

# Place-based Policy, Migration Barriers, and Spatial Inequality\*

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## Abstract

How should governments reduce spatial inequality—by attracting firms to disadvantaged regions or helping people reach thriving ones? This paper studies Vietnam’s implementation of both policies, place-based tax incentives in 2003 and relaxation of the household registration system (*Ho Khau*) in 2005. I embed these shocks in a dynamic spatial general equilibrium model with firm life cycles and endogenous public services, estimating key elasticities from policy-induced variations. The combined policies raise aggregate welfare by 1.3% and reduce spatial inequality by 0.7%. Migration reform alone reduces spatial inequality three times more than tax incentives. However, the migration policy’s impact depends critically on destination targeting: facilitating migration to the largest cities generates minimal redistribution, while reducing barriers to other destinations cuts spatial inequality by 1.3%, nearly double the combined policy effect. These findings suggest that strategic policy design matters more than choosing between place-based and people-based approaches.

*Keywords:* Tax Incentives, Migration, Ho Khau, Policy Interaction

*JEL codes:* O18, O25, R58, H25, H70

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## 1 Introduction

Countries worldwide implement seemingly contradictory policies regarding economic development and worker mobility. The U.S. invests billions annually in Opportunity Zones to draw businesses to disadvantaged areas, but many urban centers limit housing development, hindering worker mobility to available opportunities. China creates Special Economic Zones for business development but maintains *Hukou* restrictions on urban migration, though it selectively relaxes these barriers (Lu et al., 2019; An et al., 2024). This pattern raises a question: should governments attract firms to disadvantaged regions through place-based incentives, or help workers reach jobs by easing migration barriers?

In practice, both approaches are often implemented together, yet the economic literatures on place-based policy and internal migration have largely developed in isolation. India runs backward district tax incentives while limiting urban access to migrants (Hasan et al., 2021; Imbert and Papp, 2020). Brazil pairs western-region subsidies with highway investments (Pellegrina and Sotelo, 2024; Morten and Oliveira, 2023). Despite this widespread policy coordination, two questions remain unanswered: What are the welfare effects when both policies are implemented simultaneously? How do they reinforce or offset one another?

I answer these questions by analyzing Vietnam's nationwide policy reforms through a dynamic spatial general equilibrium model that embeds firm life cycles, endogenous local public goods, and policy-dependent migration costs. Vietnam offers an ideal laboratory for this analysis. It implemented place-based tax incentives in 2003, offering age-dependent enterprise income tax reductions to firms in disadvantaged districts, followed by *Ho Khaу* (household registration) reforms in 2005 that reduced internal mobility barriers.

Analyzing these policy interactions requires confronting analytical challenges. Place-based policies often feature age-dependent firm incentives that are common worldwide but understudied due to the lack of firm dynamics in spatial general equilibrium models (Slattery and Zidar, 2020). Migration policies, in turn, interact with firm dynamics and fiscal externalities that existing frameworks ignore. The key missing element is how firm life-cycle decisions, migration responses, and fiscal policy interact in general equilibrium.

I therefore develop a dynamic spatial general equilibrium model that incorporates firm life cycles with age-dependent policy responses and endogenous local public goods provision. This framework extends Caliendo and Parro (2020) by adding entrepreneurial life-cycle decisions, which are essential for analyzing age-graded tax incentives, and endogenizing local public goods provision to capture fiscal spillovers when tax incentives affect government revenue.

To discipline the model, I estimate key structural parameters using policy variations and firm- and household-level data. I exploit tax policy variation across space, time, and firm age to identify the firm survival elasticity, and leverage differential changes in migration patterns following the Ho Khaу reform to identify changes in migration costs.

My analysis yields three main findings. First, Vietnam's combined implementation of place-based tax incentives and migration reform raises aggregate welfare by 1.25% and lowers the spatial Gini of household expected lifetime utility by 0.71%. Disaggregating the policy package reveals stark contrasts. Tax holidays raise the number of firms in disadvantaged districts by 22% but shrink local public-service quality by 1% due to revenue losses from tax incentives, yielding only a 0.21% decline in spatial inequality. These findings mirror those of [Slattery \(2025\)](#), who show that U.S. states' discretionary firm-specific subsidies mostly shuffle businesses across state lines and do little to narrow regional disparities.

Second, the Ho Khau reform redistributes welfare nearly three times more effectively than tax incentives, reducing the spatial Gini by 0.59%. The combined package outperforms each policy alone. However, they partially substitute for each other, as the aggregate and distributional gains are less than the sum of their individual effects, since each policy addresses some distortions already tackled by the other.

Third, policy design matters more than the type of instrument, as I further analyze the results of the Ho Khau reform. Allowing mobility into non-major cities nearly doubles the redistribution achieved by both policies together. In contrast, easing entry into metropolitan areas yields little redistribution and, in some parameter specifications, increases spatial inequality due to amplifying agglomeration forces.

This paper contributes to three literatures. I provide the first systematic comparison of place-based and people-based spatial policies using a unified dynamic model. This approach builds on growing studies examining policy interactions, including [Caliendo et al. \(2021\)](#) studying welfare effects from the EU expansion by reducing both trade and migration costs while [Tombe and Zhu \(2019\)](#) and [Fan \(2019\)](#) examine similar effects in China. However, these papers focus on trade-migration policy interactions rather than place-based tax and migration policies, and do not examine the endogenous and dynamic decisions of firms in general equilibrium.

Second, I contribute to the large literature on place-based policies that examine how location-specific incentives affect job creation and local development ([Neumark and Simpson, 2015](#); [Kline and Moretti, 2014](#); [Austin et al., 2018](#); [Busso et al., 2013](#); [LaPoint and Sakabe, 2021](#)).<sup>1</sup> In developing countries, [Chaurey \(2017\)](#) examines the effects of tax incentives for backward regions in India, while [Heblich et al. \(2022\)](#) investigates how the historical development of manufacturing facilities influences long-term economic outcomes in remote areas of China. The closest paper is [Atalay et al. \(2023\)](#), who study the aggregate and distributional impacts of investment incentives in Turkey, building on [Kleinman et al. \(2023\)](#). Relative to their work, my dynamic model incorporates endogenous firm entry and exit, as well as public services derived from tax revenues.<sup>2</sup> Furthermore, I estimate the key structural parameter—the firm stay elasticity—using a model-consistent approach that exploits tax policy variation across space, time, and firm age.

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<sup>1</sup>Recent theoretical advances by [Fajgelbaum and Gaubert \(2020\)](#) and [Fajgelbaum and Gaubert \(2025\)](#) provide frameworks for optimal place-based policy design.

<sup>2</sup>[Parro and Desmet \(2025\)](#) provides a recent review of the growing literature on dynamic spatial models.

Third, I extend the migration literature by demonstrating the heterogeneous effects of different large-scale policy designs. I show how targeted design can unlock the pro-poor potential of mobility reforms or exacerbate spatial inequality due to agglomeration.<sup>3</sup> The Ho Khau cost estimates also shed light on how household registration systems, such as China’s Hukou regime, shape labor mobility in developing economies (Bryan and Morten, 2019; Imbert and Papp, 2020). The closest paper is Pellegrina and Sotelo (2024), who examine the effects of reducing migration barriers in Brazil and builds on the dynamic model in Allen and Donaldson (2022). Similar to their approach, I rely on quasi-experimental variation to identify structural parameters in a model-consistent and transparent way. However, I examine interactions with place-based policies and, crucially, allow for firm dynamic response to changes in migration costs.

The remainder of the paper proceeds as follows. Section 2 provides institutional background on Vietnam’s spatial policies. Section 3 describes the data and presents motivating empirical evidence. Section 4 develops the dynamic spatial general equilibrium model. Section 5 discusses the estimation strategy and presents parameter estimates. Section 6 evaluates the impacts of actual policies. Section 7 explores counterfactual policy combinations and traces the efficiency-equity frontier. Section 8 concludes.

## 2 Institutional Context: Vietnam’s Spatial Policies

Vietnam’s rapid economic transformation between 2000-2019 coincided with remarkable convergence in per capita income across provinces. As real Vietnam GDP per capita rose from 6% to 13% of U.S. levels, the Gini coefficient of province-level GDP per capita declined steadily from 0.40 to 0.25 (Figure 1). This convergence period also coincided with two major spatial policy reforms that provide a unique opportunity to study how place-based incentives and migration liberalization interact in shaping regional development. This section describes the institutional context of these reforms.

### 2.1 Enterprise Income Tax Incentives

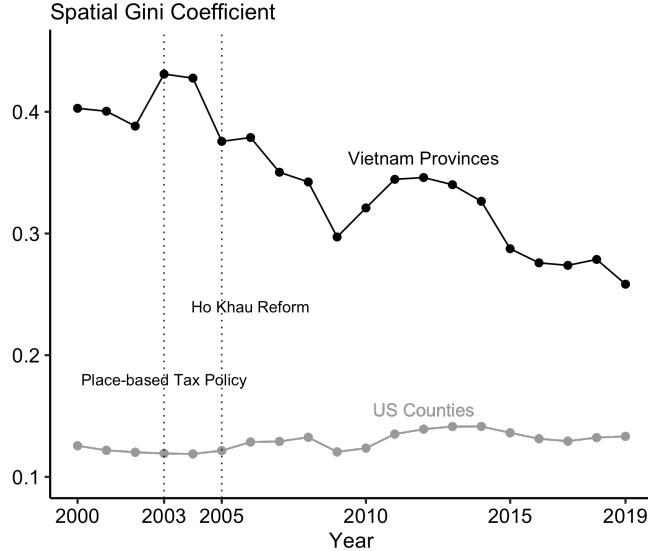
Vietnam’s initial place-based tax policy was established through Decree No. 51/1999/NĐ-CP of July 8, 1999. This early framework created the foundational three-tier classification system, categorizing Vietnam’s districts into advantaged areas (A), areas with socio-economic difficulties (B), and areas with special socio-economic difficulties (C). Under the 1999 policy, firms faced a standard tax rate of 32%, but those locating in B districts received a reduced rate of 25%, while C district firms paid only 20% (Figure 2, left panel).

The 2003 Enterprise Income Tax Law Reform, enacted through the Law on Enterprise Income

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<sup>3</sup>Other studies examine the allocation effects from easing internal mobility barriers, including studies in China (Wang et al., 2021; Wu and You, 2024; Imbert et al., 2022; Kinnan et al., 2018), and other reductions in migration barriers (Lagakos et al., 2023; Morten and Oliveira, 2023).

Figure 1: Gini Coefficients of Regional GDP per Capita in Vietnam and the United States



Sources: Vietnam data from [Trinh \(2019\)](#) based on General Statistics Office provincial GDP statistics. U.S. data from Bureau of Economic Analysis

Tax No. 09/2003/QH11 from the National Assembly and Decree No. 164/2003/NĐ-CP,<sup>4</sup> fundamentally simplified and enhanced the incentive structure. The government maintained the three-tier district classification system but revised some designations, as illustrated in the spatial distribution in Figure 3a. These classifications, based on undisclosed criteria yet correlate strongly with 1999 poverty rates—averaging 28% in A districts versus 65% in C districts—population density, and ethnic minorities, as documented in table A1.

Under the new regime, all firms faced a reduced base rate of 28% (down from 32%), but firms locating in disadvantaged areas received additional age-dependent benefits that varied by location (Figure 2, right panel). Specifically, new firms in B districts paid no profit tax for two years, then 10% for years 3-8, 20% for years 8-10, and 28% thereafter. Firms in C districts received even more generous treatment: no tax for two years, then 7% for years 3-8, 15% for years 8-10, and 28% subsequently. This age-dependent feature is a common yet understudied feature of place-based policies around the world<sup>5</sup>.

These tax differentials represent substantial economic incentives. Enterprise income taxes accounted for nearly 40% of Vietnamese government tax revenue in 2000, exceeding value-added tax (22%) and personal income taxes (2%) ([Shukla et al., 2011](#)). For a firm choosing between an A district and a C district, the tax savings over a ten-year period could reach 15-20 percentage points of cumulative profits—a significant factor in location decisions.

<sup>4</sup>Implemented alongside Decree No. 88/2004/TT-BTC. See Law on Enterprise Income Tax No. 09/2003/QH11 for legislative details.

<sup>5</sup>For examples, see [Hasan et al. \(2021\)](#) for India, the Regional Assistance Zones (ZAFR) for France, [Slattery and Zidar \(2020\)](#) for the US

Figure 2: Enterprise Profit Tax Varies over Time, across Districts, and Firm Ages



Sources: Decrees No. 51/1999/NĐ-CP, 164/2003/NĐ-CP and 88/2004/TT-BTC. Notes: The 2003 reform maintained the three-tier district classification while introducing age-dependent tax rates. Firms in disadvantaged areas (B and C districts) received progressively larger benefits in their early years of operation.

The policy design included several features that enhance its credibility as a source of variation. First, district classifications showed remarkable stability, with 82% of districts maintaining their 1999 designations through 2003, as shown in Figure A2. The main empirical analysis focuses on districts with stable classifications to ensure identification comes from the policy reforms rather than endogenous relabeling.

Second, the high costs of business closure and restart significantly limited firms' ability to exploit tax incentives through strategic dissolution and reentry. Vietnamese regulations require extensive documentation for business closure, including debt clearance certificates, asset liquidation records, and formal approval from multiple government agencies—processes designed explicitly to prevent tax evasion and capital flight. Second, simply changing business names while maintaining the same ownership structure does not qualify for new firm tax benefits, as tax authorities track beneficial ownership across corporate restructuring.<sup>6</sup>

The policy's treatment of multi-establishment firms adds additional complexity but does not undermine the coming model and empirical analysis. In 2000, 99% of Vietnamese firms operated single establishments (Table A2), limiting multi-plant concerns. For the small fraction of multi-location firms, those operating across districts within a single province pay taxes at the provincial level, while firms spanning multiple provinces must file separate returns for establishments in tax-advantaged areas.<sup>7</sup> This treatment ensures that location-specific incentives apply to actual business operations rather than mere administrative headquarters.

<sup>6</sup>See Section III Article 1 of Decree 128/2003/TT-BTC and Item 6.1.2 of Decree 88/2004/TT-BTC for specific regulatory provisions.

<sup>7</sup>See Section III Article 1 of Decree 128/2003/TT-BTC and Article 11 of Decree 126/2020/NĐ-CP.

Figure 3: District and Provincial Tax Classifications



(a) Map of Tax Policy Labels

(b) Map of Tax Policy Labels at Province level

*Sources:* Panel (a): District classifications from Decrees 164/2003/NĐ-CP and 88/2004/TT-BTC. Panel (b): Author's calculations based on district classifications aggregated to provincial level using 1999 population shares.

*Notes:* Panel (a) displays Vietnam's district-level tax policy classifications as of 2003. Panel (b) shows provincial-level aggregations where provinces are classified based on the population-weighted share of disadvantaged (B and C) districts within each province.

## 2.2 2005 Ho Khau Reform

The Ho Khau system is Vietnam's household registration framework that determines where individuals are officially recognized as residents. Under this system, every Vietnamese citizen must maintain a registered address that serves as their legal residence for administrative purposes. This registration status governs access to essential public services and benefits in their registered location, including public healthcare, education for children, social insurance, bank credit, and various government programs.

Vietnam's Ho Khau system, similar to China's Hukou registration, historically restricted internal migration by linking these services to permanent residence status in one's registered location.<sup>8</sup> Prior to 2005, obtaining permanent residency in a province different from one's birth province required meeting complex bureaucratic requirements, including relocation certificates from origin provinces and property ownership documentation at the destination province that often created circular requirements for migrants (Liu and Meng, 2019).

