-level 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. By exploiting regional variations in the exposure to tariff changes stemming from the initial difference in the industry mix, I find that among various trade shocks associated with China's accession to the WTO, *input tariff liberalization* played a dominant role in shaping the spatial labor reallocation in China.[3] I find that a prefecture at the 95th percentile of *input tariff exposure* experienced a 16.68-percentage-point larger employment increase than a prefecture at the 5th percentile. In provinces with the least hukou frictions, the effect of input tariff cuts was three times larger than the average effect. Regional adjustments on other margins suggest that the observed regional employment changes were mainly driven by interregional labor adjustments. However, the number of local hukou holders only increased in prefectures with less-stringent hukou systems, confirming the existence of hukou frictions. My baseline results are robust to accounting for various concurrent policy and economic shocks and to instrumenting tariff changes using the 1992 tariff levels.

Two concerns about my baseline findings are whether they are robust to changes in the composition of migrants and whether the hukou measure truly captures the regional variation in hukou supply. To address the first concern, I show that my baseline findings are mainly driven by the inflows of migrant workers and remain robust when examining migrants by skill type. To address the second concern, I first show that my findings are robust to alternative hukou measures constructed using subsamples of migrants who are more likely to demand local hukou; I then use a unique group of migrants who temporarily face no hukou frictions, university migrants, to conduct placebo tests. I find that the placebo hukou measure constructed using university migrants explains little of the variation in my baseline measure and does not influence the effect of tariff changes.[4]

[3]Throughout the empirical analysis, I control for output tariff cuts, external tariff changes and their interactions with the hukou friction measure (among others) and do not find robust evidence of their impacts on migration. When accounting for both the input and output channels, 29 percent of the regional variation in employment changes can be attributed to trade liberalization, most of which is explained by the input channel.

[4]In contrast, the hukou measure constructed using a comparable sample, recent university graduates, is highly correlated with my baseline hukou measure.

Next, I interpret the empirical results through the lens of a 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 drives up wages and attracts workers from elsewhere. In 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. Ultimately, the hukou system affects not only the aggregate gains from trade but also their distribution across otherwise identical workers. Despite the complex general equilibrium interactions, the welfare changes in my model 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 and (ii) the income elasticity of labor supply.

I proceed by calibrating the model to identify the general equilibrium effects of tariff reductions and quantify the importance of hukou frictions. 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 increased China's welfare by 0.71%. However, the welfare gains were not shared equally across provinces. Individuals with Beijing and Shanghai hukou experienced welfare improvements of 1.72% and 1.50%, while individuals who hold a hukou from Jiangxi or Sichuan provinces gained only 0.53% and 0.58%, respectively. In general, trade liberalization amplified regional inequalities. I further assess the extent to which China would have gained from trade liberalization if the hukou system had been abolished. For this purpose, I first quantify the cost of the hukou system. I find that in a province with median hukou frictions, migrant workers are willing to forgo 17% of their income to obtain a local hukou. Abolishing the hukou system improves aggregate welfare by 1.33% but leads to welfare losses for some regions' hukou holders. Starting from this new equilibrium, the aggregate gains from tariff reductions increase by 2% relative to the case with hukou frictions and become more evenly distributed across provinces.

This paper contributes to a rich empirical literature on trade and local labor markets. Autor et al. (2016) provide a thorough survey of the existing literature. Unlike most of the work focusing on the downsides of increased import competition (Autor et al. (2013), Dauth et al. (2014), Dix-Carneiro and Kovak (2017), Kovak (2011, 2013), McLaren and Hakobyan (2010) and Topalova (2007, 2010), Facchini et al. (2017), among others),[5] I highlight the positive impact of input trade liberalization and emphasize the importance of migration frictions in shaping the impact of trade policy. Relatedly, Goldberg and Pavcnik (2007b) and Topalova (2007) find that the poor are more likely to share in the gains from trade liberalization in regions with flexible labor markets. In terms

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

of focus, my paper also broadly connects to the large literature on trade and labor allocation in less-developed countries (see Goldberg and Pavcnik (2007a) and Harrison et al. (2011) for surveys) and on trade and costly labor adjustments. Examples include Kambourov (2009), Artuç et al. (2010), Artuç and McLaren (2012), Caliendo et al. (2015), Dix-Carneiro (2014), and many others (see McLaren (2017) for a recent review).

In terms of modeling techniques, this paper closely follows a growing literature that develops spatial general equilibrium models to analyze the welfare consequences of aggregate shocks while accounting for 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), who study how the reduction of trade and migration frictions, rather than the interaction between the two, has contributed to 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 when facing *hypothetical* trade shocks.[6] I contribute to the literature by examining *real-world* trade liberalization and am thus able to guide my model construction with credibly identified empirical evidence and confirm its validity by comparing the observed regional response to that generated by the model. In this sense, my paper is closely related to Caliendo et al. (2017), who quantify the effect of trade and labor market integration due to EU enlargement by exploiting the observed changes in tariffs and migration policies.

To the best of my knowledge, this is the first paper to systematically study the impact of hukou on China's internal migration. Undeniably, the hukou system is a key element in understanding many social and political issues in China, from its reforms to rural land ownership to the lost generation of left-behind children. Numerous sociological and economic studies have emphasized its importance, but few have provided direct empirical evidence. The hukou measure proposed in this paper could therefore be usefully applied to study other short- and long-run consequences of the hukou system.

The remainder of this 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 the effects of tariff reductions, and explore a counterfactual scenario in which the hukou system is abolished. Section 5 concludes the paper.

[6] Other works studying the interaction between trade and domestic geography include Coşar and Fajgelbaum (2013) 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, and Ramondo et al. (2016) find that domestic trade costs are substantial impediments to scale effects.

2 Input Liberalization and Regional Hukou Frictions

In this section, I explain the history of trade reforms and the hukou system in China, describe the data and measurements, and present four empirical patterns that demonstrate input-liberalization-induced spatial labor adjustments and the presence of hukou frictions.

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%.[7] This tariff schedule was introduced in 1950 and went nearly unchanged in subsequent decades, partly due to the relative unimportance of trade policy in a centrally planned economy.[8] 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). In addition, the Chinese RMB depreciated by more than 60% in the 1980s and by a further 44% in 1994 to help firms export (Li, 2013).[9] As a result, changes in tariff duties reflect neither the changes in the actual protection faced by Chinese firms nor the accessibility of imported inputs.

In 1996, to meet the preconditions for WTO accession, the Chinese government engaged in substantial reforms that did away with most of the 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.[10] 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.[11] Thus, I measure trade liberalization based on the change in tariff rates

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

[8]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).

[9]There was also substantial tariff redundancy resulting from various preferential arrangements, for example, imports for processing purposes, for military uses, to Special Economic Zones and to 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.

[10]The share of 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. The transformation was similarly far-reaching on the export side (Lardy, 2005). The duty-free policy on imports for personal use in Special Economic Zones was gradually abolished in the 1990s; the 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 over 188,000 policy measures implemented by provincial and municipal governments were stopped (Li, 2011).

[11]All numbers are calculated using the simple average of Most Favored Nation (MFN) applied tariffs at the HS6

between 2000 and 2005.

The Hukou System

A hukou is a household registration record that officially identifies a person as a resident of an area in China and determines where citizens are officially allowed to live. The hukou system was introduced in the early 1950s to harmonize the old household registration systems across regions, but it was soon re-purposed to restrict both interregional and rural-to-urban migration.[12] At the beginning of the 1960s, free migration had become extremely rare. Migrant workers required six passes 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 and other resources were allocated entirely based on local hukou; urban dwellers without local hukou would be fined, arrested and deported. These practices made it 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 populations 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 internal migration was thus 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 (Chan, 2009).

Nevertheless, the hukou system continues to serve as the primary instrument for regulating interregional migration. As cheap labor continues to flood the labor market, in the absence of related fiscal transfers, local governments in general have very little incentive to provide public services to migrant workers. 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

level from the United Nations' (UN) Trade Analysis Information System (TRAINS).

[12]The uneven allocation of resources under the centrally planned economy led to a massive influx of migrants into cities, threatening agricultural production in rural areas (Kinnan et al., 2015). In response, the Chinese government began to tighten migration controls. In 1958, the Standing Committee of the National People's Congress adopted the Household Registration Regulations. According to these regulations, citizens could only apply to move after the registration authority had granted their local hukou. China then entered an era with strict migration controls, with the hukou being at the center of the migration control system. The details of this policy change are provided in section 2.5, when discussing the hukou instrument.

to lower-level governments, local governments have largely gained the authority to determine the number of hukou to issue in their jurisdictions. In 1992, some provinces began to offer 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). 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 Henan is relatively generous in granting local hukou to migrants. This heterogeneity in hukou-granting practices provides variation that is exploited by 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. After an experimental period, national implementation of the reform began in 2001. However, this reform, which is largely an affirmation of local policies that were already in practice, has generally been put on hold since mid-2002 following stability concerns (Wang, 2004). According to Chan and Buckingham (2008) and many others, it only had a marginal impact in facilitating internal migrations.[13] In 2011, "a hukou reform" was again mentioned in China's Five-Year Plan, but the exact plan only began to take shape in 2014.

2.2 Data and Measurement

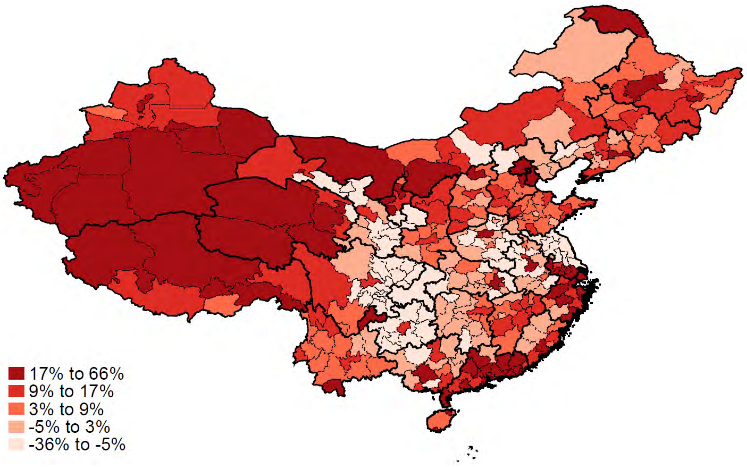
To evaluate the impact of tariff reductions on regional economies in China, I construct a panel dataset of 337 Chinese prefecture-level divisions (prefectures for short). The core data track prefectures decennially from 2000-2010, with the 1990 value being available for some variables. Table 1 contains descriptive statistics of the main variables that are used in Section 2, which I describe throughout this section. I provide a more detailed discussion of the data construction and the other variables used in the paper in Appendix B.[14]

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, thus Chinese prefectures serve as a good proxy for commuting zones. To account for prefecture boundary changes, I use information on

[13]Similar arguments are made in Hou (2014), Sun et al. (2011), Ran et al. (2011) and Zhang and Chen (2014). In particular, using an indivdiual-level panel of the National Rural Social-economic Survey, Sun et al. (2011) finds little evidence that hukou reforms between 2003 and 2006 affected the migration of rural workers.

[14]One data contribution of the paper is to consolidate 16 datasets (including different publications of the Chinese population census) and to create crosswalks that are consistent across various data sources.



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

Figure 1: Regional Employment Changes

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 directly controlled municipalities and 333 prefecture-level divisions that cover all of mainland China. Compared to the commuting zones in the United States, the Chinese prefectures are approximately 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 the population holding local hukou in each prefecture. I collect these variables at the county level from the Tabulation of Population Census of China by County for the years 2000 and 2010 and 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.[15] Figure 1 shows the prefecture-level employment changes in China between 2000 and 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 an over 50% increase in local employment, while others faced a more than 30% decrease.

[15] According to Park et al. (2012), informal employment in China is defined either based on (i) whether 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. Migrant workers account for 49.0% of the informal employment in China under the first definition and 65.7% under the second. The employment data from the population census include all informal workers, as long as they engaged in at least one hour of paid work the week before the survey date or were on leave.

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 are collected from the Tabulation of the 2000 Population Census published by each province. The original data are by county and by 92 two-digit 1994 Chinese Standard Industrial Classification (CSIC1994), which I aggregate to prefecture level.[16] I use the simple average of MFN applied tariffs at the HS6 product level from the UN TRAINS database to compute tariff changes. The cost share of each industry is obtained from the 2002 Chinese National Input-Output (IO) table.[17] To utilize these datasets, I construct a common industry classification with 71 industries, including 5 agricultural and 28 non-traded industries.[18] The crosswalk between the above-mentioned datasets is presented in Appendix B, Table A1.

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 input tariff cuts ΔIT are measured as the input-cost-weighted average of tariff reductions; the weight $\delta_{is} = \frac{L_{is} \frac{1}{\phi_s}}{\sum_{s \in K} L_{is} \frac{1}{\phi_s}}$, where 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.[19] 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 simply using initial employment as the weight.