In 2005, Decree 108/2005/NĐ-CP fundamentally reformed this system by simplifying the path to permanent residency. The reform eliminated most bureaucratic prerequisites and introduced a path to permanent residency solely based on proof of residence. Migrants could now apply for permanent status by demonstrating legal residence through property certificates, official residence

<sup>8</sup>The Ho Khau policy is less strict than the Hukou policy because, unlike the Hukou, it does not restrict individuals to the birth sector.

confirmations from local authorities, or formal lease agreements.

Critically, the reform created differential migration cost reductions across Vietnam's provinces. While the policy reduced migration barriers nationwide, it maintained additional requirements for Vietnam's five centrally administered cities (Hanoi, Hai Phong, Da Nang, Ho Chi Minh City, and Can Tho)<sup>9</sup>. Migrants to these major urban centers (designated A\* provinces) must demonstrate continuous residence for at least one year, whereas no such requirement applies to other provinces.<sup>10</sup>

This institutional feature generates spatial and time variations in the magnitude of migration cost reductions. The reform substantially lowered migration costs to all provinces but created a smaller reduction for moves to the five major cities (A\* provinces) compared to other destinations. This differential treatment provides identifying variation for estimating migration costs associated with the Ho Khau policy in the spatial equilibrium model.

### 2.3 Fiscal Redistribution Policy

Vietnam operates an extensive fiscal redistribution system that transfers resources from economically advantaged to disadvantaged provinces. The central government adjusts both revenue retention rates and direct transfers based on provincial development levels, creating systematic differences in effective fiscal capacity across regions.

For analyzing fiscal redistribution alongside migration and place-based policies, I aggregate the district-level tax classifications to the provincial level using 1999 population shares of C districts within each province (Figure 3b). This aggregation is necessary because migration and fiscal data are only available at the provincial level. The aggregation maintains similar distributional properties to the district-level classifications while enabling analysis of migration flows and fiscal transfers.

Figure 4 illustrates the magnitude of these transfers using the provincial classifications described above including A\*, A, B, C, based on official Ministry of Finance records in 2003, 2006, and 2015.<sup>11</sup>. On average, the most disadvantaged provinces (C) retain 100% of locally generated revenue while receiving central transfers worth approximately 500% of their local revenue in 2003 which later dropped to 100% in 2015. Intermediate provinces (B) retain about 93% of revenue and receive transfers worth 160% of local revenue. In contrast, the most advantaged provinces (A\*) retain only 65-75% of locally generated revenue and receive minimal transfers (5-10% of local revenue).

This redistribution system creates additional equilibrium effects that must be accounted for when evaluating the main spatial policies of interest. The fiscal transfers partly offset the development disadvantages that the tax incentives aim to address, while also affecting the relative attractiveness of different locations for both firms and workers. I treat these transfers as an observed policy instrument and incorporate their effects in the equilibrium analysis.

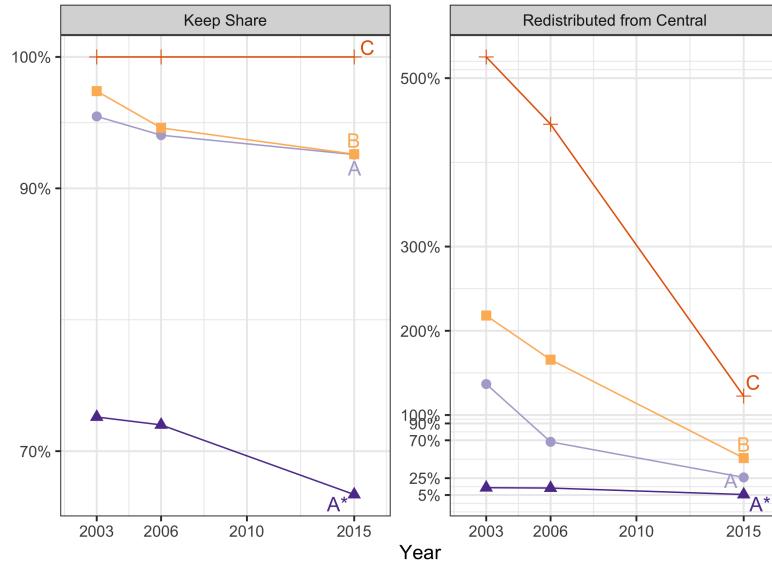
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<sup>9</sup>Ha Tay was merged into Ha Noi in 2008 and thus is considered part of Ha Noi in this study

<sup>10</sup>While Decree 108/2005/NĐ-CP requires a continuous stay of at least three years, the Residence Law of 2006 81/2006/QH11 reduces the requirement to at least one year.

<sup>11</sup>Ministry of Finance, Decisions 757/2003/QD-BTC, 4526/QD-BTC, and 3137/QD-BTC.

Figure 4: Fiscal Redistribution Policy



Sources: Ministry of Finance, Decisions 757/2003/QD-BTC, 4526/QD-BTC, and 3137/QD-BTC.

Notes: The A, B, and C labels are at the provincial levels, constructed using the 1999 population share in C districts within each province. See Figure 3b for a map of these provincial labels.

### 3 Data and Motivating Facts

This section presents the data sources and two motivating facts. I document how the enterprise income tax reforms affected firm location decisions and how the Ho Khau migration reform influenced household mobility patterns.

#### 3.1 Data Sources

**Establishment-Level Data.** The primary firm-level analysis draws on annual enterprise surveys conducted by Vietnam's General Statistics Office (GSO) covering 2000 to 2019. This survey is mandatory for all registered firms, providing detailed information on firm location, employment, and industry classification.

Following McCaig et al. (2022), I construct consistent firm identifiers and ISIC industry codes to track firms over time. Starting in 2004, single-location household businesses employing fewer than ten workers became exempt from registration requirements, allowing them to operate informally without survey reporting or tax obligations.

Despite this exemption, many small enterprises register voluntarily, as evidenced by the firm size distribution in Figure A3. The omission of the informal sector from our establishment data has minimal impact on measuring policy effects for several reasons. First, McCaig et al. (2022) and McCaig and Pavcnik (2021) document that most private firms begin as formal entities, with

only 2% of informal firms transitioning to formality within two years. Second, while informal employment represents a substantial share of total employment, [Cling et al. \(2011\)](#) estimates that informal activities contribute only 20% of GDP. Third, the identification strategy in section 5 relies primarily on variation in firm behavior across ages and locations among already-registered firms, rather than relying on firm entry, which could be contaminated by informal-to-formal transitions.

**Household Migration Data.** To analyze migration responses to policy changes, I use the Population and Housing Census data from 1999, 2009, and 2019. These censuses provide representative migration flows for Vietnam's 60 provinces. Following the GSO definition, I classify individuals as migrants if their current province differs from their residence five years prior. While this definition may underestimate total mobility by excluding seasonal migration or return migration within five years, it provides a consistent measure of permanent migration decisions that align with the Ho Khau system's focus on permanent residence status.

**Inter-provincial Trade and Geographic Data.** I use inter-provincial trade flows data for 2000 from [JICA \(2000\)](#). I supplement these trade flows with truck distance calculations between all province pairs using ArcGIS network analysis tools and the 1999 IPUMS administrative boundary maps. These data allow me to examine the relationship between trade costs and geographic distance, providing essential parameters for our spatial equilibrium model.

**Provincial Economic and Demographic Data.** I draw on [Trinh \(2019\)](#) for provincial-level Gross Domestic Product (GDP) data spanning the analysis period. Annual provincial population data from 2000 to 2019 come from Vietnam's statistical yearbooks ([General Statistics Office, 2016](#)).

### 3.2 Fact 1: Tax Policy Increased Employment and Firms in Targeted Areas

To document the effects of the 2003 Enterprise Income Tax reform, I implement an event-study design comparing firm location decisions before and after the policy change. This analysis focuses on districts with stable B and C classifications between 1999 and 2003, ensuring that identification comes from the policy reform rather than endogenous relabeling.

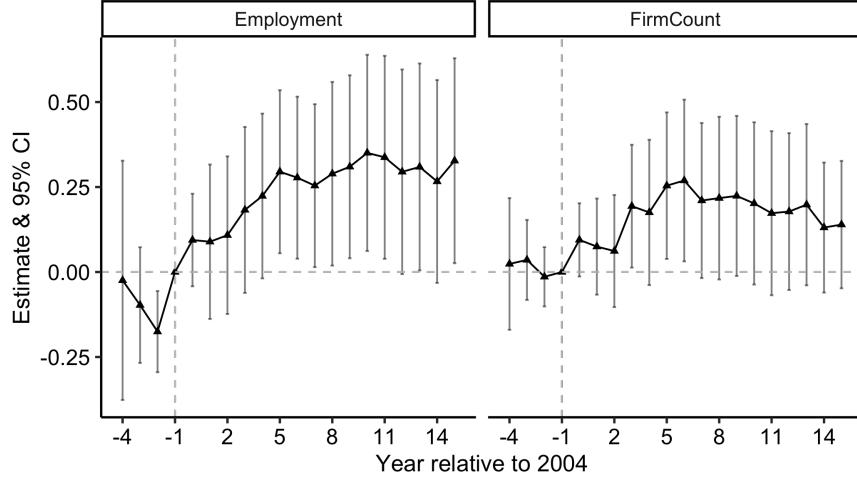
I estimate the following event-study specification:

$$y_{ist} = \sum_{j=2000, j \neq 2003}^{2019} \beta_j \cdot \mathbf{1}\{i \in C\} \cdot \mathbf{1}\{t = j\} + \alpha_i + \theta_{st} + \varepsilon_{ist}, \quad (1)$$

where  $y_{ist}$  measures either the number of firms or total employment in district  $i$ , sector  $s$ , and year  $t$ . The indicator  $\mathbf{1}\{i \in C\}$  equals one for C districts and zero if  $i \in B$ . with 2003 serving as the omitted base year to align with the policy implementation timing. I include district fixed effects ( $\alpha_i$ ) and sector-year fixed effects ( $\theta_{st}$ ) to control for time-invariant location characteristics and sector-specific trends. Standard errors are clustered at the district level to account for spatial

correlation. To handle the presence of zeros in firm counts and employment, I estimate equation (1) using Poisson Pseudo Maximum Likelihood (PPML), which provides consistent estimates under both heteroskedasticity and the presence of zero observations.

Figure 5: Event-Study Analysis of Firm Count and Employment



*Source:* Annual Enterprise Surveys (2000–2019).

*Notes:* Panel (a) shows employment growth; Panel (b) shows firm count growth. Each panel displays PPML estimates from equation (1) comparing C districts to B districts, with 95% confidence intervals clustered at the district level. The vertical dashed line indicates 2003, when the tax reform was announced.

Figure 5 reveals suggestive evidence that the enhanced tax incentives for C districts attracted more firms and employment. Pre-2003 coefficients are close to zero and not statistically significant. Following the 2003 reform, firm counts and employment in C districts increased significantly relative to the pre-reform baseline, with effects building gradually and reaching approximately 25% for employment around the same magnitude for firm counts.

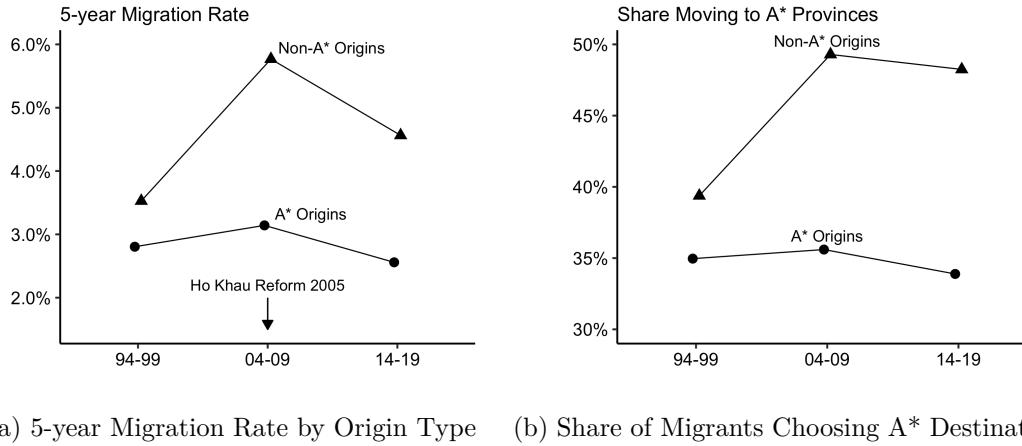
The magnitude and persistence of these effects indicate that place-based tax incentives can meaningfully influence firm location decisions. The gradual build-up of effects over time suggests that employment responds to tax incentives with some delay, possibly reflecting the time needed for firms to set up and start hiring.

### 3.3 Fact 2: Migration Increased Following Ho Khau Reform

The Ho Khau reform 2005 substantially reduced internal migration costs, generating significant changes in household mobility patterns throughout Vietnam. Figure 6 documents these changes using census data.

Figure 6a shows that migration rates increased substantially between the 1994–1999 and 2004–2009 periods, coinciding with the implementation of the Ho Khau reform. Households from non-A\* provinces experienced the most dramatic increase, with migration rates rising from approximately 3.5%, on average, to nearly 6.0%—a roughly 70% increase. Migration from A\* provinces also

Figure 6: Trends in Vietnamese Migration Patterns: 1999, 2009, 2019



(a) 5-year Migration Rate by Origin Type    (b) Share of Migrants Choosing A\* Destinations

Sources: Population and Housing Census data from 1999, 2009, and 2019.

Notes: A\* designates five centrally administered provinces, while non-A\* refers to Vietnam's remaining provinces. Panel (a) shows the average percentage of people migrating from each origin type between years  $t$  and  $t + 5$ . Panel (b) displays the proportion of migrants choosing A\* destinations.

increased but more modestly, from about 2.8% to 3.1%. By 2014-2019, migration rates declined somewhat but remained above pre-reform levels.

Figure 6b reveals heterogeneity in destination choices that reflects the differential impact of Ho Khau reform across locations. Out-migrants from non-A\* provinces dramatically increased their preference for A\* destinations, with the share choosing A\* rising from about 39% in 1994-1999 to 49% in 2004-2009. In contrast, migrants from A\* provinces showed stable destination preferences, with approximately 35% consistently choosing A\* destinations across all periods.

Interpreting the event-study above on firm location and the migration patterns documented here as causal effects of tax incentives or Ho Khau reform requires careful consideration of several limitations. First, the close timing of these policies makes it difficult to isolate the separate effects of each policy through reduced-form methods, as both reforms may have contributed to the observed changes in firm and household location patterns. Second, the event-study design treats districts in isolation, ignoring the spatial interconnections that may amplify or attenuate policy effects through labor mobility, firm relocations, and fiscal spillovers across locations.

Third, and most importantly, while these reduced-form analyses provide motivating evidence of policy effectiveness, they cannot assess the welfare consequences of these interventions or inform the design of spatial policies. Understanding how place-based tax incentives interact with migration costs to affect welfare and spatial equity requires a dynamic spatial equilibrium framework that explicitly models the mechanisms through which policies influence firm and household location decisions.

## 4 A Dynamic Spatial Model

To evaluate the welfare effects of Vietnam’s spatial policies and explore potential interaction between policies, I develop a dynamic spatial general equilibrium model with three key features: age-dependent firm entry/exit decisions, integration of firm tax revenues into government budgets, and migration costs that vary by policy regime. The model extends [Caliendo and Parro \(2020\)](#) by incorporating endogenous firm location responses to age-graded tax incentives—the common but understudied form of place-based policy worldwide. This framework yields transparent relationships between policy parameters and spatial allocations while capturing how firm location incentives can create alternative destinations for migrant flows.

### 4.1 Environment

Time is discrete and indexed by  $t$ . The economy consists of  $N$  locations indexed by  $i$ , each with  $J$  sectors indexed by  $j$ .

The geography of the economy at period  $t$  is characterized by the set of exogenous fundamentals  $\mathcal{F}_t$  which includes trade costs, local TFPs, and non-policy migration costs  $\{d_{int}^j, A_{it}^j, m_{int}\}_{i,n,j}$ , and a policy set  $\mathcal{P}_t$  with profit tax, Ho Khau policy, and revenue distribution policies.

Each location  $i$  has a population  $\mathcal{L}_{it} = L_{it} + E_{it}$ , comprising  $L_{it}$  workers and  $E_{it}$  entrepreneurs. The local government provides public services  $G_{it}$  which, following [Fajgelbaum et al. \(2018\)](#), enter agents’ utility on a per-capita basis ( $G_{it}/\mathcal{L}_{it}$ ).

### 4.2 Workers

Workers in each location are fully mobile across sectors. At the start of period  $t$ , they supply labor for wage  $w_{it}$ . Their indirect utility in location  $i$  at time  $t$  is given by

$$u_{it}^w = \log(C_{it}^w) + \max \left\{ \Xi_{it} + \chi \varepsilon_{it}^0, \max_{j=1,\dots,J} \left\{ \beta V_{it+1}^{j1} + \chi \varepsilon_{it}^j \right\} \right\} \quad (2)$$

where  $\beta \in (0, 1)$  is the discount factor. Worker consumption combines public services and private goods

$$C_{it}^w = \left( \frac{G_{it}}{\mathcal{L}_{it}} \right)^\gamma \left( \frac{w_{it}}{P_{it}} \right)^{1-\gamma} \quad (3)$$

where  $\gamma \in (0, 1)$  is the consumption share of public services.

As in standard spatial models, workers exhibit a nested constant elasticity of substitution (CES) preference structure over varieties produced by entrepreneurs across locations. The aggregate price index in location  $i$  is

$$P_{it} = \prod_{j=1}^J \left( \frac{P_{it}^j}{\alpha^j} \right)^{\alpha^j}, \quad 0 < \alpha^j < 1 \text{ and } \sum_j \alpha^j = 1 \quad (4)$$

where  $\alpha^j$  is the consumption share of sector  $j$  goods. The sector-specific price index is

$$P_{it}^j = \left( \sum_{n=1}^N E_{nt}^j (p_{nit}^j)^{1-\sigma} \right)^{1/(1-\sigma)} \quad (5)$$

where  $\sigma$  is the elasticity of substitution between varieties,  $E_{nt}^j$  is the measure of entrepreneurs (varieties) in location  $n$  and sector  $j$ , and  $p_{nit}^j$  is the price of goods produced in  $n$  and sold in  $i$ .

#### 4.2.1 Occupational Choice

After consumption, workers draw productivity shocks  $\varepsilon_t = \{\varepsilon_t^j\}_{j=0,\dots,J}$  across occupations (where  $j = 0$  denotes continued employment) from a Type-I Extreme Value distribution with dispersion  $\chi > 0$ . The parameter  $\chi$  governs the transition of workers to entrepreneurs. Higher values indicate greater heterogeneity in entrepreneurial ability, leading to lower aggregate responsiveness to policy changes. The value  $V_{it+1}^{j1}$  denotes the expected value of becoming a new entrepreneur in location  $i$  and sector  $j$  at  $t + 1$ , and  $\Xi_{it}$  represents the option value of migration from  $i$ .

The occupational choice probabilities are given by

$$\psi_{it}^j = \frac{\exp(V_{it+1}^{j1})^{\beta/\chi}}{\exp(\Xi_{it})^{1/\chi} + \sum_{k=1}^J \exp(V_{it+1}^{k1})^{\beta/\chi}}, \quad j > 0 \quad (6)$$

for entrepreneurship in sector  $j$ , and

$$\psi_{it}^0 = \frac{\exp(\Xi_{it})^{1/\chi}}{\exp(\Xi_{it})^{1/\chi} + \sum_{k=1}^J \exp(V_{it+1}^{k1})^{\beta/\chi}} \quad (7)$$

for remaining a worker.

#### 4.2.2 Migration

Workers who continue as employees draw location-specific shocks  $\epsilon_t = \{\epsilon_{nt}\}_{n=1}^N$  and choose where to migrate based on migration costs  $m_{int}$ , the expected value of being in destination  $n$ , denoted by  $U_{nt+1} \equiv \mathbb{E}_\epsilon [u_{nt+1}]$ . Following Caliendo et al. (2021), the migration cost  $m_{int}$  from origin  $i$  to destination  $n$  consists of a fixed component  $m_{in}$  (like distance) and a Ho Khau policy-related cost  $mpol_{int}$  for those migrating from  $i$  to  $n$

$$m_{int} = m_{in} + mpol_{int}, \text{ with } m_{it} = 0 \text{ and } m_{int} > 0 \text{ for } n \neq i. \quad (8)$$

The migration option value is given by

$$\Xi_{it} \equiv \mathbb{E} \left[ \max_{\{n=1,\dots,N\}} \beta U_{nt+1} - m_{int} + \nu \epsilon_{nt} \right] = \nu \log \left[ \sum_{n=1}^N \exp(\beta U_{nt+1} - m_{int})^{1/\nu} \right], \quad (9)$$

and the share of workers who migrate from origin  $i$  to destination  $n$  between time  $t$  and  $t+1$

$$\mu_{int} = \frac{\exp(\beta U_{nt+1} - m_{int})^{1/\nu}}{\sum_{n=1}^N \exp(\beta U_{nt+1} - m_{int})^{1/\nu}}. \quad (10)$$

The lifetime utility of a worker in location  $i$  is given by

$$U_{it} = \gamma \log(G_{it}/\mathcal{L}_{it}) + (1-\gamma) \log(w_{it}/P_{it}) + \chi \log \left[ \exp(\Xi_{it})^{1/\chi} + \sum_{j=1}^J \exp(V_{it+1}^{j,I})^{\beta/\chi} \right]. \quad (11)$$

### 4.3 Entrepreneurs

Unlike workers, entrepreneurs are sector-specific and characterized by their age  $a \in \{1, 2, \dots, \mathcal{A}\}$ . They face local profit tax rates  $\tau_{it}^a$  that vary by firm age.

#### 4.3.1 Production

An entrepreneur in location  $i$  and sector  $j$  produces output:

$$q_{it}^j = A_{it}^j (L_{it}^j)^{\xi^j} (H_{it}^j)^{1-\xi^j} \quad (12)$$

where  $A_{it}^j$  is productivity,  $\xi^j$  is labor share, and the total amount of land in each location  $i$  is fixed, i.e.  $\sum_{j=1}^J H_{it}^j = \bar{H}_i$ .

The firm's cost minimization problem determines the unit cost bundle as

$$x_{it}^j = B^j (w_{it})^{\xi^j} (r_{it})^{1-\xi^j} \quad (13)$$

where  $w_{it}$  denote the local wage,  $r_{it}$  the land price, and  $B^j$  is a constant,  $B^j = \xi^j - \xi^j (1 - \xi^j)^{-(1-\xi^j)}$ . The input markets are perfectly competitive, so cost minimization implies the following land market clearing condition

$$r_{it} H_{it}^j = \frac{1 - \xi^j}{\xi^j} w_{it} L_{it}^j. \quad (14)$$

In addition to input costs, firms in sector  $j$  and location  $i$  incur iceberg trade costs  $d_{int}^j$  in destination  $n$ . Thus, entrepreneurs set their optimal prices by including a constant markup to the combined input cost and the trade cost

$$p_{int}^j = \frac{\sigma}{\sigma - 1} \frac{d_{int}^j x_{it}^j}{A_{it}^j}. \quad (15)$$

Entrepreneurs sell their varieties across all locations, generating pre-tax profits:

$$\pi_{it}^j = \left( \frac{\sigma - 1}{\sigma} \right)^\sigma \left( \frac{A_{it}^j}{x_{it}^j} \right)^{\sigma-1} \sum_{n=1}^N (d_{int}^j)^{1-\sigma} X_{nt}^j (P_{nt}^j)^{\sigma-1} \quad (16)$$

where  $X_{nt}^j$  represents the expenditure on sector  $j$  in location  $n$ . If varieties are substitutes (i.e.,  $\sigma > 1$ ), profits rise with lower effective input costs ( $x_{it}^j/A_{it}^j$ ), lower trade costs, and higher demand.

### 4.3.2 Dynamic Decisions

Entrepreneurs consume and then decide to continue operations or exit to become workers. Thus, it takes at least two periods for current entrepreneurs in location  $i$  to become entrepreneurs in a different location  $n$  because they need to first exit and migrate before setting up a new firm in  $n$ . While an entrepreneur in practice might pursue various outside options like managing a different firm, I limit their outside option to being a worker based on observations that exiting firms seldom return and firms rarely change locations.

The value function for entrepreneurs in sector  $j$  and age  $a$  is given by

$$v_{it}^{ja} = \log(C_{it}^{ja}) + \max\{\beta V_{it+1}^{ja'}, \beta U_{it+1} + \chi \varepsilon_t^{ja}\} \quad (17)$$

where  $a' = \min\{a + 1, \mathcal{A}\}$  and  $V_{it+1}^{ja'}$  is the expected value function.

Entrepreneurs consume their after-tax profits

$$C_{it}^{ja} = \left( \frac{G_{it}}{\mathcal{L}_{it}} \right)^\gamma \left( (1 - \tau_{it}^a) \frac{\pi_{it}^j}{P_{it}} \right)^{1-\gamma}.$$

The expected value for entrepreneurs is thus

$$V_{it}^{ja} = \log(C_{it}^{ja}) + \chi \log \left[ \exp(V_{it+1}^{ja'})^{\beta/\chi} + \exp(U_{it+1})^{\beta/\chi} \right], \quad (18)$$

and the continuation probability is

$$\varsigma_{it}^{ja} = \frac{\exp(\beta V_{it+1}^{ja'}/\chi)}{\exp(\beta V_{it+1}^{ja'}/\chi) + \exp(\beta U_{it+1}/\chi)}. \quad (19)$$

## 4.4 Local Government

In each location  $i$ , local governments fund public services  $G_{it}$  through central transfers, land rent, and profit taxes. The budget constraint is

$$P_{it} G_{it} = \Omega_{it} \Lambda_t + \omega_{it} \underbrace{\left( r_{it} H_i + \sum_{j=1}^J \sum_{a=1}^{\mathcal{A}} E_{it}^{ja} \tau_{it}^a \pi_{it}^j \right)}_{\Gamma_{it}} \quad (20)$$

where  $\omega_{it}$  is the local retention rate of revenue  $\Gamma_{it}$  from land and profit taxes,  $\Omega_{it}$  is location  $i$ 's share of central government budget, and  $\Lambda_t$  is total central government revenue which is given by

$$\Lambda_t = \sum_{i=1}^N (1 - \omega_{it}) \Gamma_{it} \quad (21)$$

As detailed in Subsection 2.3,  $\omega_{it}$  and  $\Omega_{it}$  reflect observed fiscal redistribution policies. The model assumes local governments collect all land rent and spend all revenue on public services, abstracting from bureaucratic frictions or other political considerations. This assumption is empirically motivated by the substantial land rent revenue of local governments in Vietnam, particularly in special economic zones. Furthermore, incorporating dynamic and strategic public finance interactions between local and central governments is beyond the scope of this paper.

## 4.5 Equilibrium

The bilateral trade share in sector  $j$  from origin  $i$  to destination  $n$  is:

$$\lambda_{int}^j = E_{it}^j \left( \frac{p_{int}^j}{P_{nt}^j} \right)^{1-\sigma} \quad (22)$$

Location  $i$ 's total income  $\Pi_{it}$  combines government budget, labor income, and after-tax profits:

$$\Pi_{it} = P_{it} G_{it} + \sum_{j=1}^J \left( w_{it} L_{it}^j + \pi_{it}^j \sum_{a=1}^A E_{it}^{ja} (1 - \tau_{it}^a) \right) \quad (23)$$

Sectoral expenditure follows constant shares

$$X_{it}^j = \alpha^j \Pi_{it}. \quad (24)$$

Labor market clearing requires

$$w_{it} L_{it}^j = \xi^j \frac{\sigma - 1}{\sigma} \sum_{n=1}^N \lambda_{int}^j X_{nt}^j. \quad (25)$$

The evolution of entrepreneurs and workers captures both occupation and age transitions. For entrepreneurs, the dynamics are:

$$E_{it+1}^{j1} = \psi_{it}^j L_{it} \quad (26)$$

$$E_{it+1}^{ja} = \varsigma_{it}^{ja} E_{it}^{ja} \quad \text{for } a \in \{2, \dots, \mathcal{A} - 1\} \quad (27)$$

$$E_{it+1}^{j\mathcal{A}} = \varsigma_{it}^{j\mathcal{A}} E_{it}^{j\mathcal{A}}. \quad (28)$$

The total mass of entrepreneurs by location is:

$$E_{it+1} = \sum_{j=1}^J \sum_{a=1}^{\mathcal{A}} E_{it+1}^{ja} \quad (29)$$

Worker dynamics combine migration flows and occupational transitions:

$$L_{it+1} = \sum_{n=1}^N \mu_{nit} \psi_{nt}^0 L_{nt} + \sum_{j=1}^J \sum_{a=1}^{\mathcal{A}} (1 - \varsigma_{it}^{ja}) E_{it}^{ja} \quad (30)$$

I now define the equilibrium given the economy's fundamentals, policies, and state variables. Let  $\mathcal{F}_t \equiv \{d_{int}^j, A_{it}^j, m_{in}\}_{i,n,j}$  be the exogenous fundamentals (trade costs, TFP, migration costs),  $\mathcal{P}_t \equiv \{\tau_{it}^a, mpol_{int}, \omega_{it}, \Omega_{it}\}_{i,n,a}$  be the policy set, and  $\mathcal{S}_t \equiv \{L_{it}, E_{it}^{ja}\}_{i,j,a \geq 1}$  be the state variables (distribution of workers and entrepreneurs)

**Definition 1.** Each period  $t$ , given  $\{\mathcal{S}_t, \mathcal{P}_t, \mathcal{F}_t\}$ , the *static equilibrium* is a set of factor prices  $\{w_{it}, r_{it}\}_i$  that solve the price indices (4)-(5), firm optimization (15)-(16), and market clearing (22)-(25)

For ease of notation, let variables with only time subscripts denote matrices. For example,  $L_t$  is an  $N \times 1$  matrix representing the cross-location distribution of labor at  $t$ .

**Definition 2.** Given initial allocations  $\mathcal{S}_0$  and sequences  $\{\mathcal{F}_t, \mathcal{P}_t\}_{t=0}^\infty$ , a *sequential competitive equilibrium* consists of sequences:

$$\{L_t, \mu_t, E_t, \varsigma_t, \psi_t, V_t, U_t, w_t, r_t, P_t\}_{t=0}^\infty$$

that solve the worker and entrepreneur problems (11), (17), population dynamics (30), (26), (27), (28), government budget (20), and static equilibrium conditions at each  $t$ .