Disparities in the initial industry mix generated substantial regional variations in exposure to input liberalization, as illustrated in Figure 2. The three trade hubs of China, the Bohai Economic Rim, the Yangtze River Delta, and the Pearl River Delta, are among the greatest beneficiaries of the input liberalization. Some of the western prefectures also experienced large decreases in regional input tariffs because of their specialization in animal husbandry or basic food-processing industries. Those industries are heavy users of agricultural products, the tariffs on which declined significantly after China's accession to the WTO.

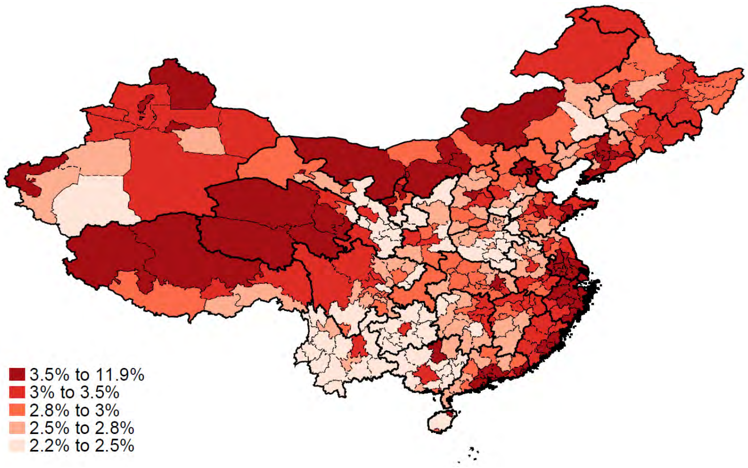
Similar to calculating the regional *input tariff cuts*, I compute regional *output tariff reductions* as a δ_{is}-weighted average of industry-specific tariff reductions. To construct external tariff changes,

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

[17] 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.

[18] The common industry classification is created to achieve the maximum disaggregation between different classifications; 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 further details.

[19] In a specific-factor model with a constant-returns production function, $\frac{1}{\phi_s}$ represents the labor demand elasticity (Kovak, 2013).



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

Figure 2: Regional Input Tariff Cuts

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 over the 2000-2010 period to obtain prefecture-industry-specific tariff reductions. In the last step, I compute the weighted-average tariff changes across industries using δ_{is} for each prefecture. Table A2 provides descriptive statistics of these variables.

Relevance of Trade Flows

Before analyzing the impact of input tariff reductions on regional employment and migration, I first provide evidence that input liberalization indeed had a positive impact on trade flows at both the industry and regional levels. I employ Chinese firm-level customs data to exclude processing imports, as they are exempt from tariffs.[20] Table A3 presents the estimation results. Guided by Goldberg et al. (2010), I begin by examining the responsiveness of import values to tariffs by regressing the logged import value of an HS6 product on Chinese tariffs at the same level, controlling for product and year fixed effects.[21] Table A3, columns (1) and (2) of panel (a) report the coefficient estimates on tariffs for all products and for intermediates, respectively. In both cases, declines in tariffs were associated with higher imported values. In columns (3) and (4), I explore the impact of tariff reductions on unit values of HS6-country varieties by regressing the unit value of the HS6-country product on the tariff, a year fixed effect, and an HS6-country fixed effect. I find that lower tariffs were associated with declines in the unit value of existing intermediate imports. Finally, I

[20]This restricts my analysis to 2000-2006.

[21]I set tariffs as $ln(1 + t)$, consistent with my regional tariff reduction measures. I also lag tariff reductions by one year in all specifications because China joined the WTO at the end of 2001 (negotiations on China's entry were concluded in September, and the final approval by the WTO came in November).

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	0.53	0.28	0	1	31

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

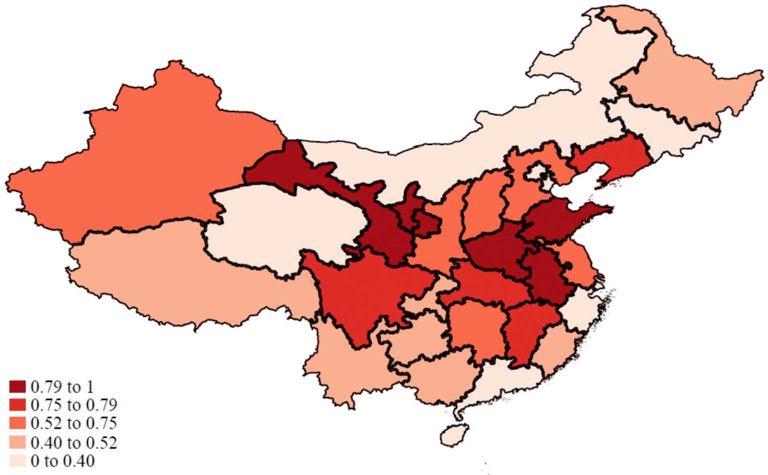
explore the impact of tariff reductions on the expansion of imported varieties, with a variety being defined as an HS6-country-specific product. As shown in columns (5) and (6), tariff declines were associated with increases in imported varieties. In panel (b), I examine the regional correlations. In columns (1) and (2), I explore the correlation between prefecture-level import changes and regional input tariff cuts; columns (3) and (4) examine the responsiveness of imported varieties. In all regressions, I control for external tariff reductions, output tariff reductions, and province fixed effects. I find that larger regional input tariff cuts were associated with a greater increase in regional imports and imported varieties, and the results are robust when focusing on intermediates.

The Hukou Measure

The primary dataset that I use to construct the hukou measure is the 0.095% random-sampled microdata of the Population Census in 2000. The sample was drawn at the household level, with a unique identifier linking individuals in the same household. It 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. To draw out these effects, I construct the hukou measure as follows: focusing on individuals who moved between 1995 and 2000 to a prefecture that was not their birthplace,[22] 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 logged age ($ln(age)$), gender, ethnicity (Han versus other), marital status, the difference in logged GDP per capita between the migrate-out and migrate-in provinces, a migrate-from-rural-areas dummy, a migrate-within-province dummy, education-level dummies,[23]

[22]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; because most people never migrate, the number of observations in my regressions is 62,289.

[23]The 2000 census distinguishes 9 levels of education: illiterate, pre-primary eduction, primary education, lower secondary education, upper secondary education, vocational education, three-year college education, Bachelor's level, Master's level and above.



Name	Value
The 5 provinces with the most frictions	
Beijing	0
Shanghai	0.02
Qinhai	0.06
Hainan	0.16
Tianjin	0.17
The 5 provinces with the least frictions	
Shandong	0.79
Anhui	0.85
Ningxia	0.94
Henan	0.99
Gansu	1

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

Figure 3: Province-level hukou Measure

year of residence (in the current city) dummies and prefecture fixed effects. To allow for possible non-linear effects of age, I also include $ln(age)^2$ and $ln(age)^3$ in the regression.

I then take a simple average of the estimated prefecture fixed effects by province. I aggregate the measure for several reasons. First, to connect my empirical and quantitative exercises, and especially to quantify the cost associated with the hukou system, the hukou stringency must be measured at the same level of aggregation as the *bilateral* migration flows, which are only available at the province level. Reassuringly, as hukou policies are set in a hierarchical order, the majority of the variations are between provinces (F-ratio 3.68). In addition, the main empirical results remain quantitatively similar when using the city-level hukou measure and when using alternative aggregation approaches (shown in Table A6), supporting the validity of my baseline measure. To facilitate interpretation of the results, I further normalize the hukou measure to be between zero and one. Table A2 presents the summary statistics of both the normalized and non-normalized measures; all empirical results remain robust when using the non-normalized hukou measure.[24]

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 policy. Figure 3 illustrates the regional variation in hukou stringency. As one would expect, Beijing and Shanghai are among the most difficult provinces for obtaining a local hukou. Qinghai and Tibet also have very stringent hukou systems, likely driven by limited farming land and political stability concerns.[25] Another region that has stringent hukou policy is Northeast China, likely due to the dominant presence of state-owned enterprises and the associated nepotism (Zhang and Guo, 2009). As a by-product of quantifying the cost of the hukou system, I also document robust, model-consistent evidence

[24] Results are available upon request.

[25] Even in 2016, internal migration remained highly restricted in Tibet, and the police constantly check the identities of migrant workers.

that provinces with less hukou frictions received more migration inflows in the period 1995-2000 in Section 4 (Table A8).

Legislative-based Measures: A Discussion

Very few studies have attempted to estimate hukou frictions, and all of them are legislation-based (Wu et al. (2010), Tian (2019), Fan (2015) and Kinnan et al. (2015)). Though both approaches have pros and cons, my approach has several advantages in comparison.

First, historical data on hukou-related laws and regulations are limited; therefore, existing studies typically focus on a small number of cities or provinces. Second, the actual implementation of local regulations can vary substantially across regions; importantly, as the granting of hukou follows the practice of "examine and approve" (*Shenpi Zhi*), even satisfying application criteria does not always guarantee migrants a local hukou. Third, the timing of the regulation announcements can be strategic and correlated with other unobservables; in some cases, new regulations are simply affirmations of existing practices. In these circumstances, regulations do not necessarily reflect the *real* difficulty of obtaining a local hukou. Moreover, regulations do not capture regional variations in discriminatory practices against non-hukou holders. If those practices affect migrants' propensity to apply, this will be captured by my measure but not by regulation-based measures. Furthermore, hukou granting rules are not always detailed (Kinnan et al., 2015), making it difficult to quantify the stringency of the system based on legislation.

Lastly and perhaps the most importantly, when solely replying on the legal documents, it is rather subjective to assign scores to different regulations, additionally the same requirement may be much harder to achieve in some cities compared to the elsewhere, for instance "purchasing an apartment" may be much more difficult for migrants in cities like Beijing. These difficulties have rendered aforementioned papers to focus on legislation *changes* instead of hukou friction in *levels*, with the only exception being Wu et al. (2010), who took into account the degree of difficulties behind the regulation contents across Chinese regions when constructing their measure. Reassuringly, when I compare my measure with that calculated by Wu et al. (2010), the Spearman correlation is as high as 0.65. In addition, as will show in section 2.4, my empirical results are robust when controlling for relevant legislation changes after trade liberalization.

2.3 Empirical Results

Given the regional input tariff cuts and the hukou measure at hand, I examine the impact of input liberalization on labor adjustments using the following specifications:

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

and

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

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 logged 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 impacts of input tariff reductions depending on hukou frictions; the D_p terms are province fixed effects, and $\mathbf{X}$ represents a set of additional controls. In the main specification, I include regional output tariff and external tariff reductions to control for the effect of increased import competition and improved market access after China's WTO accession, respectively.[26] In addition, I include the pre-liberalization level of the outcome variable to allow for possible mean convergence. $Hukou_p$ is the hukou friction measure; in the second specification, its interactions with external and output tariff reductions are also included. The standard errors are clustered at the provincial level (31 provinces), accounting for the possible covariance between the error terms across prefectures within the same province.

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. These regressions are weighted by the log of beginning-of-period employment. Columns (1)-(3) present the model without interactions. Column (1) shows the OLS results. Column (2) includes baseline controls, and column (3) further includes province fixed effects to control for province-specific trends. The estimate of 5.10 in column (3) implies that a 1-percentage-point regional input tariff cut was associated with an approximately 5-percentage-point relative employment increase. The difference between regional input tariff cuts in regions at the 95th and 5th percentiles is 3.27 percentage points. Evaluated using the estimate in column (3), a prefecture at the 95th percentile experienced a 16.68-percentage-point larger employment increase than a prefecture at the 5th percentile.

Columns (4)-(6) explore whether input-liberalization-induced employment adjustments were more pronounced in provinces with less-stringent hukou systems. Similar to the case without interactions, I first present the OLS results in column (4) and then add additional controls in columns (5) and (6). As I normalized the hukou measure to a unit interval, coefficients on ΔRIT can be interpreted as the impact of input tariff cuts in prefectures with the highest hukou frictions. In the preferred specification in column (6), input tariff reductions had no impact on regional employment in the prefectures with the most stringent hukou policies. In contrast, in regions with the most relaxed hukou systems, a 1-percentage-point increase in input tariff cuts led to a 17-percentage-

[26]External tariff reductions capture the positive impact of tariff reductions by China's trading partners after its WTO accession; note that 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	6.76***	6.92***	5.10***	1.35	3.19*	-1.18
	(1.72)	(0.94)	(1.65)	(2.62)	(1.67)	(2.02)
Regional input tariff cuts × Hukou				10.88**	7.28**	18.45***
				(4.72)	(3.12)	(6.05)
Regional output tariff change		-2.69***	-2.48***		-2.51**	-3.81***
		(0.66)	(0.72)		(1.04)	(1.31)
External tariff change		0.21	0.24		-0.23	0.04
		(0.19)	(0.22)		(0.25)	(0.30)
Initial employment		-0.02	-0.00		-0.01	-0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Regional output tariff change × Hukou					0.98	5.34*
					(1.84)	(3.10)
External tariff change × Hukou					0.82	0.37
					(0.55)	(0.47)
Province fixed effects			Yes			Yes
Observations	337	337	337	337	337	337
R-squared	0.32	0.46	0.66	0.43	0.51	0.69

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

point relative increase in employment,[27] much larger than the 5-percentage-point average found in column (3). This number may appear excessive, but note that the employment in the most-migrant-receiving prefecture increased by over 60% over the 2000-2010 period. In all cases, the coefficient on the interaction term is positive and statistically significant.

Consistent with the existing literature, regional output tariff reductions had a negative impact on employment, although of a smaller magnitude than the impact of input tariff cuts. The effects of external tariff reductions and their interaction with the hukou measure have the expected positive sign but are statistically insignificant. The relaxed hukou system seems to have mitigated the negative impact of output tariff reduction, but the results are less robust.[28] Calculated based on the specification in column (6), when taking into account both input and output channels, 29 percent of the regional variation in employment changes can be accounted for by trade liberalization, most of which is explained by the input tariff cuts.[29]

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.

[27] $18.45 - 1.18 \approx 17$. The sum of $\hat{\beta}_2$ and $\hat{\beta}_3$ is statistically significant unless otherwise stated.

[28] Additionally, I find no statistically significant evidence that hukou frictions have shaped the effect of output tariff reduction on local population or migration inflows, as reported in Table 3.

[29] The partial R-squared of regional input tariff cuts, regional output tariff cuts and their interactions with the hukou measure is 0.29. The partial R-squared of regional input tariff cuts and their interaction with the hukou measure is 0.21, while those of output tariff cuts and external tariff cuts are only 0.03 and 0.002, respectively.

To validate that the spatial reallocation of labor drives pattern 1, I next examine how the total and working age (15 to 64 years of age) populations responded to tariff changes. If the observed employment changes were mainly due to intraregional adjustments, such as changes in the unemployment or labor participation rate, trade shocks should have had no impact on the local population, whereas if the changes were primarily due to interregional adjustments, the local population should react to trade shocks in a quantitatively similar manner to that of employment.

Columns (1)-(4) in Table 3 present the estimation results. As shown in columns (1) and (3), a 1-percentage-point increase in regional input tariff cuts on average led to 5.71 and 4.52-percentage-point increases in the total and working age population of a prefecture, respectively. Both prefecture-level total and working age populations reacted positively and significantly to input tariff cuts, and the coefficients are quantitatively similar to those of employment, suggesting that interregional labor reallocation was the driving force behind regional employment changes.

Pattern 3: Prefectures facing larger input tariff cuts experience a relative increase in population inflows from other provinces, 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 directly examine migration. As the decadal change in net migration inflows is not available, I instead consider the most similar measure reported in the census: the number of migrants from other provinces in the past five years. Note that because this variable counts migrant inflows in five-year periods, I will compare the number of migrants between 1995 and 2000 with that between 2005 and 2010. As tariff reductions began in 2001, I will not be able to obtain a significant result if the impact of tariff reductions levels off quickly.

With this concern in mind, I regress the change in the log 5-year inflow of population from other provinces on regional input tariff reductions, with and without interactions. Because migration is a flow rather than a stock variable, the magnitude of the estimates is much larger. Column (5) in Table 3 shows that a 1-percentage-point increase in regional input tariff reduction led to a 13.96-percentage-point increase in migrant inflows from other provinces. Column (6) confirms that input tariff cuts lead to larger migrant inflows when the hukou system is less stringent. This provides additional support for the notion that regional input tariff cuts increased local employment by attracting labor from other locations and that this effect crucially depended on frictions caused by the hukou system.

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

In columns (7) and (8) of Table 3, I further examine how the number of individuals holding local hukou (hukou population) in a prefecture responded to input tariff reductions. If local hukou can be obtained costlessly, the hukou population should be highly correlated with the total population in

Table 3: Effect of Input Tariff Cuts on Other Adjustment Margins

	Total Population		Working Age population		Migrant Inflows		Hukou Population	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional input tariff cuts (ΔRIT)	5.71***	0.98	4.52**	-2.52	13.96**	-7.25***	-0.23	-4.90***
	(1.22)	(1.61)	(1.74)	(1.98)	(5.65)	(2.37)	(0.83)	(1.56)
Regional input tariff cuts × Hukou		13.16***		20.31***		66.62***		11.33***
		(4.62)		(5.46)		(11.82)		(3.17)
Regional output tariff change	-2.63***	-2.39*	-1.92**	-2.78**	-4.11	-2.76	-3.90***	-3.57*
	(0.64)	(1.39)	(0.77)	(1.24)	(3.03)	(3.17)	(0.69)	(1.99)
Regional output tariff change × Hukou		1.25		4.59		3.54		0.26
		(2.91)		(2.77)		(7.34)		(3.51)
External tariff change	0.25	-0.15	0.26	-0.16	1.70	-0.52	-0.14	-0.26
	(0.25)	(0.28)	(0.25)	(0.25)	(1.38)	(1.43)	(0.12)	(0.22)
External tariff change × Hukou		0.76*		0.80*		4.54**		0.12
		(0.37)		(0.44)		(2.19)		(0.29)
Pre-liberalization Y	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	337	337
R-squared	0.84	0.64	0.58	0.62	0.41	0.45	0.71	0.73

Notes: The dependent variables are the 10-year changes in the logged total population, working age population, migrant inflows from other provinces between 2005 and 2010 and between 1995 and 1990, and population holding local hukou permits (in columns (1)-(2), (3)-(4), (5)-(6) and (7)-(8), respectively). The sample contains 333 prefectures and four directly controlled municipalities. All regressions include the full vector of control variables from column (3) of Table 1; regressions 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. The models are weighted by the log of beginning-of-period prefecture population. *** p<0.01, ** p<0.05, * p<0.1.

a given region and hence react positively to input tariff reductions. The empirical results, however, suggest the contrary: column (7) indicates that on average, reductions in regional tariffs did not cause significant changes in the hukou population. However, in prefectures with less hukou frictions, the hukou population increased in positively affected regions. As shown in column (8), in a prefecture with the most free hukou system, a 1-percentage-point increase in regional input tariff cuts led to a 6.43-percentage-point increase in the hukou population.[30] The magnitude, however, is only half 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 systems. Because I construct the hukou measure based on the granting probabilities of each region, the positive coefficient on the interaction term provides additional support for 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, and this effect is heterogeneous in regions' hukou stringency. Interestingly, I find that, on average, neither the regional output tariff reductions nor the external tariff changes had a significant effect on migrant inflows. The impact of output tariff reductions also did not heterogeneously depend on hukou frictions. This is intuitive, as stringent hukou policies make it difficult for migrants to settle in but do not directly affect locals' decision to out-migrate. In prefectures with less hukou frictions, greater external tariff reductions attract more migrant inflows, but the results are less precisely estimated and smaller in magnitude than that of input liberalization. These results, in addition to the estimation results on

[30] $11.33 - 4.90 = 6.43$.

employment changes, suggest that among various trade shocks associated with China's accession to the WTO, input tariff liberalization seems to have played the dominant role in shaping spatial labor reallocation in China. Therefore, in the remainder of the empirical section, I will focus on the impact of input liberalization and its interaction with hukou frictions. I view the reduced-form exercise as a transparent way to demonstrate the major economic force at play and to guide my model construction. The task of quantifying the general equilibrium effects of tariff reductions and the importance of hukou frictions is relegated to the quantitative section.

2.4 Confounding Factors to Trade Liberalization

In this and the following subsections, I present a battery of robustness checks of my baseline results. For brevity, I focus on *pattern* 1; the results on other regional adjustments are available upon request.

Contemporaneous Shocks

An important concern with my findings is that in addition to input liberalization, there might be other concurrent policy or economic shocks that affect labor adjustments across regions. Specifically, I examine how the pre-liberalization trends, SOE reforms, currency appreciation, housing booms, agglomeration into regional capitals, and the development of Special Economic Zones could affect the results. To control for pre-liberalization trends, I digitalize the 1990 population census tabulation by provinces and compute the logged prefecture-level employment change between 1990 and 2000. I employ the data from Annual Surveys of Industries (AIS) to construct the regional shifts in the employment share of SOEs between 2000 and 2009 to account for the massive layoffs from the late 1990s that were due to SOE reforms.[31] To control for the impact of currency appreciation, I compute the changes in the regional exchange rate as follows: I first calculate the industry-prefecture-specific change in logged real exchange rates between 2000 and 2010 as a trade-share-weighted average across partner countries; I then average the variable across industries with δ_{is} being the weight. To account for possible agglomeration into regional capitals, I control for capital fixed effects. Finally, I exclude the 7 prefectures with Special Economic Zones.

In column (1) of Table 4, I report the result of regressing employment changes on regional input tariff cuts, accounting for all of the above-mentioned factors. Including the full set of additional controls leads to a lower coefficient on ΔRIT, but it remains positively significant. Column (2) reports the results with interaction terms: the estimate of the interaction between ΔRIT and the hukou friction is in line with the baseline case and is statistically significant at the 5% level. Tables A4 and A5 additionally report the regression results when controlling for one factor at a time without and with interaction terms, respectively.

[31] I choose not to use the data of the year 2010, as they contain erroneous information on employment statistics. Brandt et al. (2014) provide an excellent summary of the data issues of the AIS database.

Table 4: Effect of Input Tariff Cuts on Local Employment: Robustness

	Additional Controls		2SLS		dEmp, 90-00		Control dHukou	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional input tariff cuts (ΔRIT)	2.78*	-1.88	2.42*	-2.56	7.42	21.23	5.19***	-0.08
	(1.49)	(2.16)	(1.30)	(2.01)	(7.57)	(14.85)	(1.61)	(2.95)
Regional input tariff cuts × Hukou		14.47**		15.40***		-30.48		22.97***
		(6.33)		(5.85)		(21.17)		(7.40)
Changes in state-owned employment shares	-0.01	-0.02	-0.01	-0.02				
	(0.01)	(0.02)	(0.01)	(0.02)				
Real exchange rate	0.70	0.95	0.79*	1.19*				
	(0.44)	(0.88)	(0.42)	(0.72)				
Initial share of employment, real estate	5.77*	-7.25	5.66**	-6.76*				
	(3.11)	(4.43)	(2.82)	(4.08)				
Capital dummy	0.05**	-0.00	0.05**	0.02	0.05*	0.12*		
	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)	(0.07)		
Pre-liberalization employment trend	0.04	-0.07	0.06	-0.04				
	(0.08)	(0.12)	(0.07)	(0.10)				
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drop Special Economic Zones	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap stat.			48.62	17.63				
Observations	330	330	330	330	280	280	337	337
R-squared	0.69	0.73	0.35	0.45	0.29	0.36	0.67	0.69

Notes: The sample contains 296 prefectures without Special Economic Zones and four directly controlled municipalities. All regressions include the full vector of control variables from column (3) of Table 1; regressions 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 the additional control variables are also included. In most cases, the estimates on the interaction between the hukou measure and the controls (both the baseline and additional controls) are statistically insignificant. Robust standard errors in parentheses are adjusted for province clusters. The models are weighted by the log of beginning-of-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

Exogeneity of Trade Liberalization

To draw any causal implications of input trade liberalization, the observed tariff changes must be unrelated to counterfactual industry employment growth. 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). However, this may be less of a concern 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 a greater desire to open than to protect its domestic industries (Woo, 2001). Indeed, I find only marginal and statistically insignificant correlations between tariff changes and pre-WTO industry employment in both *changes* and *levels*: the simple correlations are 0.13 and 0.16, respectively.[32] Following Goldberg and Pavcnik (2005), Figure A7 shows that industries with higher tariffs in 2000 also experienced larger tariff cuts after WTO accession, with the correlation being -0.84. This suggests that the primary goal of policymakers was to reduce tariff rates in general and to smooth cross-industry variations, thus further ruling out the political economy concerns.

Furthermore, even after rounds of voluntary tariff reductions, the Chinese tariff structure in

[32] 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 employment concerns, industries with larger employment (in *levels*) in 2000 would have experienced lower tariff cuts.