## 4.6 Solving the Model with Policy Changes

To analyze the impact of policy changes from  $\mathcal{P}_t$  to a counterfactual  $\mathcal{P}'_t$ , I need data on exogenous fundamentals and policy levels before and after the changes based on equilibrium definitions. To simplify this task, I extend the “dynamic hat algebra” approach from Caliendo et al. (2019). This method not only eliminates the need to estimate a large set of unknowns but also allows for the economy to be in transition which is particularly useful for rapidly growing economies like Vietnam.

The first step involves constructing the actual economy with observed data, reflecting equilibrium outcomes that incorporate both the evolution of fundamentals and policy changes. As the data only spans up to 2019, I assume that fundamentals and policies remain constant from the last data period and solve the model to reach a steady state. This sequential equilibrium, combined with available data, constitutes the actual economy, reflecting the presence of policy reforms.

To get the sequential equilibrium from the last data period, I extend Proposition 2 in Caliendo et al. (2019) to this model, which accounts for heterogeneous entrepreneurs and occupational choice. I use their dot notation to indicate relative time changes for each variable  $y$ , denoted by  $\dot{y}_{t+1} \equiv \dot{y}_{t+1}/y_t$ . Appendix B provides the proofs of the next propositions.

**Proposition 1.** *Given allocation  $(\mathcal{S}_t, \mu_{t-1}, \varsigma_{t-1}, \psi_{t-1}, \lambda_t)$  and constant sequences of policies and fundamentals following  $t$ , the sequential equilibrium in relative time change can be solved without knowing the levels of fundamentals and policies.*

Once I have the actual economy after applying Proposition 1, I then solve for a counterfactual economy using the hat notation for each variable  $x$ ,  $\hat{x}_{t+1} = \frac{\dot{x}'_{t+1}}{\bar{x}_{t+1}}$  where  $x'$  is the value of variable  $x$  in the counterfactual economy. The following proposition outlines the main advantage of this approach in solving counterfactual economies:

**Proposition 2** (Dynamic Hat Algebra). *Given an economy,  $\{\mathcal{S}_t, \mu_{t-1}, \varsigma_{t-1}, \psi_{t-1}, \lambda_t\}_{t=0}^\infty$  and a sequence of policy changes relative to the actual economy  $\{\hat{P}_t\}_{t=1}^\infty$ , the counterfactual sequential equilibrium  $\{\mathcal{S}'_t, \mu'_{t-1}, \varsigma'_{t-1}, \psi'_{t-1}, \lambda'_t\}_{t=1}^\infty$  can be determined without requiring information on the level of the fundamentals.*

Proposition 2 enables the creation of a counterfactual economy that mirrors the actual economy except for the absence of policy changes. I assume that households do not anticipate the counterfactual policy at time  $t = 0$  but instead learn about the entirely new policy sequence starting from period  $t = 1$ . Consequently, this approach allows me to address the counterfactual question: How would the economy change if the only alteration were a policy while all other factors (such as changes in fundamentals and other policies) continued to evolve as observed in the data?

Finally, I can calculate the welfare changes for workers in location  $i$ , denoted as  $\widehat{W}_i$ , using compensating variation. The welfare change of workers in hat notation is given by

$$\widehat{W}_i = \sum_{t=1}^{\infty} \beta^t \log \frac{(\widehat{G}_{it}/\widehat{L}_{it})^\gamma (\widehat{w}_{it}/\widehat{P}_{it})^{1-\gamma}}{(\widehat{\mu}_{iit})^\nu (\widehat{\psi}_{it}^0)^\chi}. \quad (31)$$

To apply Proposition 2 for calculating the welfare effects in (31), essential data includes allocations, flows, parameter estimates, and quantification of policy changes. Crucial to this quantitative exercise are the variations in migration costs due to the Ho Khau policy,  $\Delta mpol_{int}$ , and the firm entry elasticity governed by the parameter  $\chi$ . While profit tax figures are readily available, quantifying the Ho Khau policy's impact on migration costs in utils is more challenging.

## 5 Empirical Strategy and Estimation

Taking the model to the data requires estimating two key parameters: how firm survival responds to tax incentives (governing the strength of place-based job creation) and how migration costs changed

under Ho Khau reform (governing migration flow responses). This section develops identification strategies that exploit policy variation across space, time, and firm characteristics to estimate these parameters transparently while maintaining general equilibrium consistency.

### 5.1 Identifying the Firm–Stay Elasticity

The 2003 Enterprise Income Tax reform introduced statutory rate cuts that vary across districts, years, and, crucially, firm-age brackets. The model implies a tight link between those tax changes and the probability that an incumbent establishment survives into the next period. Taking the ratio between stayers versus exiters using equation (19) and substituting the continuation values from (18) gives

$$\log \left( \frac{\varsigma_{it}^{ja}}{1 - \varsigma_{it}^{ja}} \right) = \frac{\beta}{\chi} \log(C_{it+1}^{ja+1}) + \beta \log \left[ \exp(V_{it+2}^{ja+2})^{\beta/\chi} + \exp(U_{it+2})^{\beta/\chi} \right] - \frac{\beta}{\chi} U_{it+1}$$

Notice that the continuation term in the spare bracket reflects the exit rates of age  $a + 1$  firms:

$$1 - \varsigma_{it+1}^{ja+1} = \frac{\exp(U_{it+2})^{\beta/\chi}}{\exp(V_{it+2}^{ja+2})^{\beta/\chi} + \exp(U_{it+2})^{\beta/\chi}}.$$

Rearranging and taking logs yields

$$\log \left( \frac{\varsigma_{it}^{ja}}{1 - \varsigma_{it}^{ja}} (1 - \varsigma_{it+1}^{ja+1})^\beta \right) = \frac{\beta}{\chi} \left( \gamma \log \frac{G_{it+1}}{\mathcal{L}_{it+1}} + (1 - \gamma) \log \left[ (1 - \tau_{it+1}^{a+1}) \frac{\pi_{it+1}^j}{P_{it+1}} \right] \right) + \Phi_{it}, \quad (32)$$

where  $\Phi_{it} = \frac{\beta^2}{\chi} U_{it+2} - \frac{\beta}{\chi} U_{it+1}$  capturing continuation values that are common to all firms in an  $(i, j, a)$  cell.

Define the outcome variable in equation (32) as the *Local Age-Specific Turnover rate* (LAST)

$$\text{LAST}_{it}^{ja} = \frac{\varsigma_{it}^{ja}}{1 - \varsigma_{it}^{ja}} (1 - \varsigma_{it+1}^{ja+1})^\beta$$

where I also denote  $\text{StayExit}_{it}^{ja} \equiv \frac{\varsigma_{it}^{ja}}{1 - \varsigma_{it}^{ja}}$  for *stay-exit odds ratio*. This outcome variable  $\text{LAST}_{it}^{ja}$  captures both the current odds of survival and the continuation probability one period ahead, given a discount factor  $\beta$ .

Equation (32) suggests the following linear regression

$$\log(\text{LAST}_{it}^{ja}) = \theta \log(1 - \tau_{it}^a) + \Phi_{ijt} + \varphi_{ja} + \eta_{jat} + \varepsilon_{it}^{ja}, \quad (33)$$

with  $\theta = \beta(1 - \gamma)/\chi$  and the fixed-effects  $\Phi_{ijt}$  (district  $\times$  sector  $\times$  year),  $\varphi_{ja}$  (age  $\times$  sector), and  $\eta_{jat}$  (age  $\times$  sector  $\times$  year). I cluster the standard errors at the district level.

Identification of  $\theta$  rests on the assumption that, after conditioning on the rich set of fixed

Table 1: Firm–Stay Elasticity Estimates

	log(StayExit)		log(LAST)	
	(1)	(2)	(3)	(4)
log( $1 - \tau$ )	1.43*** (0.15)	1.58*** (0.18)	0.41*** (0.11)	0.27** (0.11)
R <sup>2</sup>	0.63	0.66	0.61	0.63
Observations	76,070	76,070	40,923	40,923
District-Sector-Year fixed effects	✓	✓	✓	✓
Age-Sector fixed effects	✓		✓	
Age-Sector-Year fixed effects		✓		✓

*Notes:* Dependent variable in columns (1)-(2) is log odds of firm survival; columns (3)-(4) use the LAST measure incorporating continuation values. All specifications include district-sector-year fixed effects. Columns (2) and (4) add age-sector-year fixed effects. Standard errors clustered at the district level. Sample covers 2000–2019 for firms in districts with stable A/B/C classifications.

effects,  $\mathbb{E}[\varepsilon_{it}^{ja} | \tau_{it}^a, \Phi_{ijt}, \varphi_{ja}, \eta_{jat}] = 0$ . This assumption would be violated if an unobserved shock occurred precisely with the 2003 reform, differed across district–sector cells, and favored one age group relative to another exactly like the 2003 tax policy reform.

Table 1 reports the estimates of  $\theta$  with the first two columns reporting only the stay-exit odds ratio, which is only part of  $\text{LAST}_{it}^{ja}$  without accounting for the continuation value. The last two columns report the main results with different sets of fixed effects. Column (4), which contains the full set of fixed effects, delivers  $\hat{\theta} = 0.27$  (s.e. 0.11).<sup>12</sup> Thus, a ten-percentage-point cut in the statutory rate increases the odds that an incumbent survives by approximately 2.2%.

Estimates of a firm–stay elasticity comparable to  $\theta$  are virtually absent from the literature. The lone partial analogue is Cevik and Miryugin (2022), who report a complementary–log–log hazard coefficient of 3.951 on the effective marginal tax rate (EMTR) in a twenty-one-country panel. Converting their semi–elasticity into our metric—first scaling by the mean EMTR of 0.30 and then mapping a discrete hazard increment to a log odds change—yields an implied elasticity of about 0.84 per unit change in  $\log(1 - \tau)$ .<sup>13</sup>

<sup>12</sup>The LAST specification uses 40,923 observations, roughly half the sample in the StayExit columns, because construction of  $\text{LAST}_{it}^{ja}$  requires observing the same cohort one year later; any district–sector–age cell that is missing in  $t+1$  (or has zero incumbents) is therefore excluded.

<sup>13</sup>Starting from a hazard semi–elasticity of 3.951, a 1-percentage-point (3.3 percent) rise in EMTR increases the exit hazard by  $\exp(3.951 \times 0.01) - 1 \simeq 0.040$ . Dividing 0.040 by 0.033 gives an elasticity of 1.2 with respect to  $\tau$ ; multiplying by  $(1 - \tau) = 0.70$  at the sample mean delivers 0.84 for  $\log(1 - \tau)$ . The calculation ignores timing differences between their continuous–time hazard and our annual odds ratio but provides a ballpark figure.

Taken together, the preferred estimate of 0.27 and the external benchmark of 0.84 bracket the plausible range once one recognizes two distinctions: (i) EMTRs embed depreciation and financing provisions absent from Vietnam's age-graded statutory cuts and (ii) the identification here relies on sharp variation within the district and age that strips out cross-country heterogeneity. The proximity of the two numbers despite these differences lends credibility to the magnitude of  $\hat{\theta}$  and, by extension, to the calibrated idiosyncratic-shock dispersion parameter  $\chi$  used in the counterfactual exercises that follow.

## 5.2 Identifying Changes in Ho Khau-related Migration Cost

The Ho Khau reform in 2005 relaxed registration hurdles nationwide, but the five centrally controlled provinces ( $A^*$ ) received a *smaller* cut in migration costs than the remaining provinces ( $\bar{A}^*$ ). For each ordered pair of provinces  $(i, n)$  with  $i \neq n$  define the policy change

$$\Delta_{in} = mpol_{in,post} - mpol_{in,pre} < 0,$$

and write  $\Delta_T = \mathbb{E}[\Delta_{in}]$  for the average temporal drop and the additional non- $A^*$  discount  $\Delta_L \equiv \mathbb{E}[\Delta_{\cdot, \bar{A}^*} - \Delta_{\cdot, A^*}] > 0$ . Because the five  $A^*$  experienced a *smaller* reduction,  $\Delta_{\cdot, A^*}$  is closer to zero, making  $\Delta_L$  positive.

To identify these changes, I use migration data and leverage the relationship between migration flows and migration costs presented in equation (10). By applying this equation and taking the log of the ratio between migration shares from location  $i$  to  $n$  and the share of stayers in  $i$ , I get

$$\log \frac{\mu_{int}}{\mu_{iit}} = -\frac{1}{\nu} m_{int} + \frac{\beta}{\nu} (U_{nt+1} - U_{it+1}). \quad (34)$$

This equation implies that any change in migration cost  $m_{int}$  can impact the future value of being in location  $n$  through the second term on the right-hand side, which captures the general equilibrium effects. To difference away those option-value effects, I follow Head and Ries (2001) and construct the *Head-Ries index*

$$\text{HR}_{int} = \log \left( \frac{\mu_{int} \mu_{nit}}{\mu_{iit} \mu_{nnt}} \right) = -\frac{1}{\nu} (m_{int} + m_{nit})$$

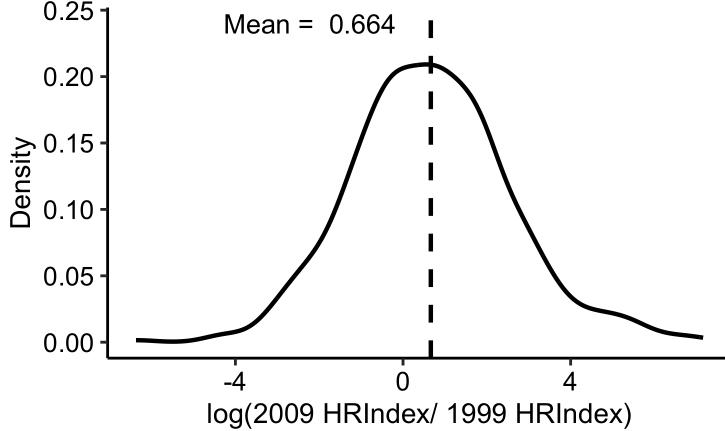
which is symmetric in  $(i, n)$ . The change  $\text{HR}_{in,post} - \text{HR}_{in,pre} = -\frac{1}{\nu}(\Delta_{in} + \Delta_{ni})$ , therefore, isolates the policy shocks without GE contamination.

Figure 7 displays the distribution of  $\Delta \log \text{HR}_{int}$  for  $\bar{A}^*-\bar{A}^*$  pairs only. The mean of  $-0.664$  identifies  $-\frac{2}{\nu}\Delta_T$  under the assumption that other time-varying frictions in non- $A^*$  dyads are orthogonal to the 2005 Ho Khau reform.

To quantify the spatial component  $\Delta_L$  I estimate the PPML specification

$$\text{HR}_{int} = \gamma \mathbf{1}(i \in A^*, n \in A^*, t > 2005) + \varrho_{in} + \vartheta_{it} + \varphi_{nt} + \varepsilon_{int}, \quad (35)$$

Figure 7: Temporal Changes in Migration Costs for Non-A\* Pairs, 1999–2009



Source: Population and Housing Census 1999 and 2009.

Notes: Density of  $\log HR_{int,2009} - \log HR_{int,1999}$  for all origin–destination pairs where both provinces are outside  $A^*$ . Dashed line marks the sample mean, which identifies  $-\frac{2}{\nu} \Delta_T$ .

where the triple interaction equals one only when *both* origin and destination are  $A^*$  after the reform year 2005. Bilateral fixed effects  $\varrho_{in}$  absorb time-invariant frictions, while  $\vartheta_{it}$  and  $\varphi_{nt}$  net out origin- and destination-specific shocks in each census year; standard errors are clustered by origin–destination.