2000 remained similar to that in 1992, with a correlation of 0.93.[33] On the other hand, the *bound* duties after joining the WTO were largely imposed externally, benchmarking the tariff levels of other WTO members. Unlike many other developing countries, there is no gap between China's *bound* and *applied* duties, and the binding coverage is 100%. If the pre-liberalization tariffs were highly correlated with the protection structure set a decade earlier while the post-liberalization tariffs were externally set, it is unlikely that tariff reductions between 2000 and 2005 in China would be correlated with counterfactual industry employment changes. To further address this concern, I instrument tariff changes with year-1992 tariff levels,[34] in addition to controlling for other confounding factors. Columns (3) and (4) of Table 4 report the two-stage results: a 1-percentage-point regional input tariff cut led to a 2.42-percentage-point employment increase on average and a 15.40-percentage-point employment increase in regions with the most relaxed hukou systems. The magnitudes are quantitatively very similar to those of the OLS estimation results in columns (1) and (2).

Pre-liberalization Employment Changes

Finally, to verify that my results are not due to spurious correlation, I regress pre-liberalization employment changes (1990-2000) on regional input tariff cuts, using the employment share from 1990 to compute ΔRIT.[35] The results are presented in columns (5) and (6) of Table 4. Regional input tariff cuts had no statistically significant impact on pre-liberalization employment; the interaction term is also statistically insignificant and has the opposite sign.[36]

Trade-induced Institutional Changes

Another important concern with my findings is that hukou policies themselves might also change in response to trade liberalization. If the increased labor demand results in local governments relaxing migration policies in prefectures positively affected by trade shocks, my estimates on the interaction between hukou friction and ΔRIT may be biased upwards. To address this concern, I further control for the hukou-related legislation change index developed by Fan et al. (2015). The estimation results are reported in columns (7) and (8) of Table 4: a 1-percentage-point regional input tariff cut led to a 5.19-percentage-point employment increase on average and a 22.97-percentage-point employment increase in regions with the most relaxed hukou systems, very similar to the baseline results.

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

[34]Specifically, I construct an instrument following the formula of ΔRIT but replace the 2000-2005 tariff changes with the 1992 tariff levels. Similarly, I also instrument regional output tariff changes using the 1992 tariff levels.

[35]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-level cities that have employment information for all industries.

[36]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 calculated based on the 61 industries, I obtain positive and significant estimates, and they are quantitatively in line with the baseline results (available upon request).

Table 5: Changes in Migration Inflow by Individual Types

	Skill Type				Working Migrants		Placebo: Marriage Migrants			
	High-skilled		Low-skilled				Levels		Shares	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Regional input tariff cuts (ΔRIT)	32.26***	-6.71	20.53***	-1.93	27.25***	-6.42	7.69*	5.29	-39.97***	1.41
	(8.11)	(9.13)	(5.72)	(7.39)	(6.88)	(9.78)	(4.38)	(15.65)	(10.72)	(16.44)
Regional input tariff cuts × Hukou		97.80***		73.82***		108.67***		7.28		-113.41***
		(22.83)		(20.83)		(21.63)		(35.06)		(35.19)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	184	184	328	328	304	304	243	243	243	243
R-squared	0.40	0.44	0.46	0.47	0.39	0.41	0.51	0.52	0.37	0.41

Notes: Columns (1)-(8) present the impact of input tariff cuts on labor inflows by 4 individual (age 15-65, not in school) types: high-skilled workers, low-skilled workers, migrants who moved for working purpose, and migrants who moved for marriage reasons, respectively. Columns (9)-(10) present the impact of input tariff cuts on the share of marriage migrants in total migrants. 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. All dependent variables are calculated using the 0.095% sample of the 2000 population census and 0.1% sample of the 2010 population census. Although the National Assembly reported positive labor inflows in all prefectures, I observe prefectures with zero inflows due to my limited micro-sample size. Those prefectures are dropped from the analysis. Robust standard errors are in parentheses. The models are weighted by the log of beginning-of-period prefecture population. *** p<0.01, ** p<0.05, * p<0.1.

2.5 Validity of the Hukou Measure

Alternative Measures

Table A6, columns (1)-(8), presents a set of robustness checks using alternative hukou friction measures. In column (1), I run the regression with the simple hukou-granting probabilities (without adjusting for individual characteristics) as the hukou measure. In column (2), I instead use a measure constructed based on province fixed effects. Specifically, 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 fixed effects as my measure of hukou frictions. In column (3), I directly use the prefecture fixed effects as the hukou friction measure. In all cases, the coefficients on the interaction terms remain positive and significant and are quantitatively similar to the baseline results, suggesting that my baseline findings are unlikely to be driven by the specific way I aggregate the hukou friction measure.

It is possible that the fixed effects are not precisely estimated for prefectures with low migration inflows. To address this concern, in column (4), I construct the provincial hukou friction measure as the inverse-standard-error-weighted average of prefecture fixed effects instead of the simple average. The idea is to assign lower weights to prefecture hukou frictions that are not precisely estimated. In column (5), I drop prefectures with fewer than 30 migrants when constructing the hukou measure. The estimation results are robust when using these alternative hukou measures.

The Composition of Migration Inflows

Another concern is that my estimation results may be biased if prefectures receive different mixes of migrants. For instance, high-skilled workers tend to be more mobile than low-skilled workers. If regions with low hukou frictions happened to attract more skilled workers after trade liberalization, total migration might appear to respond more to trade shocks in these regions. Another example is that individuals who migrate to marry a local will have easier access to local hukou, and my baseline results might simply capture its spurious correlation with the hukou frictions. To address these concerns, I use the microdata sample of censuses in 2000 and 2010 to construct prefecture-level migrant inflows by skill groups and for migration reasons.

Table 5 reports the impact of input liberalization on different types of migration inflows: high-skilled workers, low-skilled workers, migrants who moved for working reasons, and migrants who moved for marriage purposes. I focus on working-age individuals and exclude those who moved for education or were in school when they were surveyed. As shown in columns (1)-(4), both high-skilled and low-skilled workers responded positively to input liberalization, and the effect was stronger in regions with low hukou frictions. Consistent with my conjecture, high-skilled workers tended to be more mobile and hence more responsive to trade shocks and sensitive to hukou policies. However, the magnitudes of the estimated coefficients are comparable to those of the low-skilled coefficients and are not significantly different from one another. This is also true for the working migrants, as shown in columns (5)-(6). In short, my results are robust to considering migrants of different skill types and to focusing solely on individuals who moved for working reasons.

In columns (7)-(10), I use migrants who moved for marriage purposes as a placebo. If the change in marriage migration is what drives my baseline results, one should expect that the *share* of marriage migrants increased more in regions with higher input tariff changes, and such an increase would have to be more pronounced in areas with low hukou frictions. However, columns (9)-(10) show the opposite results, suggesting that this conjecture is unlikely to be true. In fact, the share of marriage migrants dropped in regions with higher ΔRIT. The reason is that although the number of migrants who moved for marriage purposes increased slightly in regions with higher input tariff cuts, it did so considerably less than that for working migrants (see the estimation results in levels in columns (5) and (7)). This also suggests that where people move for marriage purposes might depend on various factors other than economic ones. The insignificant interaction term in column (8) confirms that migration for marriage purposes is less affected by the hukou system.

Unobserved Heterogeneity

Even though I showed that our results are robust when looking at migrants by skill types and by focusing on working migrants only, one can still be worried about the role of unobserved heterogeneity. For instance, migrant workers who choose to work in stricter regions may have better information about the area or face better job offers by selection. However, these unobserved heterogeneities are likely to be positively correlated with migrants' probability of obtaining hukou, therefore downward bias the regression results. To further address this concern, I replace the hukou measure with a dummy variable equaling to 1 if the friction is below the median. Compared to a continuous variable, the dummy measure is more robust to measurement errors. The results remain robust as shown in column (8) of Table A6: in regions with the above-median relaxed Hukou system, a 1-percentage-point increase in input tariff cuts led to 6-percentage-point relative increase in employment compared to regions below the median.

The Demand for Local Hukou

The validity of my hukou measure crucially depends on the assumption that it captures the stringency of hukou supply instead of demand-side factors. Because I do not observe migrants' hukou application decisions, a low hukou-obtaining probability in a region may simply reflect a lack of demand. For instance, if there are very few gains from accessing a location's hukou, or if migrants expect to migrate temporarily, they may not request a local hukou.

The above-mentioned conjectures are theoretically possible but are unlikely to be the case in reality for multiple reasons. First, as various social benefits are tied to the local hukou, it is difficult to imagine that migrants would not request one if they could obtain it without any cost.[37] Moreover, for public services that hukou holders are eligible to access, such as education or health care, there were very few private sector substitutes available in the 1990s, making the demand for a local hukou almost inelastic. The lion's share of temporary migrants came from rural areas: calculated using the 2000 census data, 83% of the migrants who moved between 1995 and 2000 held a rural residence permit.[38] As urban hukou was much more attractive than rural hukou at the time, temporary migrants were "temporary" precisely because of the difficulty in obtaining an urban hukou, not because they did not want to settle permanently in the cities.[39] Finally, a region may adopt a strict hukou policy for various reasons (as discussed in Section 2.2); therefore, although there are regional variations in hukou demand, as long as it does not positively correlate with hukou supply, the baseline findings should be downward biased.

In addition, I provide two exercises to support my conjecture. I first show that my results are robust to alternative hukou measures constructed using subsamples of migrants who were more likely to demand local hukou regardless of their idiosyncratic preferences. Then, I use a unique group of migrants who temporarily faced no hukou frictions, university students, to perform placebo tests.

Hukou measures based on subgroups If migrants did not want to obtain a local hukou in some prefectures, the small value of my hukou measure might reflect their reluctance to apply for local hukou rather than their limited supply. This issue is partly addressed by including the GDP per capita difference between migrants' destination and source provinces when constructing

[37]The importance of having a local hukou has been emphasized by many researchers. See Cheng and Selden (1994), Chan and Buckingham (2008), Montgomery (2012) and Chan (2009).

[38]The number is calculated based on migrants who had not obtained a local hukou in 2000 using the census microdata. The share could be upward-biased if urban migrants were more likely to obtain a local hukou.

[39]I strictly refer to urban hukou when discussing the supply of and demand for hukou; since collectivization in the 1950s, rural hukou has entailed membership in the village collective and was not given to migrants (Sun and Fan, 2011). Almost all migration inflows in the periods I examine were towards cities. The divide between urban and rural hukou creates an interesting environment for several areas of study, such as land tenure arrangements, which are not the focus of this paper.

Table 6: Hukou for University Students: Placebo

(a) Hukou-granting probability: university students vs. other types of migrants

	No. of Provinces	Mean	Std.Dev.	Min.	Max.
University students	28	0.97	0.03	0.92	1
Rural workers	31	0.30	0.14	0.02	0.49
Recent university graduates (age 22-27)	25	0.79	0.18	0.40	1.00
Total migrants	31	0.37	0.14	0.07	0.56

Notes: This subtable presents the summary statistics of the hukou-granting probability by migrant type. The hukou-granting probability for a given migrant type is calculated as the share of individuals who have obtained local hukou among migrants of that type. As before, I focus on individuals who moved to the prefecture-level city in which they live in the past 5 years. All variables are calculated using the 0.095% sample of the 2000 population census. In the sample, 18 to 22 year-olds accounted for over 90% of university students.

(b) Relevance tests and placebo hukou measure

	Relevance: Hukou Measure			Placebo: Local Employment
	(1)	(2)	(3)	(4)
University students	1.47			
	(1.83)			
Rural workers		1.66***		
		(0.18)		
Recent university graduates (age 22-27)			0.70**	
			(0.32)	
Regional input tariff cuts (ΔRIT)				9.21*
				(5.29)
Regional input tariff cuts × Hukou_{Uni}				-11.24
				(15.40)
Baseline controls				Yes
Province FEs				Yes
Observations	28	31	25	308
R-squared	0.03	0.64	0.22	0.66

Notes: Columns (1)-(3) present the correlation between the hukou measure and the hukou-granting probability by migrant type. Column (4) reports the placebo result of regressing regional input tariff cuts on the change in logged prefecture employment, using the hukou measure constructed based on migrant university students. Controls include province fixed effects and the full vector of control variables from column (6) of Table 1; robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

the hukou measure, as people who moved to more developed regions should be more willing to obtain a local hukou. In columns (6) and (7) of Table A6, I provide additional robustness checks by constructing alternative hukou measures using subsamples of my data. In column (6), I focus solely on migrants with local family ties, namely migrants who live with family members who already have the local hukou. In this case, I expect migrants to be more likely to settle permanently and hence to also prefer to have the local hukou. In column (7), I construct the hukou measure using only migrants with rural origins. Because the majority of migrants moved to urban areas during my sample period, and at the time urban hukou were strictly preferred to rural hukou, I expect rural migrants to be willing to obtain a local hukou if the application process is costless. I obtain very similar estimates to the baseline results in both cases.

Using university students as a placebo To further address the concern that my hukou friction measure may reflect migrants' willingness to apply for local hukou, I use university students as a placebo. In China, university students can choose to either retain their original hukou or transfer it to the area of the school. If a student decides to transfer her hukou, she will be granted a *Jiti* hukou (collective household residence permit), which allows her to enjoy social benefits as other locals during her studies. After graduation, her hukou will be automatically transferred back to her original hukou location or to an area where she had applied for and obtained a new hukou. As the transfer is voluntary and costless, we should expect the hukou-granting ratio among university students to capture only their willingness to obtain a local hukou. It thus serves as a useful check of whether my hukou measure captures the regional variations in hukou demand.

I first examine the simple hukou-granting probability for university students migrating for their studies. Table 6 (a) presents the summary statistics. On average, 97% of university students chose to obtain a new hukou, and the number varies little across provinces. This provides additional evidence that the demand for local hukou is nearly inelastic. In contrast, for rural working migrants or for the full population, the average granting probabilities were much lower (0.30 and 0.37), and the regional variations were substantial. To address the concern that university students may have different skill levels (which may affect hukou supply) and location preferences (which may affect hukou demand), I also compare the student migrants to migrants who recently graduated from university. The difference is still striking: for recent university graduates, the average hukou-granting probability is nearly 20% lower, and the standard deviation is approximately 4 times larger.

Then, I use the sample of university student migrants to construct a hukou placebo. As shown in column (1) of Table 6 (b), it explains little of the variation in the baseline friction measure (R-squared of 0.03). In contrast, hukou frictions constructed based on rural migrants and university graduates are both significantly correlated with the baseline measure, as shown in columns (2)-(3). In column (4), I find no evidence that the placebo hukou measure shapes the impact of regional input tariff cuts. In conclusion, although I cannot entirely rule out the possibility that the hukou demand may contaminate my baseline results, the evidence presented in this subsection suggests that it is less of a concern.

3 A Spatial Model with Migration Frictions

In the previous section, I documented a significant impact of input liberalization on local employment through spatial labor reallocation and that the impact is 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. In this section, I propose a quantitative spatial model to further explore the general equilibrium effects of trade liberalization and to quantify the importance of hukou frictions. To keep the quantitative exercises tightly linked to my empirical analysis, I avoid ingredients that have no direct counterparts in the empirical part when constructing the model. In particular, I disallow additional agglomeration forces such as increasing returns to scale or heterogenous productivity draws of workers across locations. With these purposes in mind, the model builds on Eaton and Kortum (2002, henceforth, EK) and Redding (2016) with both trade and migration frictions. To account for the empirical features, the model also incorporates specific factors, sector heterogeneity, input-output linkages and heterogeneous location preferences.

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 to produce the varieties: labor, composite goods from all sectors, and a 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}. l_{is}, s_{is}, and Q_{iks} are labor, structures, and composite goods, respectively, 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 $\alpha_{is}(L) + \alpha_{is}(S) + \sum_{k \in K} \alpha_{is}(k) = 1$. The total supply of labor in location i is denoted L_i, which depends on workers' residential choice (specified later). The 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. By doing so 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. Admittedly stylized, I view this as an important aspect of the Chinese economy, as those rents constitute a sizable part of local governments' fiscal revenue.[40] Nevertheless, the quantitative results change little when I instead follow the literature and assume that 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).

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 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 the iceberg trade cost $\tilde{\tau}_{ijs}$ and ad-valorem flat-rate tariff t_{ijs}. I let $\tau_{ijs} = (1 + t_{ijs})\tilde{\tau}_{ijs}$, where $\tau_{ijs} > 1$ for $i \neq j$ and $\tau_{iis} = 1$. Thus, τ_{ijs} units of a variety in sector s must be shipped from location i for one unit to arrive at location j. In the interest of brevity, I ignore tariff revenues for the present and account for them when performing quantitative exercises.

Within my empirical context, N locations can be viewed as $N-1$ Chinese regions and "the rest

[40] Structures such as land and natural resources are nationally owned in China. Except for offshore petroleum resources, rents from the rest accrue to local governments.

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.[41] I assume that d_{hi} consists of both the hukou frictions (H_{hi}) and other types of resettlement 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 non-locals; therefore, $H_{hi} = H_i > 1$ for $h \neq i$ and $H_{hh} = 1$.

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 $\bar{L}_h$. Labor is internationally immobile.

3.2 Equilibrium

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

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

[41] In reality, the costs of hukou have three main aspects. First, 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, be married, or apply for a birth permit or visa application in one's hukou city. Second, workers without a local hukou may have lower bargaining power in the labor market and hence earn lower wages. Finally, 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 one's hukou city to consume those goods. In any case, 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 the empirical analysis or guidance from real data, iceberg migration costs, given their brevity and straightforward interpretation, seem a reasonable case to consider first. Alternatively, I 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 obtain a larger correction of the distributional impact of trade when abolishing the hukou system; the result of which is available upon request.

where w_i is the wage, r_i represents 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.[42] 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. Each worker's income equals her wage plus the transferred rents from structures:

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

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

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

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. A higher κ implies more homogeneous location preferences across workers and 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.

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

As the number of workers holding a hukou of a given location is fixed, by the law of large numbers, the total number h of 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 obtain:

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

Finally, the structure market clearing implies that the equilibrium rental rates can be determined by equating the demand for 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 for using equations (8), (9) and (10). Higher factor prices imply a higher factor supply but a lower factor demand. These two forces work against one another and pin down the equilibrium values of w_i and r_i.

3.3 Comparative Statics

How would the equilibrium change when tariffs or migration frictions change? I proceed as in Dekle et al. (2008) and solve the equilibrium in relative changes. Using the $\hat{x} \equiv x'/x$ notation, where x' is the value of x in the new equilibrium and x is the initial value, 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. Note 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.[43]

[43] Without taking into account structures, the last term drops out, and I obtain 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 in real income are proportional to changes in real wages. However, if employment increases are more concentrated in those sectors that use structures relatively more intensively, the 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 obtain:

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

The general equilibrium interactions in the model are too complex to allow for a closed-form expression of how tariff cuts impact regional employment. Nevertheless, I discuss two extreme cases in which labor is either perfectly mobile or immobile to link the quantitative and empirical analysis. With *perfect labor mobility* (no hukou or other migration frictions), the residential choices of workers do not depend on their hukou of 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 $\Psi = \sum_{j\in N}\pi_j\left(\hat{y}_j/\hat{P}_j\right)^{\kappa}$. 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 labor is, the more elastic the response of the regional labor supply[44] – which is consistent with my reduced-form findings in Section 2.

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 a Fréchet distribution, the expected utility of

[44] This can be seen from the quantitative results on the regional employment response to trade shocks, before and after hukou abolition, in Section 4.3.

workers holding hukou h conditional on living in location j is the same across all locations. A better location directly raises the utility that a worker can derive from that location, but it also attracts workers with lower amenity draws. The Fréchet distribution of amenities ensures that these two effects exactly cancel out each other.

Workers holding hukou from location h have higher utility if h (i) offers higher amenity-adjusted real income (captured by $A_h(\frac{y_h}{P_h})^\kappa$), and (ii) has a more stringent hukou system (captured by H_h). Intuitively, a high $A_h(\frac{y_h}{P_h})^\kappa$ implies that location h is an attractive region, and a high H_h implies that such "local premia" are more exclusive for local hukou holders. When hukou 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 workers. In other words, the hukou system can introduce welfare gaps among otherwise identical workers.

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

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

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 equation (27) can be decomposed into four parts. The first part has the same expression as in Arkolakis et al. (2012) and captures the impact of cost reductions on consumer welfare due to 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. 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, the expected utility of type-h workers must increase more than the real income.

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 until their welfare equalizes, even though regional income changes may be different. However, with migration frictions, this will not be the case. Intuitively, the relative change in expected utility across workers will depend solely on $\hat{\pi}_{hi}^{\frac{-1}{\kappa}}$. Consider workers holding hukou h relative to those with hukou h'; the former's 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 relative 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 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 for people to migrate. Therefore, given the value of $\frac{\hat{\pi}_{hi}}{\hat{\pi}_{h'i}}$, the smaller κ is, 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 the pre-liberalization year 2000 to quantify the general equilibrium effects of tariff reductions on trade, employment, and welfare 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

This subsection provides a summary of the sources and the construction of all parameters except for the hukou frictions, which will be discussed in greater 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 (using the same industry classification as in Section 2) because the data on labor distribution (L_{hi}) and wages (w_i) are available only at the province level. Tibet is also excluded from the analysis due to a lack of data on trade flows between Tibet and other Chinese regions. 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 hukou frictions (which I discuss further in Section 4.3). 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.[45] The sectoral trade elasticity θ_s

[45] In particular, the quantitative results change little when I set κ equal to 1.5, 3, and 4.5. These results are available

is calculated based on the method developed by Caliendo and Parro (2015). I provide estimation details in Appendix D. In the quantitative exercises that follow, I take tariff revenue into account and assume that 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 by 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. To do so, I use the 2002 Standard Make and Use Tables from the Bureau of Economic Analysis (BEA) and concord it to my 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 the 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 the 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.[46] 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 and 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 sectors and provinces, I set export shares 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 partialed 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 while

upon request. One reason that the results are not sensitive to different values of κ is that although a lower κ implies a higher elasticity of migration, it also implies lower pecuniary costs of the hukou system for a given spatial labor distribution (this will become clear in Section 4.2). As a result, the effect of hukou abolition changes little when κ changes.

[46]With a slight abuse of terminology, non-service sectors refer to 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.

holding China's aggregate trade deficit 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* represents the constructed rest of the world.

Initial labor distribution Within China, I obtain data on the population distribution from the Tabulation of 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, on the basis of 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 Quantifying Hukou Frictions

The hukou friction H_i is a critical parameter for understanding the complementarity between migration and trade policies. It is also of great policy interest per se, given its importance in affecting people's lives and 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 obtain:

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

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 sources of regional differences, and a stochastic error term. Specifically, the parameter 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 provincial capitals, and $D_{c.border}$ is a dummy indicating whether 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.[47] The last three controls together correspond to $\tilde{d}_{hi}$ in the model. Taking logarithms of equation (29) and using equation (30) to substitute for $\ln d_{hi}$, I obtain:

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

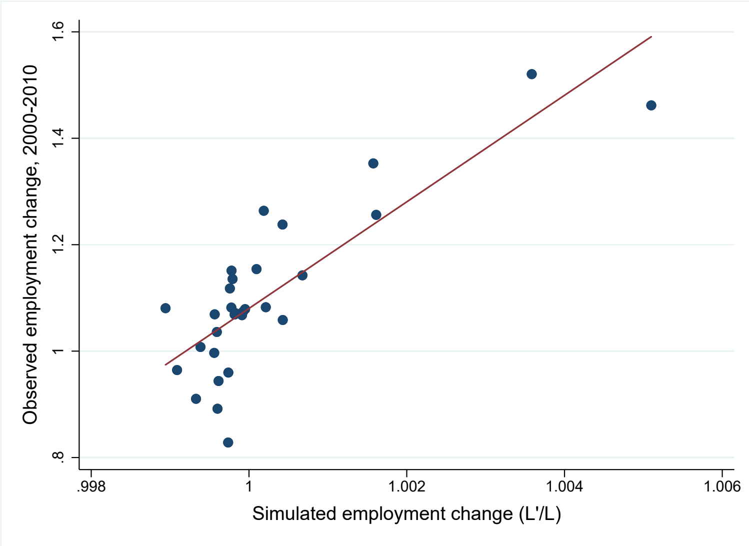
where $\tilde{\epsilon}_{hi} = \kappa(\epsilon_{hi} + \epsilon_{ih})$. I estimate equation (31) using OLS and obtain an R-squared of 0.64 and $\hat{\kappa\psi_l}$ of 0.29, which is positive and significant at the 1% level. When $\kappa = 2.54$, the elasticity of migration costs with respect to hukou is $\psi_l = 0.11$. The median hukou measure estimated in the data is 0.20, which suggests a hukou-related migration cost $H_i = 1.20$, i.e., the additional cost of living for migrant workers in a province with median hukou frictions is approximately 20% of their income.[48] The estimated coefficient changes little when I further control for ethnic and industry similarities between regions; these results are presented in Appendix D, Table A8. To the best of my knowledge, this is the first attempt in the literature to quantify the cost of the hukou system. Using the Chinese Household Income Project Survey (CHIPS), Chen et al. (2010) find that if hukou restrictions were removed in 2002, the average consumption of migrants would have risen by 20.8% after controlling for the impact of remittances. Although not directly comparable, my estimates are quantitatively in line with this result.

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 exercise, I introduce Chinese tariff changes from 2000 to 2005 into the model and fix hukou frictions at 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-abolition 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 of workers holding different hukou.

[47] 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)

[48] H_i for the median province is calculated as $\frac{1}{0.2^{0.29/2.54}} \approx 1.20$. In other words, migrants are willing to forgo $1 - \frac{1}{1.2} \approx 17\%$ of their income to obtain a local hukou.