Column (1) of Table 2 replaces  $HR_{int}$  with raw inflow counts and uses a simple two-way fixed effect model using post-2005  $A^*$  dummy. The positive and significant coefficient merely confirms that large cities kept attracting migrants but tells us nothing about bilateral costs as explained in equation (34). Equation (35) in Column (2) introduces the necessary origin dimension, and the estimate  $\hat{\gamma} = -0.52$  (s.e. 0.24) implies that  $A^*-A^*$  pairs saw a *smaller* fall in migration costs than non- $A^*$  pairs, consistent with the policy’s intent to keep big-city inflows relatively tight. Had the triple interaction been insignificant, it would simply tell us that post-reform cost cuts were uniform—a possibility the data reject at the 5% level.

In conclusion, the estimated temporal and spatial variations in Ho Khau policies are both scaled by the migration elasticity parameter,  $\nu$ . With the calibrated value of  $\nu$ , I can calculate the changes in migration costs resulting from the Ho Khau reform to feed into the dynamic model for counterfactual analysis.

### 5.3 Internal Trade Flows

Bilateral trade costs are not directly observed, so I infer them from the gravity relationship implied by (22). Following Monte et al. (2018), I assume that the iceberg cost of shipping sector  $j$  goods from province  $i$  to province  $n$  is a power function of road distance,

$$d_{in}^j = (\text{dist}_{in})^{\kappa^j},$$

Table 2: Spatial Variation Estimates of 2005 Ho Khau Reform

	FlowsIN	HRIndex
	(1)	(2)
$\mathbf{1}(n \in A^*, t > 2005)$	0.35*** (0.13)	
$\mathbf{1}(i \in A^*, n \in A^*, t > 2005)$		-0.52** (0.24)
Observations	3,278	2,837
Pseudo R <sup>2</sup>	0.93	0.18
OD fixed effects	✓	✓
Year fixed effects	✓	
Origin-Year fixed effects		✓
Destination-Year fixed effects		✓

*Sample:* Population and Housing Censuses 1999 & 2009.

*Notes:* Column (1) estimates a DiD on log inflow counts using Poisson PML; Column (2) use the Head–Ries outcome and adds a triple interaction ( $A^*$  origin  $\times$   $A^*$  destination  $\times$  Post-2005) and replaces year dummies with origin–year and destination–year fixed effects. Standard errors, in parentheses, are clustered by origin–destination pair. \*\*\*, \*\*, \* denote significance at the 1, 5, and 10 % levels.

where  $\kappa^j$  is the sector-specific distance elasticity. Substituting this expression into (22) and taking logs yields the cross-sectional specification

$$\log \lambda_{in}^j = (1 - \sigma) \kappa^j \log \text{dist}_{in} + \alpha_i^j + \delta_n^j + \varepsilon_{in}^j,$$

with  $\lambda_{in}^j$  the share of  $n$ 's expenditure on goods from  $i$ ,  $\alpha_i^j$  an origin fixed effect that absorbs  $\log A_i^j$ , and  $\delta_n^j$  a destination fixed effect that absorbs  $\log P_n^j$ .

The trade flows come from the nationwide input–output study by [JICA \(2000\)](#), which reports inter-provincial flows for the year 2000. I digitised those tables and matched them to great-circle truck distances computed on the 1999 IPUMS province shapefile using an ArcGIS network-routing algorithm. Because a non-trivial fraction of province pairs record zero shipments, I estimate  $(1 - \sigma)\kappa^j$  with PPML, clustering standard errors by origin–destination.

Figure A4 plots the resulting elasticities together with 95 percent confidence intervals. Sectoral estimates range from  $-0.8$  to  $-1.8$ , highly statistically significant and similar to the benchmark  $-1.29$  reported for the United States by [Monte et al. \(2018\)](#).

## 5.4 Taking the Model to Vietnamese Data

**Data harmonization.** Integrating the establishment panel with the decennial Population and Housing Censuses poses three hurdles. First, firms are observed annually, whereas the censuses report five-year migration rates every ten years. To have one model period corresponding to a calendar year, I recover annual gross migration flows by combining population data and 5-year migration flows with the model’s migration equilibrium condition following Kleinman et al. (2023). Appendix A details the interpolation.

Second, while firm data are available at the district level, migration data are representative only at the provincial level. I therefore conduct the counterfactual simulations at the province level, aggregating district-level tax categories  $A$ ,  $B$ , and  $C$  with 1999 population weights (see Figure 3b). This choice is not only dictated by data, but it also simplifies matching to province-level fiscal variables—the local income and redistribution shares are legislated at that tier (see section 2.3).

Third, to avoid heavy computation for a vast number of firm ages, I collapse firm-level ages into three groups. Every establishment is assigned to “Young” if its age is less than 3 years, to “Middle” if the age lies between 3 and 8 years, and to “Old” once it reaches 9 years. These three bins are used before forming province-level counts and stay rates.

**Calibration.** I set the annual discount factor to  $\beta = 0.95$  and adopt the standard value  $\sigma = 6$  for the elasticity of substitution across varieties. The labor share in value added is fixed at  $\xi^j = 0.7$  for every sector, and the annual migration elasticity is  $1/\nu = 0.63$ , the estimate that incorporates public-goods consumption in Caliendo et al. (2021).<sup>14</sup> Government expenditure’s share of aggregate consumption is calibrated to  $\gamma = 0.194$ , the mean revenue-to-GDP ratio for 2000–2019 following the approach of Fajgelbaum et al. (2018).

With these numbers and observed province-level income GRDP, the sectoral consumption weights  $\{\alpha^j\}$  follow directly from the labor-market clearing condition (25). The dispersion of idiosyncratic productivity shocks is pinned down by the firm-stay elasticity in Section 5.1. With  $\hat{\theta} = 0.27$ , I have  $\chi = 2.84$ .

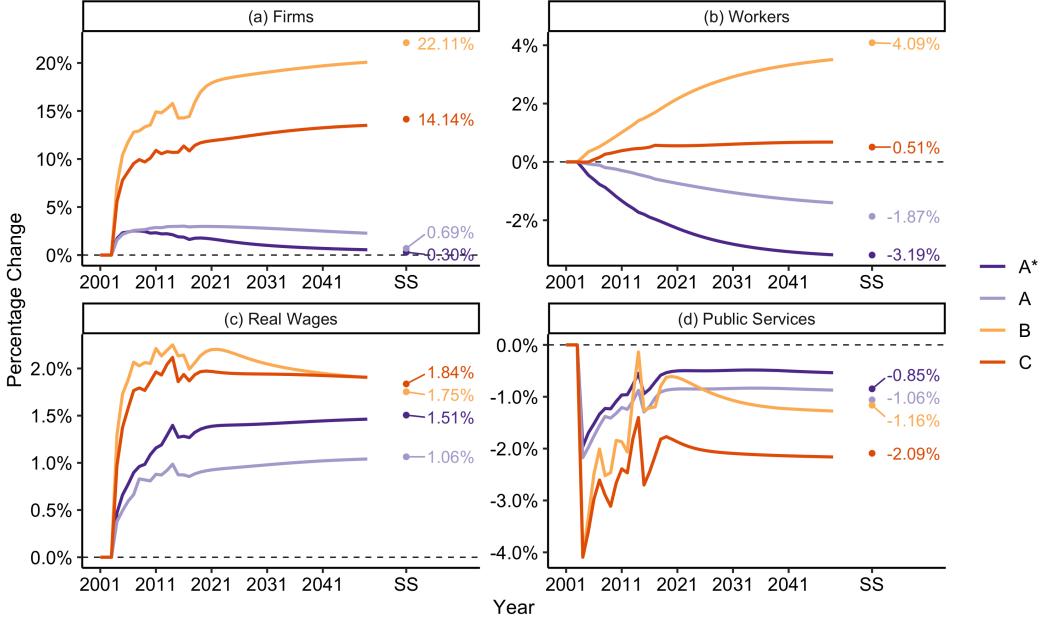
## 6 Policy Evaluation

This section evaluates the 2003 place-based tax schedule and the 2005 *Ho Khau* reform within the calibrated model. I first document how the joint policy package reshapes the spatial distribution of firms and workers, then translate those reallocations into welfare outcomes.

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<sup>14</sup>The migration elasticity  $1/\nu = 0.63$  corresponds to a five-year elasticity of approximately 3, consistent with the value used by Balboni (2025) for Vietnam and within the range found by Bryan and Morten (2019) for Indonesia

Figure 8: Dynamic Effects of Combined Tax and Migration Policies



*Notes:* This figure shows the dynamic effects of the 2003 tax reform and 2005 Ho Khau reform aggregated across four location types (A\*, A, B, and C provinces). Each panel traces the percentage change in key economic variables (establishments, population, wages, and per-capita public services) relative to a counterfactual economy without policy changes, from 2001 to steady state.

## 6.1 Firm and Worker Dynamics

I examine the dynamics of spatial reallocation driven by Vietnam’s place-based policies, focusing on how firm location decisions and worker migration patterns respond to the combination of tax incentives and migration barriers reduction. To analyze these spatial reallocation effects, I compute a counterfactual economy without the policy changes by feeding into the model the inverse of both the estimated migration costs and the observed 2003 tax changes. Figure 8 traces the transition from 2001 to the model’s steady state.

Panel (a) reveals the most striking change occurs in firm reallocation. By the steady state, B provinces experience a dramatic 22.11% increase in the number of establishments, while C provinces see a 14.14% rise. This firm movement is heavily front-loaded, with most of the adjustment occurring in the first decade as businesses respond quickly to tax incentives. In contrast, A provinces and A\* metros see minimal changes, with A provinces growing by just 0.69% and A\* metros increasing by 0.30%.

Panel (b) shows how worker movement follows a relatively different pattern, both in magnitude and timing. B provinces gain population by 4.09% and C provinces by 0.51%, but these increases are much smaller than the corresponding firm changes. Meanwhile, both A provinces and A\* metros lose population, declining by 1.87% and 3.19% respectively. The slower pace of worker reallocation reflects the gradual nature of migration decisions, as households respond to evolving wages and

amenities rather than immediate policy changes.

Panel (c) demonstrates how wage changes are more uniform across provinces. C provinces lead with 1.84% wage growth, followed closely by B provinces at 1.75%, while A\* metros gain 1.51% and A provinces see 1.06% growth. This relatively uniform wage growth suggests that spatial arbitrage effectively distributes productivity gains across regions, even in the presence of migration frictions.

Public services reveal the fiscal costs of these policies, with all regions experiencing declines. C provinces face the largest reduction at 2.09%, followed by B provinces at 1.16%, while A provinces and A\* metros see smaller declines of 1.06% and 0.85% respectively. The public service decline is particularly sharp in the early years, reflecting the immediate impact of large tax cuts for younger firms on local government revenue, especially in C provinces where the tax cut is the largest, but the entry of firms is not as large as the B places, demonstrating the intricate trade-off between tax incentives and fiscal sustainability.

The combined effects of both policies differ from what each policy achieves in isolation. When examining just the enterprise tax reform (Figure A6), firm reallocation to disadvantaged regions is even more pronounced than under the combined scenario (Figure 8). Specifically, under tax reform alone, B provinces see a 23.85% increase in firms and C provinces a 19.03% increase, compared to smaller increases of 22.11% and 14.14% respectively when both policies are implemented together.

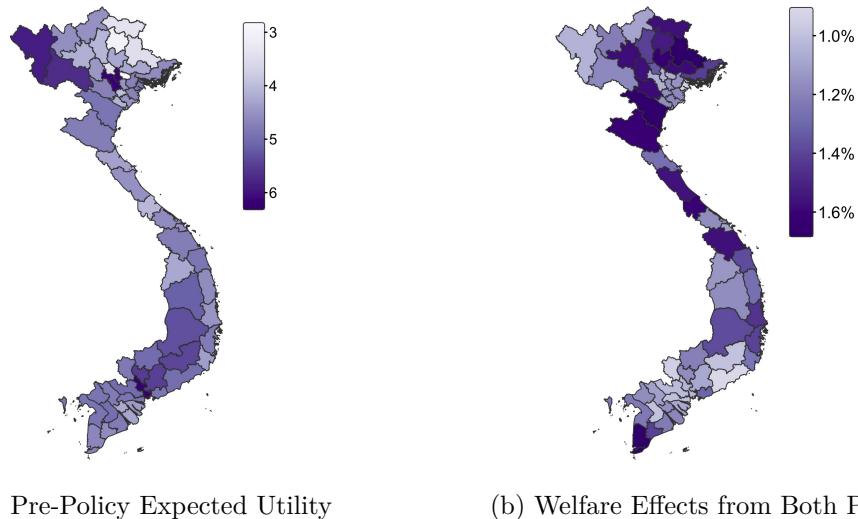
This dampening effect occurs through the occupational choice margin. When migration barriers are lowered, some potential entrepreneurs who would have started firms in B and C provinces under tax incentives alone instead choose to become workers in more developed regions, as evidenced by the negative firm creation (-0.98% in A\* and -2.55% in C provinces) under Ho Khau reform alone (Figure A7). This effect is particularly pronounced in C provinces, where the tax cut is largest but the entry of firms is not as large as the B places.

The migration patterns reveal important interactions between the two policies. When only tax reform is implemented, B provinces experience a large population increase of 4.61% as workers follow new firm creation. However, introducing the Ho Khau reform significantly changes these migration flows. With lower migration barriers, population shifts toward A provinces (+0.84%) while decreasing in A\* metros (-1.1%).

In particular, notice how the Ho Khau reform reduces the loss of population A provinces, by from -2.76% under the tax reform alone to -1.87% under the combined policy. This result suggests that reducing migration barriers enables workers to access economic opportunities in moderately developed regions without necessarily moving to the most disadvantaged areas, even when those areas offer tax advantages for firms.

These patterns highlight a key tension in spatial development policy. While tax incentives can effectively attract firms to targeted regions, their ability to generate substantial population movements depends critically on migration costs. The Ho Khau reform appears to moderate rather than amplify the spatial reallocation effects of tax policy, as evidenced by the smaller population gains in B provinces under combined policies compared to tax reform alone. This interaction

Figure 9: Pre-Policy Expected Utility and Welfare Gains from the Combined Policy



*Notes:* Panel (a) displays pre-policy expected lifetime utility by province, with darker shades indicating higher utility levels based on model equilibrium conditions and data before policy changes. Panel (b) shows welfare effects from combined tax and migration reforms, measured as percentage changes in lifetime utility relative to the no-policy counterfactual. Province boundaries as of the 1999 administrative classification.

manifests in wage and public service effects as well: tax policy generates broad wage gains (1.43–1.87%) while Ho Khau reform produces minimal wage changes but improves public service access, particularly in A\* regions (0.41%).

## 6.2 Welfare Effects

Having analyzed the spatial reallocation effects, I now examine how the combined policies affect household welfare across provinces. I measure welfare changes using an equivalent-variation metric that compares utility under the policy scenario to the no-policy baseline, following equation (31). Figure 9b displays these welfare effects geographically.

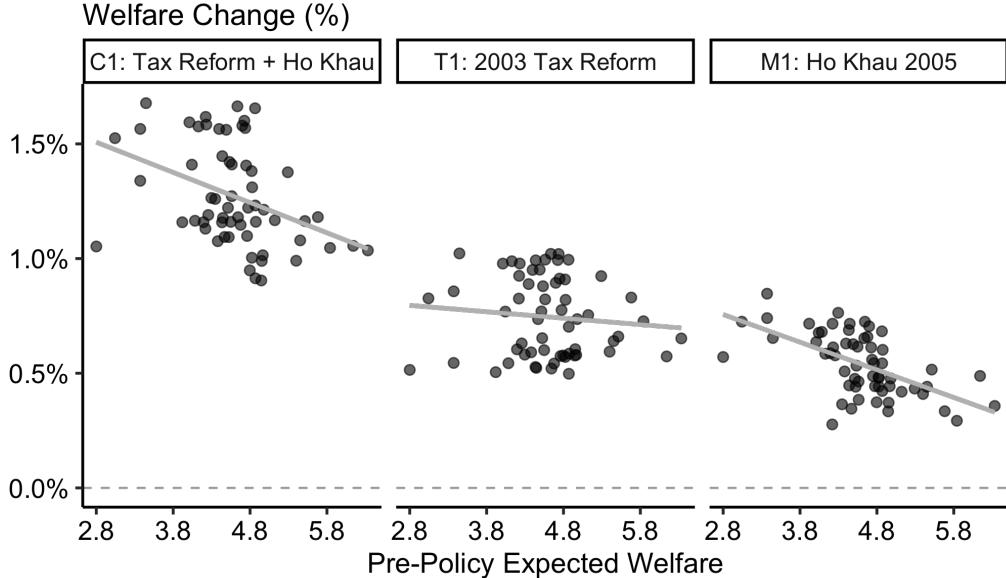
For context, Figure 9a shows each province's pre-policy expected lifetime utility  $U_{it}$ , calculated from the model's equilibrium conditions in equation (30) (see Appendix A for details)<sup>15</sup>. Figure 9a reveals the spatial distribution of pre-policy expected lifetime utility across Vietnam's provinces. As anticipated, major economic centers like Ha Noi and Ho Chi Minh City show high utility levels (darker shading). Surprisingly, two provinces in the northwest also exhibit high expected utility, suggesting that the model's measure captures factors beyond current economic conditions, including option values of future migration and entrepreneurship opportunities.

The welfare effects of the combined policies, shown in Figure 9b, display notable geographic

<sup>15</sup> Although this measure is associated with 1999 poverty rates, the correlation is moderate, with a coefficient of about -0.36, illustrated in Figure A5. I rely on the model's expected utility as it reflects not only the present condition of the area indicated by the poverty incidence but also the option values of migration and entrepreneurship.

variation. The highest gains (1.6-1.7%) concentrate in several northern provinces and along the central coast. Moderate benefits (1.2-1.4%) disperse across various regions, while some southern provinces and scattered northern areas experience more modest gains (around 1.0%).

Figure 10: Welfare Changes vs. Pre-Policy Welfare by Policy Combination



*Notes:* Each point is a province. Pink triangles: 2003 tax reform only; green crosses: 2005 *Ho Khau* reform only; black circles: combined package. Fitted lines illustrate the slope within each scenario.

Figure 10 decomposes these welfare effects by plotting them against pre-policy utility levels for each policy scenario. First, the combined policy (C1) exhibits the steepest negative relationship, indicating that provinces with lower initial utility benefit substantially more from the combined policy. More importantly, the two individual policies seem to act in different ways. The Ho Khau reform alone (M1) exhibits a negative relationship, while the tax reform (T1) alone shows little relationship between welfare gains and initial utility.

This pattern reveals a subtle interplay between policy mechanisms. The tax reform, despite successfully attracting firms (23.85% increase in B provinces) and workers (4.61% population gain), shows little impact on spatial inequality in welfare terms. This neutrality stems from the offsetting effects of increased economic activity against the increase in congestion such as public services per capita, particularly in targeted regions where tax revenues decline as firms and workers move in. The result highlights how place-based tax incentives alone may face limitations in reducing spatial disparities in welfare due to the fiscal sustainability trade-off.

The Ho Khau reform's negative relationship with initial utility is particularly noteworthy. By reducing migration barriers, this policy creates opportunities for spatial arbitrage that unexpectedly benefits lower-utility provinces. The mechanism operates through the reallocation of both firms and workers toward A provinces—the second-best locations that offer an attractive combination

of economic opportunities and amenities. This sorting pattern helps reduce spatial inequality by improving access to better opportunities for residents of disadvantaged regions while avoiding excessive concentration in A\* metros.

When combined, these policies reinforce each other in reducing spatial inequality, as evidenced by the steepest negative slope for C1. The tax reform’s ability to stimulate economic activity in disadvantaged regions pairs with the Ho Khau reform’s role in enabling better spatial matching of workers and firms. This result suggests that while individual policies may face limitations or generate unintended consequences, their careful combination can better achieve the dual objectives of promoting efficiency and reducing regional disparities. This point is further explored next.

## 7 Policy Counterfactuals

The analysis in Section 6 established that Vietnam’s 2003–05 reform package achieves higher aggregate welfare gains than either policy in isolation, with the Ho Khau reform contributing more to inequality reduction than tax incentives. This section unpacks *how* migration policy design affects these outcomes by examining three alternative approaches to easing mobility restrictions. The results reveal that the spatial targeting of migration reforms determines whether they promote convergence or exacerbate existing disparities.

### 7.1 Alternative Migration Reforms

The Ho Khau reform in 2005 was intentionally asymmetric: registration costs fell much more when the destination was a non-A\* province than when it was one of the five A\* provinces. To understand how this design choice shaped outcomes, I analyze three counterfactual migration policies alongside the actual reform.

First, I consider policy M2 (A\*-access) which reduces migration costs only for moves *into* major cities at the exact magnitude estimated for A\*. This policy mimics infrastructure projects like expressways or migration subsidies that lower the effective price of reaching the largest labor markets (Morten and Oliveira, 2023; Bryan et al., 2014).

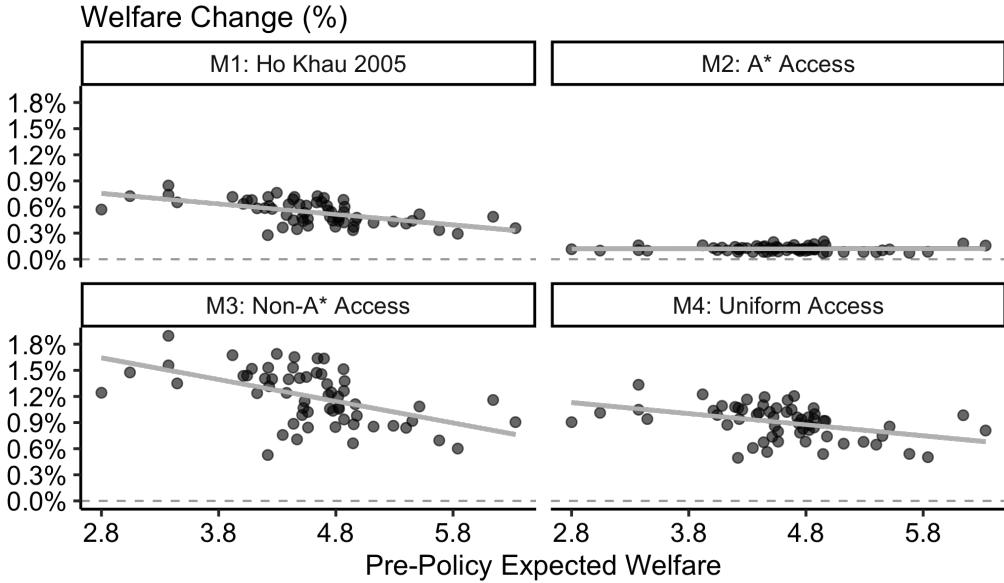
Second, I consider policy M3 (non-A\* access) which reduces migration costs only for moves into non-A\* provinces at the same magnitude as the actual reform without any reductions in migration costs to A\*. This policy is similar to China’s 2014 reform with more reductions outside of the major cities (An et al., 2024; Fan, 2019).

Third, I consider policy M4 (uniform easing) where all province pairs enjoy the same absolute drop in migration costs, equal to the reduction applied to non-metro destinations in the actual 2005 reform, representing complete removal of the Ho Khau system.

Figure 11 plots each province’s welfare gains against its initial utility level, revealing starkly different distributional patterns across the four policies.

The actual reform (M1) reduces inequality by creating a negative relationship between welfare

Figure 11: Welfare Effects from Alternative Migration Reforms



*Notes:* Each marker is a province. M1: actual Ho Khau reform in 2005; M2: A\*-access means only the A\* provinces receive the cost cuts; M3: non-A\* access means only the non-A\* provinces receive the cost cuts; M4: uniform easing means all province pairs receive the same cost cuts.

gains and initial utility, as poorer provinces benefit more. This pattern emerges from the policy's asymmetric design: by maintaining higher migration costs to A\* metros while reducing them elsewhere, the reform redirects migration flows toward mid-tier provinces, mainly A provinces. The resulting spatial reallocation creates development opportunities in lower-income regions while preventing excessive concentration in major metros.

In contrast, the A\*-access reform (M2) generates the opposite pattern. When only moves to major cities become cheaper, agglomeration in A\* provinces creates firm entry (+0.8%) and population growth (+1.2%) as shown in Figure A8. However, the resulting welfare gains are modest, as the surge in population reduces wages (-0.3%) despite the growth in labor demand. Meanwhile, sending regions lose both firms and workers, experiencing only modest wage increases from reduced population.

Third, the uniform easing reform (M4) amplifies existing inequalities by reinforcing spatial advantages rather than correcting them. Figure A10 shows that uniform cost reductions generate modest firm losses across all locations (-1% to -3.61%) except for the small rise in A\* (0.7%). Equal cost reductions across all destinations allow the most productive locations to capture disproportionate benefits, as workers flow predominantly toward major cities (+1.43%) and upper-tier provinces (+0.49%) due to their agglomeration advantages.

Finally, the non-A\* access reform (M3) achieves the strongest redistribution. Figure A9 illustrates the dynamic transformation, showing how migration flows initially increase toward A\* provinces before subsequently redirecting to A provinces in the steady state.

The policy's effectiveness stems from its ability to trigger an immediate and counterintuitive firm response. When migration barriers are reduced only for non-metro destinations, workers across all locations become less likely to start their own businesses, anticipating better opportunities as employees due to enhanced labor mobility. However, this entrepreneurship decline is smallest in A\* provinces due to their inherent productivity advantages and the fact that their migration costs remain unchanged. This creates a temporary but crucial imbalance: labor demand falls everywhere but least in A\* metros, prompting workers facing reduced employment opportunities in their current locations to migrate toward A\* provinces where productivity and job prospects remain highest.

This initial migration surge toward major cities serves a critical economic function, effectively using A\* provinces as shock absorber during the policy transition. The temporary concentration allows the economy to maintain productivity while firms and workers adjust to the new spatial incentives.

As the economy transitions toward steady state, the migration patterns reverse, revealing the policy's long-term redistributive power. Firms begin entering A provinces in greater numbers, attracted by two complementary factors: improved labor mobility between non-A\* regions that reduces their future hiring costs, and anticipation of productivity gains from enhanced worker access as the policy matures. This gradual but substantial firm entry creates employment opportunities that become increasingly attractive relative to congested A\* metros.

The superior redistributive performance of M3 stems from its ability to generate the most decisive spatial reallocation of firms away from major cities (-1.38%) while simultaneously creating viable alternative development poles. By completely excluding A\* provinces from cost reductions, the policy forces entrepreneurs to locate where workers can move freely, creating strong employment magnets in A and B provinces that can effectively compete with major cities for migrant flows.

Paradoxically, this complete exclusion of metros from cost reductions preserves their productive capacity better than partial approaches. M3 results in smaller long-term worker losses from major cities (-0.23%) compared to the actual reform's partial approach (-0.69%), demonstrating how strategic constraints can achieve spatial rebalancing without undermining the productivity of existing centers.

These results demonstrate that migration policy design fundamentally shapes distributional outcomes. Rather than simply removing barriers, strategic targeting of migration reforms can redirect development toward secondary centers and reduce spatial inequality. The key insight is that carefully designed migration barriers reductions may better serve both efficiency and equity objectives by fostering balanced spatial development.

## 7.2 Policy Combinations

To explore how different spatial policies interact, I construct a comprehensive menu that varies place-based tax incentives and migration reforms. Table 3 summarizes the policy combinations, with each evaluated along two dimensions that capture the fundamental tension in spatial policy

Table 3: Policy Menu: Welfare Effects and Spatial Inequality Reduction

Code	Policy Name	Migration	Tax	Welfare (%)	Gini Reduction (%)
T1	2003 Tax Reform	—	✓	0.73	0.21
M1	Ho Khau 2005	✓	—	0.53	0.59
M2	A* Access	✓	—	0.13	0.01
M3	Non-A* Access	✓	—	1.20	1.25
M4	Uniform Access	✓	—	0.92	0.66
C1	Tax Reform + HK	✓	✓	1.25	0.71
C2	Tax Reform + A*	✓	✓	0.85	0.21
C3	Tax Reform + Non-A*	✓	✓	1.90	1.26
C4	Tax Reform + Uniform	✓	✓	1.63	0.77

*Notes:* This table presents counterfactual policy experiments comparing individual policies and their combinations. Migration policies include: Ho Khau 2005 (M1: asymmetric cost reductions favoring non-metro destinations), A\* Access (M2: cost reductions only to major cities), Non-A\* Access (M3: cost reductions excluding major cities), and Uniform Access (M4: equal cost reductions across all province pairs). Tax policy (T1) refers to the 2003 tax reform targeting disadvantaged areas. Welfare shows population-weighted mean welfare change relative to no-policy economy. Gini Reduction measures percentage reduction in spatial inequality of welfare across provinces, with higher values indicating stronger redistribution.

design: population-weighted aggregate welfare changes (efficiency) and percentage reduction in spatial inequality of welfare across provinces (equity).

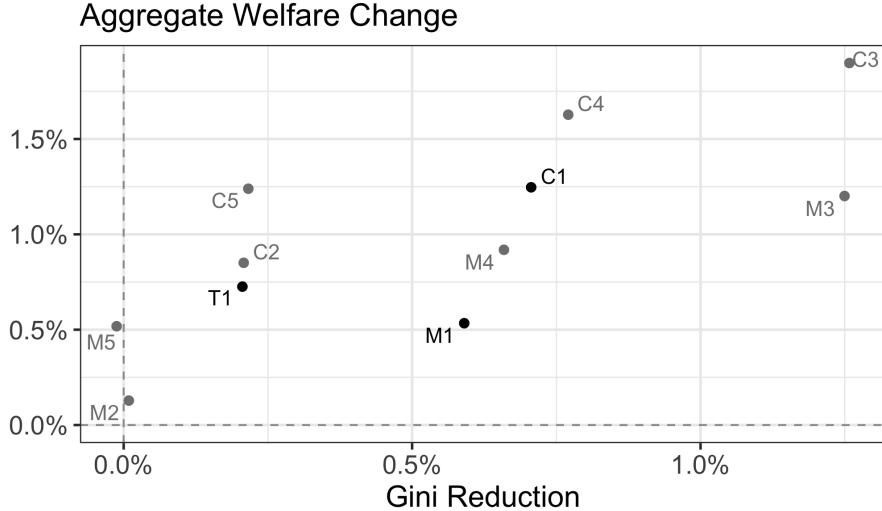
The stark differences among individual policies reveal that targeting strategy is crucial in determining effectiveness. The 2003 Tax Reform (T1) generates modest welfare gains of 0.73% and limited spatial redistribution (0.21%), establishing a baseline for place-based interventions.