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 employment changes, 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.[49] Moreover, because over two-thirds of the internal migration in China was across prefecture-level cities within the same province, the model also implies much higher migration costs, as most of the individuals live in their home province. In this sense, we can interpret the simulated employment changes as lower-bound results.[50]

Table 7 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 largest 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 one of 0.36%. The five provinces with the largest

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

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

Table 7: Regional Adjustments to Tariff Reductions

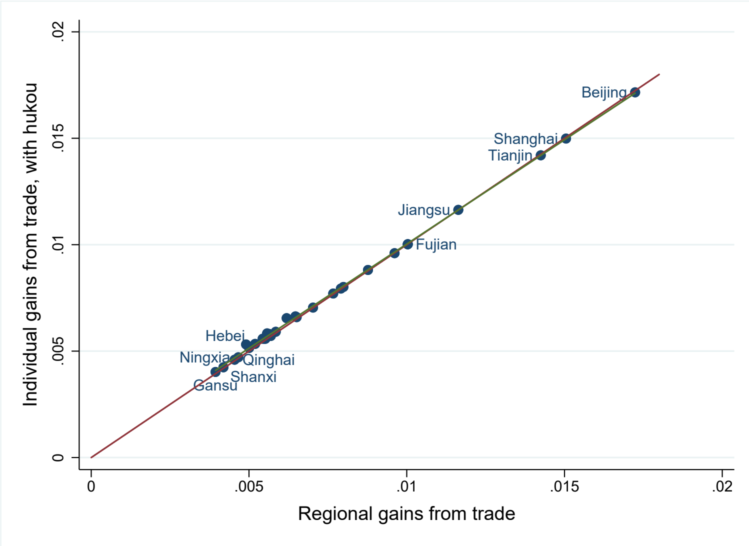
Province	(1) Employment	(2) Real Wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	0.51%	1.82%	2.75%	-2.01%	7.39%	3.44%	1.72%
Shanghai	0.36%	1.60%	2.22%	-1.80%	4.92%	4.20%	1.50%
Guangdong	0.16%	0.95%	1.26%	-1.73%	5.15%	7.34%	0.96%
Tianjin	0.16%	1.44%	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 the Chinese tariff structure changed from its 2000 to its 2005 level, holding hukou frictions constant. The nominal wage of the constructed rest of the world is the numeraire.

migration outflows are Hubei, 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 are notable. First, regional employment reacts less to trade shocks than do wages (regressing employment changes on wage changes yields a coefficient of 0.47), indicating substantial internal migration frictions in China. Second, a region with a larger real wage increase is not necessarily a region with a greater increase in employment. To see this, compare Fujian with Guangdong. The latter has a smaller rise in real wages in equilibrium, but its labor inflows rise twice as much. This suggests that migration frictions differ significantly across Chinese regions.

Column (3) of Table 7 presents changes in provincial real GDP (adjusted for the local price index). Every *region* gains from tariff reductions, but the magnitude differs significantly. Moreover, the most positively affected provinces were more developed regions before the tariff reductions, implying that trade liberalization has exacerbated regional inequality in China. Column (4) presents changes in the local price index. Beijing, Tianjin, and Shanghai experienced the largest price decreases, suggesting that they are the greatest beneficiaries of cheaper foreign imports. As shown in columns (5) and (6), total exports and imports increased in all provinces, with some experiencing a larger increase in total exports than in imports. There are two main economic forces behind changes in trade flows. The first relates to industry composition. When sectors with limited regional importance experience substantial tariff cuts, limited import competition is introduced at



Notes: This figure plots individual welfare changes in terms of hukou province (individual gains from trade) against the changes in provincial real income per capita (the sum of the first three components of welfare gains in equation (27), i.e., regional gains from trade). The green line is the linear fit, and the red line is the 45 degree line.

Figure 5: Individual and Regional Gains from Trade

the regional level, but a broad range of use sectors may benefit. This may boost local exports more than imports. The other force works through trade diversion. Input liberalization directly lowers the production costs in all regions in China. Therefore, it becomes optimal for a Chinese province to source more within China, which also suppresses growth in imports from the rest of the world.

The last column of Table 7 presents the change in welfare for individuals holding hukou from a given province. In the presence of tariff revenues, the welfare effects cannot be directly decomposed following equation (27), as changes in tariff revenues also affect 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 7, all Chinese regions (in terms of people's hukou status) gain from tariff reductions, but the distribution of the gains is uneven. Individuals with Beijing and Shanghai hukou experience welfare improvements of 1.72% and 1.50%, respectively, while individuals holding 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 the extent to which internal migration has alleviated the uneven welfare gains, Figure 5 plots individual welfare changes in terms of their hukou (individual gains from trade)

Table 8: Regional Effects of Hukou Abolition

Province	(1) Employment	(2) Real Wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	20,89%	-5,91%	13,15%	-1,42%	18,23%	-2,62%	-6,1%
Shanghai	19,70%	-5,55%	12,53%	-1,31%	15,43%	-3,00%	-5,6%
Guangdong	10,60%	-2,89%	7,34%	-0,89%	9,87%	-2,04%	-2,7%
Tianjin	5,90%	-1,60%	4,12%	-0,32%	4,70%	-0,97%	-1,4%
Hainan	3,69%	-0,55%	3,03%	-0,13%	2,67%	-0,56%	-0,1%
with the largest emp. decrease							
Guangxi	-2,84%	1,39%	-1,54%	0,22%	-4,26%	-0,49%	2,8%
Hunan	-3,86%	1,50%	-2,52%	0,69%	-6,96%	0,60%	3,1%
Sichuan	-4,48%	1,70%	-3,00%	0,89%	-6,74%	1,05%	3,6%
Anhui	-4,55%	2,12%	-2,63%	0,58%	-5,75%	0,08%	4,0%
Jiangxi	-5,11%	1,72%	-3,56%	0,69%	-6,92%	0,37%	3,9%
Weighted average							1.33%
Standard deviation							1.90%

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.

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 observe large increases in real income, most of the gains in booming areas accrue to locals due to the high costs of migration.

Effects of Tariff Reductions Given the Elimination of Hukou Frictions

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

Table 8 presents the regional adjustments following the abolition 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 employment increases of more than 10%. Jiangxi, Anhui, Sichuan, Hunan, and Guangxi are the provinces with the largest migrant outflows. The large migrant outflows in Anhui are likely (among other factors) driven by its geographic proximity to Shanghai, while the outflows in other provinces are likely due to their proximity to Guangdong. In expanding provinces, increased labor supply lowers real wages and boosts local GDP; because of the increased economic size, more intermediates are sourced locally, and hence, the local price index falls.

There are two forces that govern changes in trade flows. In a province experiencing expansion,

Table 9: Regional Adjustments to Tariff Reductions, without Hukou Frictions

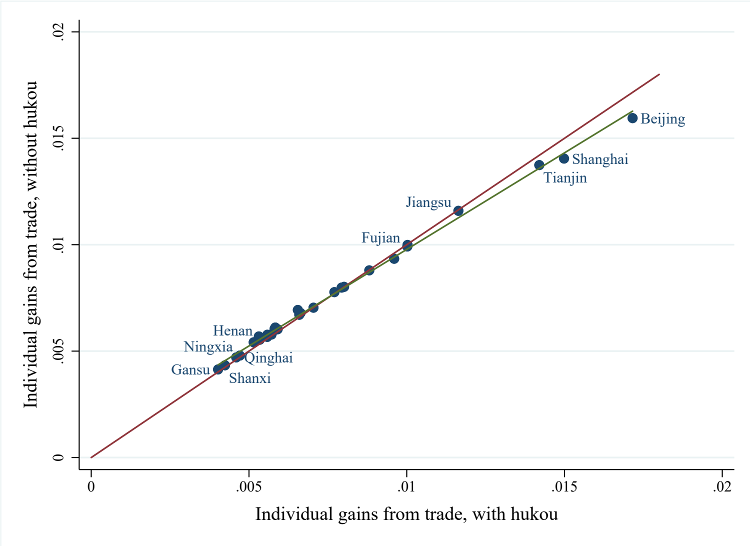
Province	(1) Employment	(2) Real Wage	(3) GDP	(4) Price	(5) Exports	(6) Imports	(7) Welfare
with the largest emp. increase							
Beijing	0,80%	1,70%	2,42%	-2,03%	7,89%	3,45%	1,59%
Shanghai	0,52%	1,50%	1,94%	-1,80%	5,09%	4,15%	1,40%
Tianjin	0,25%	1,39%	1,64%	-1,92%	5,97%	4,86%	1,37%
Guangdong	0,20%	0,93%	1,14%	-1,73%	5,10%	7,28%	0,93%
Fujian	0,09%	0,95%	1,09%	-1,64%	4,91%	7,42%	0,99%
with the largest emp. decrease							
Hebei	-0,08%	0,43%	0,44%	-1,56%	4,13%	8,41%	0,54%
Hunan	-0,09%	0,48%	0,48%	-1,44%	6,12%	5,41%	0,60%
Sichuan	-0,10%	0,50%	0,47%	-1,51%	3,87%	5,23%	0,61%
Anhui	-0,14%	0,54%	0,49%	-1,47%	4,16%	5,44%	0,69%
Jiangxi	-0,16%	0,41%	0,35%	-1,38%	3,84%	5,75%	0,57%
Weighted average							0.72%
Standard deviation							0.23%

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 the Chinese tariff structure changed from its 2000 to its 2005 level after eliminating hukou frictions. The nominal wage of the constructed rest of the world is the numeraire.

on the one hand, the increase in economic size implies increases in both exports and imports; on the other hand, increased economic size also means that the region gains cost advantages in producing a wider range of intermediates, which implies an increase in exports and a decrease in imports. Therefore, exports should always rise, while the changes in imports are ambiguous in provinces with worker inflows, and the opposite should be 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 8, I present the welfare changes. Although increased regional employment harms local hukou holders by bidding up 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 net migrant outflows unambiguously benefit from hukou reforms, those with hukou from migrant-receiving provinces may not necessarily lose. As shown in the last column of Table 8, the top expanding provinces' hukou holders experience significant welfare losses. However, of the 14 provinces that experience employment increases, the hukou holders' welfare decreases in only six. The average gain across provinces is 1.33%, which is nearly 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-abolition equilibrium, I repeat the first quantitative exercise by shocking the



Notes: This figure plots individuals' welfare changes from tariff reductions in terms of hukou provinces (individual gains from trade) with hukou abolition against the changes without hukou abolition. The green line is the linear fit, and the red line is the 45 degree line.

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

system with tariff changes. Table 9 presents the regional effects for the five provinces with the largest and smallest increases in employment. Comparing the results with those in Table 7, it is clear 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 7%. The absolute changes, however, remain small. One plausible explanation is 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 because the model still suggests very high migration frictions in levels even after abolishing the hukou system.

The last column of Table 9 presents the changes in welfare of hukou holders of a given province. Comparing the results to those in Table 7, it is clear 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. Provinces with net migration outflows experience larger employment decreases in response to trade shocks, and this is associated with greater welfare improvements.

The last two rows of column (7) of Table 9 report the weighted average and the standard deviation of welfare increases. The average gains from trade increase by approximately 2%, from 0.71% in the case with hukou frictions to 0.72%. Monte et al. (2015) find that allowing commuting across US counties improves the gains from a 20% reduction in domestic trade costs by 0.8%. Comparatively, the additional gains China could reap from trade liberalization when hukou frictions are eliminated are sizable.

The standard deviation of welfare gains across worker types decreases by 8%, from 0.24% to

0.23%.[51] Freer migration leads to greater labor adjustments across regions, which narrows the spatial wage gap. Freer migration also makes it easier for individuals to 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 negative 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. I first use a rich dataset on Chinese regional economies and a novel measure of hukou frictions to document four empirical patterns that suggest input-liberalization-induced labor reallocation across prefectures and the presence of migration frictions caused by the hukou system. Then, guided by the empirical findings, I set up 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 trade's negative distributional consequences. My results shed light on the benefits of eliminating migration frictions and the importance of accounting for these frictions 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. The existing literature suggests that migration frictions are pervasive in many countries, but this paper is the first to examine 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, 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 accounting for the interaction between migration frictions and other household characteristics.

[51]More precisely, the standard deviation declines from 0.2446% to 0.2257%.

References

Arkolakis, C., Costinot, A., and Rodríguez-Clare, A. (2012). New trade models, same old gains? *American Economic Review*, 102(1):94–130.

Artuç, E., Chaudhuri, S., and McLaren, J. (2010). Trade shocks and labor adjustment: A structural empirical approach. *The American Economic Review*, 100(3):1008–1045.

Artuç, E. and McLaren, J. (2012). Trade policy and wage inequality: A structural analysis with occupational and sectoral mobility. Working Paper 18503, National Bureau of Economic Research.