Migration policies show dramatically heterogenous patterns on their spatial targeting. The actual Ho Khau reform (M1) produces nearly three times the redistributive impact (0.59%) despite lower aggregate welfare gains (0.53%) relative to T1, indicating that mobility frictions rather than lack of employment opportunities constitute the primary constraint on spatial equity.

The variation across migration designs is particularly striking. A\* Access (M2) performs poorly on both dimensions—generating only 0.13% welfare gains and virtually no redistribution (0.01%)—because it facilitates movement toward already-prosperous locations, facilitating agglomeration. Uniform Access (M4) falls between extremes with moderate performance (0.92%, 0.66%).

Most remarkably, Non-A\* Access (M3) dominates all other individual policies, achieving the highest welfare gains 1.20% and strongest redistribution 1.25% by channeling mobility toward secondary centers. This single migration policy performs almost as well as the actual combined reform package (C1: 1.25%, 0.71%), demonstrating that careful design can substitute for policy scale.

Figure 12: The Efficiency-Equity Frontier in Spatial Policy Design



*Notes:* Vertical axis shows population-weighted aggregate welfare change (%) relative to no-policy baseline. Horizontal axis shows percentage reduction in spatial inequality measured by Gini coefficient of welfare across provinces. Each point represents a policy combination from Table 3. Points toward the upper-right indicate policies achieving both higher efficiency and stronger redistribution.

Figure 12 places every policy combination in efficiency-equity space, revealing the quantitative frontier that governs spatial policy choices. The superior performance of M3 relative to policy combinations becomes visually apparent—it achieves nearly identical outcomes to C1 while using only a single, well-targeted instrument.

Tax Reform and Ho Khau (C1) generates 0.71% Gini reduction—higher than either T1 (0.21%) or M1 (0.59%) alone, but far less than their simple sum would suggest ( $0.71 + 0.59\%$ ). More strikingly, C1’s redistributive impact is almost exactly half that of the Non-A\* Access (M3) policy alone (1.26% vs. 1.25%), revealing how allowing any mobility toward major metros creates substantial leakage that undermines spatial redistribution.

The most revealing case is Tax Reform + Non-A\* Access (C3), which achieves the highest aggregate welfare 1.90% but only 1.26% reduction—barely above Non-A\* Access alone 1.25%. This result challenges the intuitive logic that moving both “jobs to people” and “people to jobs” toward the same disadvantaged regions should reinforce each other. Instead, C3 demonstrates that even perfectly aligned geographic targeting cannot overcome the fundamental arbitrage problem.

The explanation lies in worker mobility creating continued spatial arbitrage even within constrained geographic spaces. Tax incentives make some specific locations within the Non-A\* category more attractive than others, while migration reform allows workers to move toward these most-improved locations rather than staying in places that initially needed the most help. Workers still arbitrage—just within a more constrained geographic space—spreading redistribution across the entire Non-A\* region rather than concentrating it where initially needed most.

Enhanced mobility allows workers to sort across an expanded set of viable opportunities rather than concentrating in either initially rich areas or tax-incentivized areas. The result is higher aggregate welfare through more efficient spatial allocation, but substantial leakage toward already-prosperous locations limits redistributive gains. This substitution pattern persists even when both policies target identical geographic areas, revealing that the interaction between firm location decisions and worker mobility systematically undermines spatial concentration.

### 7.3 Implications for the “Places vs. People” Debate

These findings suggest we should move beyond the “jobs to people” versus “people to jobs” framework. The real issue lies not in the direction of policy intervention, but in how firm location decisions and worker mobility interact to either create or undermine spatial development. The results here show that simply combining both approaches toward poor places cannot overcome the arbitrage problem—enhanced mobility allows continued sorting that limits redistributive gains regardless of policy coordination.

The performance of Non-A\* Access (M3) points toward a different policy logic that resembles successful Special Economic Zone strategies. Effective spatial policy requires strategic economic geography: identifying viable secondary centers with sufficient development potential, providing coordinated incentives to make them attractive to firms, and crucially, encouraging mobility to ensure adequate worker concentration for agglomeration effects while preventing leakage to already-successful locations.

### 7.4 Sensitivity Analysis

To ensure the robustness of the main findings, I examine how alternative calibrations of the migration elasticity parameter affect the efficiency-equity frontier. The baseline analysis uses  $\nu = 1.6$ , but migration elasticities estimated in the literature vary considerably across contexts and methodologies. I therefore re-estimate the model under two alternative calibrations: a lower elasticity of  $\nu = 1.1$ , representing more elastic migration responses, and a higher elasticity of  $\nu = 2.85$  similar to [Atalay et al. \(2023\)](#), representing more inelastic migration behavior.

Figures A11 and A12 demonstrate stability in the core findings across these alternative parameter values. The relative ranking of policies remains unchanged: Non-A\* Access (M3) continues to dominate other individual policies in both welfare and redistribution dimensions, while policy combinations exhibit the same partial substitution patterns observed in the baseline. The absolute magnitudes of welfare gains and inequality reduction vary with the migration elasticity—higher elasticities amplify both efficiency and distributional effects—but the fundamental insight that strategic geographic targeting matters more than instrument choice persists across all specifications.

## 8 Conclusion

This paper asked whether governments should address spatial inequality by bringing jobs to people or helping people move to jobs. Using Vietnam’s implementation of both approaches, I find that policy design matters more than instrument choice: strategic targeting can achieve substantial redistribution without efficiency costs.

Three key insights emerge. First, migration policy dominates place-based tax incentives for spatial redistribution, achieving nearly three times the inequality reduction by addressing the binding constraint: mobility frictions rather than lack of employment opportunities. Second, the policies function as partial substitutes where the actual policy package outperforms each policy alone but not the sum of their individual effects. Third, strategic geographic targeting dramatically enhances effectiveness: reducing migration frictions to everywhere except major cities nearly doubles the redistributive impact and as much as the aggregate welfare of the actual policy package. Thus, the results suggest moving beyond “jobs to people” versus “people to jobs” debate toward careful design of spatial policy.

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## A Imputing Annual Gross Migration Flows

In this appendix, I describe the procedure used to get the annual gross migration flows across provinces where direct data are unavailable.

My analysis requires annual blocks of data from 2000 to 2019. From the population census sources, I observe *gross* migration flows for the 5-year intervals 1994–1999, 2004–2009, and 2014–2019. I adapt the approach in Kleinman et al. (2023) to uncover annual migration flows.

In the first step, I use migration flows data 1994–1999 and combine them with equation (10) to estimate the bilateral migration costs  $m_{int}$  during this period. I assume that bilateral migration costs are symmetric between any pair  $in$ , and normalizing own migration frictions  $ii$  to one, (10) implies that

$$\frac{\mu_{int}\mu_{nit}}{\mu_{iit}\mu_{nnt}} = \exp\left(\frac{-1}{\nu}(m_{int} + m_{nit})\right) = \exp\left(\frac{-2}{\nu}m_{int}\right)$$

Next, I assume that these migration costs are constant between 1999 and 2004. Then, I can solve for the expected value  $U_{it+1}$  for all  $t \in \{2000, 2001, 2002, 2003\}$  by combining the inferred migration costs  $m_{int}$ , observed data between 1999 and 2004 including population, firm entry and exit, and the number of firms, and equilibrium condition (30):

$$L_{it+1} = \sum_{n=1}^N \frac{\exp(\beta U_{it+1} - m_{nit})^{1/\nu}}{\sum_{i'=1}^N \exp(\beta U_{i't+1} - m_{i'nt})^{1/\nu}} \psi_{nt}^0 L_{nt} + \sum_{j=1}^J \sum_a (1 - \varsigma_{it}^{ja}) E_{it}^{ja},$$

which uniquely pins down the expected values  $U_{it+1}$  up to a normalization. This equilibrium condition is under perfect foresight assumption. In this process, for given  $U_{it+1}$ , I can also compute migration flows using equation (10), which gives the gross migration flows  $\mu_{int}$  for  $t \in \{2000, 2001, 2002, 2003\}$ .

## B Proofs

### B.1 Proof of Proposition 1

I want to show that given allocation at a given period  $t$ ,  $(\mathcal{S}_t, \mu_{t-1}, \varsigma_{t-1}, \psi_{t-1}, \lambda_t)$  and constant sequences of policies  $\mathcal{P}_{t'}$  and fundamentals  $\mathcal{F}_{t'}$  where  $t' > t$  following  $t$ , the sequential equilibrium in relative time change can be solved without knowing the levels of fundamentals  $\mathcal{F}_t$  and policies  $\mathcal{P}_t$  at  $t$ . Recall the definition of the dot notation for any variable  $y$ ,  $\dot{y}_{t+1} \equiv \frac{y_{t+1}}{y_t}$ . Then, I use the following equilibrium conditions to solve for the baseline economy after 2019:

$$\dot{v}_{it}^{ja} = \dot{c}_{it}^{ja} \left[ \varsigma_{i,t-1}^{ja} \left( \dot{v}_{it+1}^{ja+1} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.1})$$

$$\dot{\Xi}_{it} = \left( \sum_{n=1}^N \mu_{in,t-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}} \right)^{\nu} \quad (\text{B.2})$$

$$\dot{u}_{it} = \left( \frac{\dot{G}_{it}}{\dot{\mathcal{L}}_{it}} \right)^{\gamma} \left( \frac{\dot{w}_{it}}{\dot{P}_{it}} \right)^{1-\gamma} \left[ \psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.3})$$

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}^{ja} \left( \dot{v}_{it+1}^{ja+1} \right)^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} \left( \dot{v}_{it+1}^{ja+1} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} \quad (\text{B.4})$$

$$\psi_{it}^j = \frac{\psi_{it-1}^j \left( \dot{v}_{it+1}^{j1} \right)^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}, \forall j > 0 \quad (\text{B.5})$$

$$\psi_{it}^0 = \frac{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}} \quad (\text{B.6})$$

$$\mu_{int} = \frac{\mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}}{\sum_{c=1}^N \mu_{ict-1} (\dot{u}_{ct+1})^{\frac{\beta}{\nu}} (\dot{m}_{ict})^{\frac{-1}{\nu}}}, \quad (\text{B.7})$$

as well as the equilibrium evolutions of workers and entrepreneurs

$$L_{it+1} = \sum_{n=1}^N \mu_{nit} \psi_{nt}^0 L_{nt} + \sum_{j=1}^J \sum_{a \in \{1, a, a\}} \left( 1 - \varsigma_{it}^{ja} \right) E_{it}^{ja}. \quad (\text{B.8})$$

$$E_{it+1}^{ja} = \varsigma_{it}^{ja} E_{it}^{j1} \quad (\text{B.9})$$

$$E_{it+1}^{j1} = \psi_{it}^j L_{it}. \quad (\text{B.10})$$

Notice that  $\dot{w}_{it}, \dot{P}_{it}, \dot{G}_{it}$  is the solution to the temporary equilibrium given the sequences of workers and entrepreneurs. The following equilibrium

$$\dot{P}_{it+1}^j = \left( \sum_n \lambda_{nit}^j E_{nt+1}^j \left( \dot{p}_{nit+1}^j \right)^{1-\sigma} \right)^{1/(1-\sigma)} \quad (\text{B.11})$$

$$\dot{P}_{it+1} = \prod_{j=1}^J (\dot{P}_{it+1}^j)^{\alpha^j} \quad (\text{B.12})$$

$$\dot{r}_{it+1} = \dot{w}_{it+1} \frac{\sum_j \frac{1-\xi^j}{\xi^j} L_{it+1}^j}{\sum_j \frac{1-\xi^j}{\xi^j} L_{it}^j}. \quad (\text{B.13})$$

$$\dot{r}_{it+1} = \dot{w}_{it+1} \dot{L}_{it+1} \text{ if } \xi^j = \xi^{j'} \forall j' \neq j \quad (\text{B.14})$$

$$\dot{p}_{int+1}^j = \dot{x}_{it+1}^j = (\dot{w}_{it+1})^{\xi^j} (\dot{r}_{it+1})^{1-\xi^j} \quad (\text{B.15})$$

$$\dot{\lambda}_{int+1}^j = \dot{E}_{it+1}^j \left( \frac{\dot{p}_{int+1}^j}{\dot{P}_{nt+1}^j} \right)^{1-\sigma} \quad (\text{B.16})$$

$$\pi_{it+1}^j = \frac{1}{\sigma} \sum_{n=1}^N (\dot{x}_{it+1}^j)^{1-\sigma} (\dot{P}_{nt+1}^j)^{\sigma-1} \frac{\lambda_{int}^j}{E_{it}^j} X_{nt+1}^j \quad (\text{B.17})$$

$$X_{it+1} = \alpha^j \left( P_{it+1} G_{it+1} + \sum_{j=1}^J \dot{w}_{it+1} w_{it} \dot{L}_{it+1}^j L_{it}^j + \sum_{j=1}^J \sum_a (E_{it+1}^{ja} (1 - \tau_{it+1}^a)) \pi_{it+1}^j \right) \quad (\text{B.18})$$

$$P_{it+1} G_{it+1} = \Omega_{it+1} \Lambda_{t+1} + \omega_{it+1} \sum_{j=1}^J \left( \frac{1-\xi^j}{\xi^j} w_{it+1} L_{it+1}^j + \sum_a (E_{it+1}^{ja} \tau_{it+1}^a) \pi_{it+1}^j \right) \quad (\text{B.19})$$

$$\dot{w}_{it+1} \dot{L}_{it+1}^j w_{it} L_t^j = \xi^j \frac{\sigma-1}{\sigma} \sum_{n=1}^N \dot{\lambda}_{int+1}^j \lambda_{int}^j X_{nt+1}^j \quad (\text{B.20})$$

**Deriving temporary equilibrium:** I show how to derive each of these temporary equilibrium equations first. To derive (B.11), first recall from the model the sectoral price index in location  $i$ , sector  $j$ , and period  $t$  as:

$$P_{it}^j = \left( \sum_{n=1}^N E_{nt}^j (p_{nit}^j)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}.$$

Define the “dot” notation for any variable  $x_{t+1}$  as  $\dot{x}_{t+1} \equiv x_{t+1}/x_t$ . In particular,

$$\dot{P}_{it+1}^j = \frac{P_{it+1}^j}{P_{it}^j}, \quad \dot{E}_{nt+1}^j = \frac{E_{nt+1}^j}{E_{nt}^j}, \quad \dot{p}_{nit+1}^j = \frac{p_{nit+1}^j}{p_{nit}^j}.$$

Taking the ratio of next-period and current-period price indices yields

$$\dot{P}_{it+1}^j = \frac{P_{it+1}^j}{P_{it}^j} = \frac{\left( \sum_{n=1}^N E_{nt+1}^j (p_{nit+1}^j)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}}{\left( \sum_{n=1}^N E_{nt}^j (p_{nit}^j)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}}.$$

I can rewrite this expression as

$$\dot{P}_{it+1}^j = \left( \frac{\sum_{n=1}^N E_{nt+1}^j (p_{nit+1}^j)^{1-\sigma}}{\sum_{n=1}^N E_{nt}^j (p_{nit}^j)^{1-\sigma}} \right)^{\frac{1}{1-\sigma}}.$$

I can factor out  $E_{nt}^j (p_{nit}^j)^{1-\sigma}$  inside the numerator:

$$\sum_{n=1}^N E_{nt+1}^j (p_{nit+1}^j)^{1-\sigma} = \sum_{n=1}^N [E_{nt}^j (p_{nit}^j)^{1-\sigma}] \frac{E_{nt+1}^j}{E_{nt}^j} \left( \frac{p_{nit+1}^j}{p_{nit}^j} \right)^{1-\sigma}.$$

Hence I can rewrite it as

$$\sum_{n=1}^N E_{nt+1}^j (p_{nit+1}^j)^{1-\sigma} = \sum_{n=1}^N [E_{nt}^j (p_{nit}^j)^{1-\sigma}] \dot{E}_{nt+1}^j (p_{nit+1}^j)^{1-\sigma}.$$

Recall the trade share  $\lambda_{nit}^j$  from (22):

$$\lambda_{nit}^j = \frac{E_{nt}^j (p_{nit}^j)^{1-\sigma}}{\sum_{m=1}^M E_{mt}^j (p_{mit}^j)^{1-\sigma}}.$$

Then,

$$\frac{\sum_n E_{nt+1}^j (p_{nit+1}^j)^{1-\sigma}}{\sum_n E_{nt}^j (p_{nit}^j)^{1-\sigma}} = \sum_{n=1}^N \lambda_{nit}^j \dot{E}_{nt+1}^j (p_{nit+1}^j)^{1-\sigma}.$$

Putting all pieces together back yields (B.11).

$$\dot{P}_{it+1}^j = \left( \sum_{n=1}^N \lambda_{nit}^j \dot{E}_{nt+1}^j (p_{nit+1}^j)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}.$$

To get the local price index in dot form, recall the level equation for  $P_{it}$  from (4) which is a Cobb–Douglas aggregate over sectoral price indices  $P_{it}^j$ :

$$P_{it} = \prod_{j=1}^J \left( \frac{P_{it}^j}{\alpha^j} \right)^{\alpha^j}$$

Taking the ratio from  $t$  to  $t + 1$  yields

$$\dot{P}_{it+1} = \frac{\prod_{j=1}^J \left( \frac{P_{it+1}^j}{\alpha^j} \right)^{\alpha^j}}{\prod_{j=1}^J \left( \frac{P_{it}^j}{\alpha^j} \right)^{\alpha^j}} = \prod_{j=1}^J \left( \frac{P_{it+1}^j}{P_{it}^j} \right)^{\alpha^j} = \prod_{j=1}^J \left( \dot{P}_{it+1}^j \right)^{\alpha^j}.$$

Hence we obtain (B.12).