Autor, D. H., Dorn, D., and Hanson, G. H. (2013). The China syndrome: Local labor market effects of import competition in the united states. *The American Economic Review*, 103(6):2121–2168.

Autor, D. H., Dorn, D., and Hanson, G. H. (2016). The China shock: Learning from labor-market adjustment to large changes in trade. *Annual Review of Economics*, 8:205–240.

Blancher, N. R. and Rumbaugh, T. (2004). China: International trade and WTO accession. Working Paper 4/36, International Monetary Fund.

Bosker, M., Brakman, S., Garretsen, H., and Schramm, M. (2012). Relaxing hukou: Increased labor mobility and china's economic geography. *Journal of Urban Economics*, 72(2):252–266.

Brandt, L., Van Biesebroeck, J., and Zhang, Y. (2014). Challenges of working with the Chinese NBS firm-level data. *China Economic Review*, 30:339–352.

Bryan, G. and Morten, M. (2017). The aggregate productivity effects of internal migration: Evidence from Indonesia. Working Paper 23540, National Bureau of Economic Research.

Caliendo, L., Dvorkin, M., and Parro, F. (2015). The impact of trade on labor market dynamics. Working Paper 21149, National Bureau of Economic Research.

Caliendo, L., Opromolla, L. D., Parro, F., and Sforza, A. (2017). Goods and factor market integration: a quantitative assessment of the EU enlargement. Technical report, National Bureau of Economic Research.

Caliendo, L. and Parro, F. (2015). Estimates of the trade and welfare effects of NAFTA. *Review of Economic Studies*, 82(1):1–44.

Caliendo, L., Parro, F., Rossi-Hansberg, E., and Sarte, P.-D. (2014). The impact of regional and sectoral productivity changes on the us economy. Technical report, National Bureau of Economic Research.

Chan, K. W. (2009). The Chinese hukou system at 50. *Eurasian geography and economics*, 50(2):197–221.

Chan, K. W. and Buckingham, W. (2008). Is China abolishing the hukou system? *The China Quarterly*, 195:582–606.

Chen, B., Lu, M., and Zhong, L. (2010). Household consumption constrained by hukou system. *Economic Research Journal*, 1:62–71.

Cheng, M. (2007). How do we lose the freedom of movement: formation of China's household registration system in the 1950s and its evolution. *Modern China Studies*, 4(6):6.

Cheng, T. and Selden, M. (1994). The origins and social consequences of China's hukou system. *The China Quarterly*, 139:644–668.

Conley, T. G. and Topa, G. (2002). Socio-economic distance and spatial patterns in unemployment. *Journal of Applied Econometrics*, 17(4):303–327.

Coşar, A. K. and Fajgelbaum, P. D. (2013). Internal geography, international trade, and regional specialization. Working Paper 19697, National Bureau of Economic Research.

Dauth, W., Findeisen, S., and Suedekum, J. (2014). The rise of the East and the Far East: German labor markets and trade integration. *Journal of the European Economic Association*, 12(6):1643–1675.

Dekle, R., Eaton, J., and Kortum, S. (2008). Global rebalancing with gravity: Measuring the burden of adjustment. *IMF Staff Papers*, 55(3):511–540.

Dix-Carneiro, R. (2014). Trade liberalization and labor market dynamics. *Econometrica*, 82(3):825–885.

Dix-Carneiro, R. and Kovak, B. K. (2017). Trade liberalization and regional dynamics. *American Economic Review*, 107(10):2908–2946.

Eaton, J. and Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5):1741–1779.

Facchini, G., Liu, M. Y., Mayda, A. M., and Zhou, M. (2017). The impact of China's WTO accession on internal migration. *Mimeo*, pages 1–48.

Fajgelbaum, P. and Redding, S. J. (2014). External integration, structural transformation and economic development: Evidence from Argentina 1870-1914. Working Paper 20217, National Bureau of Economic Research.

Fajgelbaum, P. D., Morales, E., Serrato, J. C. S., and Zidar, O. M. (2015). State taxes and spatial misallocation. Working Paper 21760, National Bureau of Economic Research.

Fan, H., Li, Y. A., and Yeaple, S. R. (2015). Trade liberalization, quality, and export prices. *Review of Economics and Statistics*, 97(5):1033–1051.

Fan, J. (2015). Internal geography, labor mobility, and the distributional impacts of trade. *Mimeo, University of Maryland*, pages 1–49.

Galle, S., Rodríguez-Clare, A., and Yi, M. (2017). Slicing the pie: Quantifying the aggregate and distributional effects of trade. Working Paper 23737, National Bureau of Economic Research.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., and Topalova, P. (2010). Imported intermediate inputs and domestic product growth: Evidence from india. *The Quarterly journal of economics*, 125(4):1727–1767.

Goldberg, P. K. and Pavcnik, N. (2005). Trade, wages, and the political economy of trade protection: Evidence from the Colombian trade reforms. *Journal of International Economics*, 66(1):75–105.

Goldberg, P. K. and Pavcnik, N. (2007a). Distributional effects of globalization in developing countries. *Journal of economic Literature*, 45(1):39–82.

Goldberg, P. K. and Pavcnik, N. (2007b). The effects of the Colombian trade liberalization on urban poverty. In *Globalization and poverty*, pages 241–290. University of Chicago Press.

Grossman, G. M. and Helpman, E. (1994). Protection for sale. *The American Economic Review*, 84(4):833–850.

Harrison, A., McLaren, J., and McMillan, M. (2011). Recent perspectives on trade and inequality. *Annual Review of Economics*, 3(1):261–289.

Head, K. and Ries, J. (2001). Increasing returns versus national product differentiation as an explanation for the pattern of US-Canada trade. *American Economic Review*, pages 858–876.

Hou, L. (2014). Breakthrough and new projects for reform of household registration system. *Population Journal*, 6.

Ianchovichina, E. and Martin, W. (2001). Trade liberalization in China's accession to WTO. *Journal of Economic Integration*, 16(4):421–445.

Kambourov, G. (2009). Labour market regulations and the sectoral reallocation of workers: The case of trade reforms. *The Review of Economic Studies*, 76(4):1321–1358.

Kinnan, C., Wang, S.-Y., and Wang, Y. (2015). Relaxing migration constraints for rural households. Working Paper 21314, National Bureau of Economic Research.

Kovak, B. K. (2011). Local labor market effects of trade policy: Evidence from Brazilian liberalization. *Mimeo, University of California, Carnegie Mellon University*, pages 1–64.

Kovak, B. K. (2013). Regional effects of trade reform: What is the correct measure of liberalization? *The American Economic Review*, 103(5):1960–1976.

Lardy, N. R. (1991). *Foreign trade and economic reform in China, 1978-1990.* Cambridge University Press.

Lardy, N. R. (2005). Trade liberalization and its role in Chinese economic growth. In *India's and China's Recent Experience with Reform and Growth*, pages 158–169. Springer.

Li, L. (2011). Chinese laws and regulations cleanup work lasted for 10 years without interruption. `http://cwto.mofcom.gov.cn/article/n/201109/20110907757021.shtml`.

Li, Q., Junsheng, H., and Hong, D. (2001). *Comparative analysis of Xiagang, the Chinese Style of Laying Off Workers.* Tsinghua University Press.

Li, X. (2013). China as a trading superpower. *Mimeo, London School of Economics and Political Science*, pages 1–7.

McLaren, J. (2017). Globalization and labor market dynamics. *Annual Review of Economics*, 9:177–200.

McLaren, J. and Hakobyan, S. (2010). Looking for local labor market effects of NAFTA. Working Paper 16535, National Bureau of Economic Research.

Monte, F. (2015). The local incidence of trade shocks. *Mimeo, Georgetown University*, pages 1–59.

Monte, F., Redding, S. J., and Rossi-Hansberg, E. (2015). Commuting, migration and local employment elasticities. Working Paper 21706, National Bureau of Economic Research.

Montgomery, J. L. (2012). The inheritance of inequality: hukou and related barriers to compulsory education for China's migrant children. *Pacific Rim Law & Policy Journal*, 21:591.

Park, A., Wu, Y., and Du, Y. (2012). Informal employment in urban China. Technical report, World Bank, Washington, DC.

Ramondo, N., Rodríguez-Clare, A., and Saborío-Rodríguez, M. (2016). Trade, domestic frictions, and scale effects. *American Economic Review*, 106(10):3159–84.

Ran, T., Chen, S., Hui, W., and Guzhong, Z. (2011). Paradox of "lewis turning point" and coordinated reforms of China's hukou-land-fiscal system. *International Economic Review*, 3:120–148.

Redding, S. J. (2016). Goods trade, factor mobility and welfare. *Journal of International Economics*, 101:148 – 167.

Sun, M. and Fan, C. C. (2011). China's permanent and temporary migrants: differentials and changes, 1990–2000. *The Professional Geographer*, 63(1):92–112.

Sun, W., Bai, C., and Xie, P. (2011). The effect on rural labor mobility from household registration system reform in China. *Economic Research Journal*, 1:28–41.

Tian, Y. (2019). International trade liberalization and domestic institutional reform. *Mimeo, UCLA*.

Tombe, T. and Zhu, X. (2015). Trade liberalization, internal migration and regional income differences: Evidence from China. *Mimeo*, pages 1–42.

Topalova, P. (2007). Trade liberalization, poverty and inequality: Evidence from Indian districts. In *Globalization and Poverty*, pages 291–336. University of Chicago Press.

Topalova, P. (2010). Factor immobility and regional impacts of trade liberalization: Evidence on poverty from India. *American Economic Journal: Applied Economics*, 2(4):1–41.

United Nations (2013). World Population Policies 2013. Technical report, United Nations, New York, NY.

Wang, F. (2004). Reformed migration control and new targeted people: China's hukou system in the 2000s. *The China Quarterly*, 177:115–132.

Woo, W. T. (2001). Recent claims of China's economic exceptionalism: Reflections inspired by WTO accession. *China Economic Review*, 12(2):107–136.

Wu, K., Zhang, L., and Chen, X. (2010). The barrier of hukou reform: An analysis of the qualifications for the urban hukou. *Chinese Journal of Population Science*, (1):66–74.

Xue, L. and Zhang, H. (2001). Shaping up sustainable urban transport authorities in China: Status quo assessment and reforming solutions. Working paper, World Resources Institute.

Zhang, G. and Chen, Y. (2014). The evolution of China's household registration system reform. *Economist*, 5.

Zhang, S. and Guo, F. (2009). Analysis of household registration discrimination in urban labor market in northeast China. *China Rural Economy*, 2:34–45.

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 shape parameter θ_s and 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. Because 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 $G_{jis}(p) = 1 - F_{js}(\frac{\tau_{jis}c_{js}}{p})$ yields:

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

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 lowest cost supplier of variety ν can then be computed by integrating over equation (A3) for all possible ps:

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

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 lowest 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 lowest 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 obtain:

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

Thus, conditional on j being the lowest 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 or 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 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 a Fréchet distribution with shape parameter κ and 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. Because 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 that 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 yields 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 us:

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

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 of 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 represents 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 that $w_i L_i = \sum_{s\in K} w_i L_{is}$ 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 of 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 the real income of a region depends on how labor is adjusted spatially (as 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 in 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 the data and measures used in the empirical part of this paper (both Section 2 and Appendix C).

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-level city to have stronger commuting ties and better economic integration.[52]

The number of prefecture-level divisions is relatively stable over time, [53] 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 directly controlled municipalities and 333 prefecture-level divisions that cover all of 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 IO industry classification, and the four-digit ISIC Rev.3 (International Standard Industrial Classification of All Economic Activities, Rev.3) in Table A1. Further 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 1990, 2000, and 2010. The long form of the census, which covers 10% of the total population of China, asks respondents detailed information about their current address, employment status, hukou, and affiliation (among others). Data on current address and affiliation are then coded at the county- and three-digit industry level, respectively. The complete data are 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 of Population Census

[52]I treat each directly controlled municipality (*Zhixiashi*) as a local labor market (the four directly controlled municipalities, Beijing, Tianjin, Shanghai, and Chongqing, are provincial-level administrative divisions). In addition, I combine directly controlled county-level divisions (*Shen Zhixia Xingzheng Danwei*) with the prefectures they belonged to before becoming independent administrative units. Directly controlled county-level divisions are counties that are directly administrated by the provincial government. Four provinces had directly controlled county-level divisions in 2000: Henan (Jiyuan), Hubei (Xiantao, Qianjiang, Tianmen, and Shennongjia), Hainan (17 county-level divisions, for example, Zhanzhou, Qiongshan, and Wenchang) and Xinjiang (Shihezi). By 2012, Zhanzhou had been established as a prefecture-level city, while Qianghai had become part of Haikou city, and Xinjiang province had established three more new directly controlled counties. My empirical results are robust to the exclusion of those counties.

[53]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

of China (National Tabulation), the Tabulation of Population Census of China by County (Tabulation of Population Census by County, which begins in 2000) and the Tabulation of 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 than the other tabulations. Unless noted otherwise, tabulations are obtained from the China Statistical Yearbooks Database (CSYD). In addition to the tabulations mentioned above, I also used the 1%, 1%, 0.095%, and 0.1% micro samples of the complete census data for the years 1982, 1990, 2000, and 2010, respectively, and the 10% of the year 2005 1% population survey (mini census). These samples 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 samples allow richer interactions between variables, as they are identified at the individual level. However, they do not report individuals' county of residence for the years 2000 and 2005, making it impossible to calculate time-consistent prefecture employment. Another limitation of the data is their 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 1990, county-level employment is reported in the tabulation published by provinces. The tabulations of 21 provinces (out of 30)[54] 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 are reported in 92 two-digit CSIC1994 divisions. The original data were collected from China Data Online; they are also available in the CSYD.[55] For both sets of data, I compared the values with those recorded in other tabulations (when available) at various aggregations and correct mis-recorded values. When aggregating to different levels, I also ensure that the data match the aggregated data reported in the tabulations.[56] I then sum the

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

[55]Unfortunately, I cannot construct a panel of employment by prefecture and sector. Both the national- and county-level tabulations report employment in aggregated industries (one-digit Chinese Standard Industrial Classification; 20 sectors). Most of the employment data published by provincial administrators are by disaggregated industry (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.

[56]When there are mis-recorded values, I cross-check the number from the provincial tabulation (when available),

employment by county group to obtain 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 obtain the population of the prefecture above age 15, from both the full sample and the long form. I then use the ratio between the two figures to proxy for the sampling rates of each prefecture. The rates vary substantially 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 obtain 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 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 *working-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 used for the employment data.

Cost Shares

China became a member of the WTO on 11 December 2001. I therefore use the IO table for the nearest 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. Ultimately, 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 classi-

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 sum of employment of other counties in that prefecture.

fication, 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 obtain 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 cover the universe of all Chinese import and export transactions by month; they contain the values (in US dollars) of imports and exports at the 8-digit HS classification (approximately 7,000 product categories). The data are at the transaction level and contain 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.

Other Variables

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 obtain the real exchange rate, I first collect countries' nominal exchange rates with respect to the US 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 the logged real exchange rate from 2000 to 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 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 because 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 because they contain 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

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, 2000-2010	0.01	0.03	-0.11	0.23	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
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	0.53	0.28	0	1	31
Provincial hukou measure (not normalized)	0.19	0.09	0.03	0.34	31
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
$ln(age)$	3.15	0.57	0	4.55	61905

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.

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 ammunition, 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 in logged 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.

I calculate *GDP per capita* by prefecture by dividing the prefecture GDP by total population; both sets of data come from the city statistics of China Data Online.[57]

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

Appendix C Empirical Appendix

Table A3: Relevance of Trade Flows

(a) Imports and tariffs

	Import Values		Unit Values		Imported Varieties	
	All Products	Intermediates	All Products	Intermediates	All Products	Intermediates
	(1)	(2)	(3)	(4)	(5)	(6)
Output tariff $ln(1+t_k)$	-2.44***	-2.22***	-0.15	0.29**	-6.84***	-5.10***
	(0.63)	(0.81)	(0.12)	(0.14)	(1.07)	(1.15)
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FEs	Yes	Yes			Yes	Yes
HS6-country FEs			Yes	Yes		
Observations	35,457	26,380	333,038	258,411	35,457	26,380
R-squared	0.87	0.86	0.92	0.93	0.84	0.94

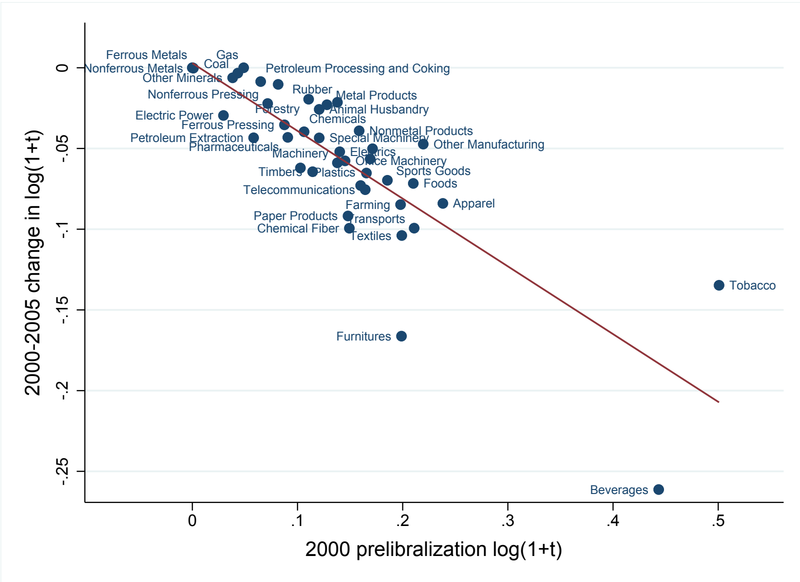
Notes: Columns (1) and (2) report coefficients on tariffs from HS6 product-level regressions of logged import value on logged tariffs ($ln(1+t_k)$), HS6 product fixed effects and year fixed effects. An observation is a HS6-year. Columns (3) and (4) regress logged unit value on logged tariffs, HS6-country fixed effects and year fixed effects. Unit values are computed for each HS6-country pair, and each observation is a HS6-country-year. Columns (5) and (6) report coefficients on tariffs from HS6 product-level regressions of the logged number of varieties on logged tariffs, HS6 product fixed effects, and year fixed effects. A variety is defined as an HS6-country pair, and an observation is a HS6-year. In all regressions, tariffs are at the HS6 level. Columns (1), (3), and (5) use all products, and columns (2), (4) and (6) report coefficients for intermediates (defined acccording to the United Nations Broad Economic Categories (BEC) classification). Regressions are run from 2000 to 2006. Processing imports are excluded from the analysis. Robust standard errors in parentheses are clustered at the HS6 level. *** p<0.01, ** p<0.05, * p<0.1.

(b) Regional results

	Δ Import Values		Δ Imported Varieties	
	All Products	Intermediates	All Products	Intermediates
	(1)	(2)	(3)	(4)
Regional input tariff cuts (ΔRIT)	28.75***	27.57***	10.93**	14.12***
	(8.47)	(9.98)	(4.86)	(3.91)
Other Tariff Controls	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes
Observations	306	302	306	302
R-squared	0.31	0.28	0.41	0.39

Notes: Columns (1) and (2) report coefficients on regional input tariff cuts from the prefecture-level regression of the logged difference in total imports between 2006 and 2000 on regional input tariff cuts (ΔRIT), regional output tariff reductions, external tariff reductions, province fixed effects and logged prefecture imports in the year 2000. Columns (3) and (4) regress the logged difference in the number of imported varieties between 2006 and 2000 on regional input tariff cuts (ΔRIT), regional output tariff reductions, external tariff reductions, province fixed effects and the (log) number of imported varieties in the year 2000. A variety is defined as an HS6-country pair, and an observation is a prefecture. Columns (1), (3) use all products, and columns (2), (4) report coefficients for intermediates (defined according to the United Nations Broad Economic Categories (BEC) classification). Processing imports are excluded from the analysis. Robust standard errors in parentheses are clustered at the province level. *** p<0.01, ** p<0.05, * p<0.1.

[57] 284 prefectures have the data available.



Notes: This figure plots logged tariff changes over the 2000-2005 period against the log year-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 A7: Tariff Changes and Pre-liberalization Tariff Levels

Table A4: Effect of Input Tariff Cuts on Local Employment: Robustness I

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Regional input tariff cuts (ΔRIT)	5.10***	4.40**	5.14***	3.18**	3.44**	4.45**	5.07***
	(1.65)	(1.89)	(1.64)	(1.39)	(1.48)	(1.63)	(1.67)
Pre-liberalization employment trend		0.06					
		(0.09)					
Changes in state-owned employment shares			-0.01				
			(0.01)				
Real exchange rate				1.26**			
				(0.57)			
Initial share of employment, real estate					10.60***		
					(3.18)		
Capital dummy						0.10***	
						(0.02)	
Drop Special Economic Zones							Yes
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	330
R-squared	0.66	0.67	0.66	0.67	0.69	0.69	0.66

Notes: The dependent variable is the 10-year change in logged prefecture employment. The sample contains 333 prefectures and four directly 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-of-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Regional input tariff cuts (ΔRIT)	-1.18	-4.56*	-0.78	-3.33	-1.86	-0.89	-0.67
	(2.02)	(2.40)	(2.05)	(2.16)	(1.98)	(2.01)	(2.07)
Regional input tariff cuts × Hukou	18.45***	24.13***	17.66***	20.22***	15.84**	16.26**	14.90***
	(6.05)	(6.61)	(5.94)	(7.20)	(6.42)	(6.11)	(5.32)
Pre-liberalization employment trend		0.05					
		(0.15)					
Changes in state-owned employment shares			-0.04				
			(0.02)				
Real exchange rate				1.81			
				(1.43)			
Initial share of employment, real estate					5.00		
					(5.41)		
Capital dummy						0.05	
						(0.05)	
Drop Special Economic Zones							Yes
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	337	330
R-squared	0.69	0.71	0.70	0.70	0.72	0.71	0.69

Notes: The dependent variable is the 10-year change in logged prefecture employment. The sample contains 333 prefectures and four directly 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-of-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

Table A6: Alternative Hukou Friction Measures

	Simple Ratio (1)	Province FE (2)	Prefecture Measures (3)	Inverse s.d. Weighted (4)	Exclude *mig.* < 30 (5)	Family Ties (6)	Rural Origin (7)	Hukou Dummy (8)
Regional input tariff cuts (ΔRIT)	-0.66	3.46**	-4.30*	-1.65	-2.23	-0.11	-0.20	3.85***
	(2.39)	(1.28)	(2.15)	(1.33)	(2.60)	(3.42)	(2.47)	(1.15)
Regional input tariff cuts × Hukou	15.01**	12.56***	23.96***	24.76***	18.43***	13.91*	15.96**	6.56***
	(5.69)	(3.55)	(6.40)	(4.13)	(6.63)	(8.14)	(7.00)	(1.68)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337	337	337	337	337	329	335	337
R-squared	0.68	0.68	0.70	0.69	0.69	0.70	0.68	0.69

Notes: This table presents the robustness checks on changes in regional employment using alternative hukou friction measures. 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-of-period prefecture employment. *** p<0.01, ** p<0.05, * p<0.1.

Appendix D Calibration Appendix

Estimating Trade Elasticities

I calculate the 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 obtain:

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

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} are orthogonal to tariffs t_{ijs}, all components of $\tilde{\tau}$ except ϵ_{ijs} cancel out, and the logged 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 the 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. Because I am estimating θ_s for more disaggregated industries than 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 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 are 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 A7 presents the estimated θ_s and heteroskedasticity-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.[58] Two industries, mining and dressing of ferrous metals and polytechnic services, have no variation in bilateral tariffs to identify

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

Table A7: 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

the θ_s (if the tariff data only vary by importing countries, the logged 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 with 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 A8 provides the regression results of equation (31) and robustness checks. Column (1) reports the baseline 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 account for any migration frictions due to the regional difference in the 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 other) of two provinces. I use the 1% random sampled data of the 3rd Population Census from 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 the 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. Nevertheless, the estimated coefficient 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 additional controls. Therefore, I use the baseline estimate to calculate income costs associated with frictions.

Solving the Model in Relative Changes

In this subsection, I present a step-by-step description of 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 the local price index, $\hat{P}_i$, using $\hat{P}_i = \prod_{s\in K} \hat{P}_{is}^{\beta_s}$ and

Table A8: Quantifying Hukou Frictions

	Main	Robustness	
	(1)	(2)	(3)
$\log(Hukou_p * Hukou_i)$	0.29***	0.29***	0.36***
	(0.10)	(0.10)	(0.11)
Distance	-1.12***	-0.88***	-0.89***
	(0.20)	(0.23)	(0.23)
Common Border	2.20***	2.31***	2.33***
	(0.23)	(0.23)	(0.23)
Ethnic Distance		-0.69**	-0.67**
		(0.27)	(0.27)
Industry Distance			1.59
			(1.07)
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 baseline estimation used for constructing hukou frictions in Section 4.2. In columns (2) and (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.

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 guesses 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 whether equation (22) holds. If not, adjust the guess of $\hat{\boldsymbol{r}}$ and return to step 1 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 whether the vector of changes in labor supply equals $\hat{\boldsymbol{L}}$. If not, adjust the guess of $\hat{\boldsymbol{L}}$ and return to step 1 until they equalize.