I now turn to the rental cost of land to derive (B.13). Recall the market clearing condition for land market (14),

$$r_{it} H_{it}^j = \frac{1 - \xi^j}{\xi^j} w_{it} L_{it}^j,$$

Summing over all sectors  $j$  yields:

$$r_{it} \sum_j H_{it}^j = \sum_j \left[ \frac{1 - \xi^j}{\xi^j} w_{it} L_{it}^j \right].$$

Notice that  $\sum_j H_{it}^j$  is the total land endowment  $H_i$  (which is assumed constant across time), then

$$r_{it} H_i = w_{it} \sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it}^j, \implies r_{it} = w_{it} \frac{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it}^j}{H_i}.$$

Taking ratios over time yields

$$\dot{r}_{it+1} = \frac{r_{it+1}}{r_{it}} = \frac{w_{it+1} [\sum_j \frac{1 - \xi^j}{\xi^j} L_{it+1}^j] / H_i}{w_{it} [\sum_j \frac{1 - \xi^j}{\xi^j} L_{it}^j] / H_i} = \frac{w_{it+1}}{w_{it}} \frac{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it+1}^j}{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it}^j}.$$

In dot notation:

$$\dot{r}_{it+1} = \dot{w}_{it+1} \frac{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it+1}^j}{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it}^j}.$$

Consider the special case in which  $\xi^j = \xi$  for all  $j$ . In the special case where every sector has the same labor share  $\xi^j = \xi$ , we get:

$$\frac{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it+1}^j}{\sum_j \left( \frac{1 - \xi^j}{\xi^j} \right) L_{it}^j} = \frac{\sum_j L_{it+1}^j}{\sum_j L_{it}^j} \equiv \dot{L}_{it+1},$$

Consequently,

$$\dot{r}_{it+1} = \dot{w}_{it+1} \dot{L}_{it+1}.$$

Now, I turn to monopolistic price and unit cost in dot form (B.15). Recall the static price setting and unit cost.

$$p_{int}^j = \frac{\sigma}{\sigma - 1} \frac{d_{in}^j x_{it}^j}{A_{it}^j},$$

where  $x_{it}^j$  is the *unit cost* for production in location  $i$ , sector  $j$ :

$$x_{it}^j = B^j (w_{it})^{\xi^j} (r_{it})^{1 - \xi^j}.$$

Thus, up to the  $\frac{\sigma}{\sigma-1} \frac{d_{in}^j}{A_{it}^j}$  factor, the behavior of  $p_{int}^j$  is essentially the same as  $x_{it}^j$  from period to period. Thus, I can express  $\dot{p}_{int+1}^j$  in terms of  $\dot{x}_{it+1}^j$ . Because  $\sigma/(\sigma-1)$ ,  $d_{in}^j$ , and  $A_{it}^j$  are assumed constant from 2019 onwards, one can write:

$$\dot{p}_{int+1}^j = \dot{x}_{it+1}^j.$$

Hence, I focus on expressing  $\dot{x}_{it+1}^j$  in terms of  $\dot{w}_{it+1}$  and  $\dot{L}_{it+1}$ . From the definition,

$$x_{it}^j = B^j (w_{it})^{\xi^j} (r_{it})^{1-\xi^j},$$

we take the ratio from  $t$  to  $t+1$ :

$$\dot{x}_{it+1}^j = \frac{x_{it+1}^j}{x_{it}^j} = \left( \frac{w_{it+1}}{w_{it}} \right)^{\xi^j} \left( \frac{r_{it+1}}{r_{it}} \right)^{1-\xi^j} = (\dot{w}_{it+1})^{\xi^j} (\dot{r}_{it+1})^{1-\xi^j}$$

In the special case of  $\xi^j = \xi$  for all  $j$ ,

$$\dot{x}_{it+1}^j = \dot{w}_{it+1}^{\xi} (\dot{w}_{it+1} \dot{L}_{it+1})^{1-\xi} = \dot{w}_{it+1} (\dot{L}_{it+1})^{1-\xi}.$$

$$\dot{p}_{int+1}^j = \dot{x}_{it+1}^j = \dot{w}_{it+1} (\dot{L}_{it+1})^{1-\xi}.$$

Next, I want to show that

$$\dot{\lambda}_{int+1}^j = \dot{E}_{it+1}^j \left( \frac{\dot{p}_{int+1}^j}{\dot{P}_{nt+1}^j} \right)^{1-\sigma}.$$

Recall the definition of the sectoral trade share (22)

$$\lambda_{int}^j = \frac{E_{it}^j (p_{int}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot}^j (p_{ont}^j)^{1-\sigma}},$$

Then,

$$\dot{\lambda}_{int+1}^j = \frac{\lambda_{int+1}^j}{\lambda_{int}^j} = \frac{\frac{E_{it+1}^j (p_{int+1}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot+1}^j (p_{ont+1}^j)^{1-\sigma}}}{\frac{E_{it}^j (p_{int}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot}^j (p_{ont}^j)^{1-\sigma}}}.$$

Observe that

$$\sum_{o=1}^N E_{ot+1}^j (p_{ont+1}^j)^{1-\sigma} = \sum_{o=1}^N [E_{ot}^j (p_{ont}^j)^{1-\sigma}] \dot{E}_{ot+1}^j (\dot{p}_{ont+1}^j)^{1-\sigma}.$$

Recall the dot definition of  $P_{nt+1}^j$ .

$$(\dot{P}_{nt+1}^j)^{1-\sigma} = \frac{\sum_{o=1}^N E_{ot+1}^j (p_{ont+1}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot}^j (p_{ont}^j)^{1-\sigma}}.$$

Therefore,

$$\frac{1}{(\dot{P}_{nt+1}^j)^{1-\sigma}} = \frac{\sum_{o=1}^N E_{ot}^j (p_{ont}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot+1}^j (p_{ont+1}^j)^{1-\sigma}}.$$

Putting it all together,

$$\lambda_{int+1}^j = \frac{E_{it+1}^j (p_{int+1}^j)^{1-\sigma}}{E_{it}^j (p_{int}^j)^{1-\sigma}} \times \frac{\sum_{o=1}^N E_{ot}^j (p_{ont}^j)^{1-\sigma}}{\sum_{o=1}^N E_{ot+1}^j (p_{ont+1}^j)^{1-\sigma}} = \dot{E}_{it+1}^j (p_{int+1}^j)^{1-\sigma} \times \frac{1}{(\dot{P}_{nt+1}^j)^{1-\sigma}}.$$

This completes the dot derivation for trade share (B.16).

Next, I want to show (B.17)

$$\pi_{it+1}^j = \frac{1}{\sigma} \sum_{n=1}^N (\dot{x}_{it+1}^j)^{1-\sigma} (\dot{P}_{nt+1}^j)^{\sigma-1} \frac{\lambda_{int}^j}{E_{it}^j} X_{nt+1}^j.$$

Recall the level definition of profits (16):

$$\pi_{it}^j = \left(\frac{\sigma-1}{\sigma}\right)^\sigma \left(\frac{A_{it}^j}{x_{it}^j}\right)^{\sigma-1} \sum_{n=1}^N (d_{in}^j)^{1-\sigma} X_{nt}^j (P_{nt}^j)^{\sigma-1},$$

or

$$\pi_{it+1}^j = \sum_n \dot{\pi}_{int+1}^j \pi_{int}^j$$

where  $\pi_{int}$  is the profit of selling from  $i$  to  $n$  which is given by

$$\pi_{int}^j = \frac{p_{int}^j y_{int}^j}{\sigma} = \frac{\lambda_{int}^j X_{nt}^j}{\sigma E_{it}^j}$$

Also, I can write

$$\dot{\pi}_{int+1}^j = \frac{\pi_{int+1}^j}{\pi_{int}^j} = \frac{(p_{int+1}^j)^{1-\sigma} (P_{nt+1}^j)^{\sigma-1} X_{nt+1}^j}{(p_{int}^j)^{1-\sigma} (P_{nt}^j)^{\sigma-1} X_{nt}^j} = (\dot{x}_{it+1}^j)^{1-\sigma} (\dot{P}_{nt+1}^j)^{\sigma-1} \dot{X}_{nt+1}^j$$

Hence, we obtain

$$\pi_{it+1}^j = \frac{1}{\sigma} \sum_{n=1}^N (\dot{x}_{it+1}^j)^{1-\sigma} (\dot{P}_{nt+1}^j)^{\sigma-1} \frac{\lambda_{int}^j}{E_{it}^j} X_{nt+1}^j.$$

Local government expenditure (20):

$$P_{it+1}G_{it+1} = \Omega_{it+1}\Lambda_{t+1} + \omega_{it+1} \left( \dot{r}_{it+1}r_{it}H_i + \sum_{j=1}^J \sum_{s=1}^a E_{it+1}^{ja} \tau_{it+1}^a \pi_{it+1}^j \right)$$

where

$$\Lambda_{t+1} = \sum_{i=1}^N (1 - \omega_{it+1}) \left( \dot{r}_{it+1} w_{it} \sum_j \frac{1 - \xi^j}{\xi^j} L_{it}^j + \sum_{j=1}^J \sum_{s=1}^a E_{it+1}^{ja} \tau_{it+1}^a \pi_{it+1}^j \right)$$

Recall that by the assumption of constant fundamentals and policies, we have  $\Omega_{it+1} = \Omega_{it}$ ,  $\omega_{it+1} = \omega_{it}$ , and  $\tau_{it+1}^s = \tau_{it}^s$  from 2019.

Turning to local income, we have

$$\Pi_{it+1} = P_{it+1}G_{it+1} + \sum_{j=1}^J \dot{w}_{it+1} w_{it} \dot{L}_{it+1}^j L_{it}^j + \sum_{j=1}^J \sum_a E_{it+1}^{ja} (1 - \tau_{it+1}^s) \pi_{it+1}^j.$$

Finally, from market clearing condition (25):

$$\dot{w}_{it+1} \dot{L}_{it+1}^j w_{it} L_t^j = \xi^j \frac{\sigma - 1}{\sigma} \sum_{n=1}^N \dot{\lambda}_{int+1}^j \lambda_{int}^j \alpha^j \Pi_{it+1}$$

**Deriving the value functions:** I will now demonstrate the equilibrium conditions of the value functions. First, the following explains how to obtain (B.3):

$$\dot{u}_{it} = \left( \frac{\dot{G}_{it}}{\dot{\mathcal{L}}_{it}} \right)^{\gamma_i} \left( \frac{\dot{w}_{it}}{\dot{P}_{it}} \right)^{1-\gamma_i} \left[ \psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^{\chi}.$$

Recall the level form of  $U_{it}$ . In the model, the worker's expected utility  $U_{it}$  is given by (11):

$$U_{it} = \gamma \ln \left( \frac{G_{it}}{\mathcal{L}_{it}} \right) + (1 - \gamma) \ln \left( \frac{w_{it}}{P_{it}} \right) + \chi \ln \left[ \exp(\Xi_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{it+1}^{j1})^{\frac{\beta}{\chi}} \right].$$

With a slight abuse of notation, define  $u_{it} \equiv \exp(U_{it})$ . Then

$$u_{it} = \exp(U_{it}) = \left( \frac{G_{it}}{\mathcal{L}_{it}} \right)^{\gamma} \left( \frac{w_{it}}{P_{it}} \right)^{1-\gamma} \left[ \exp(\Xi_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^{\chi}.$$

Similar to  $u_{it}$ , let's define  $v_{it+1}^{j1} \equiv \exp(V_{it+1}^{j1})$  and

$$\tilde{\Xi}_{it} \equiv \exp(\Xi_{it})$$

We write:

$$\dot{u}_{it} \equiv \frac{u_{it}}{u_{it-1}}, \quad \dot{G}_{it} \equiv \frac{G_{it}}{G_{it-1}}, \quad \dot{w}_{it} \equiv \frac{w_{it}}{w_{it-1}}, \quad \dot{\Xi}_{it} \equiv \frac{\tilde{\Xi}_{it}}{\tilde{\Xi}_{it-1}}, \quad \dot{v}_{it}^{j1} \equiv \frac{v_{it}^{j1}}{v_{it-1}^{j1}}$$

Hence,

$$\dot{u}_{it} = \frac{\left(\frac{G_{it}}{\mathcal{L}_{it}}\right)^\gamma \left(\frac{w_{it}}{P_{it}}\right)^{1-\gamma} \left[ (\tilde{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^\chi}{\left(\frac{G_{it-1}}{\mathcal{L}_{it-1}}\right)^\gamma \left(\frac{w_{it-1}}{P_{it-1}}\right)^{1-\gamma} \left[ (\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it}^{j1})^{\frac{\beta}{\chi}} \right]^\chi}.$$

For the bracketed expression, note that

$$\frac{(\tilde{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it+1}^{j1})^{\frac{\beta}{\chi}}}{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it}^{j1})^{\frac{\beta}{\chi}}} = \frac{(\dot{\Xi}_{it})^{\frac{1}{\chi}} (\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} (v_{it}^{j1})^{\frac{\beta}{\chi}}}{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it}^{j1})^{\frac{\beta}{\chi}}}.$$

Recall (7) and (6):

$$\psi_{it-1}^0 = \frac{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}}}{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it}^{j1})^{\frac{\beta}{\chi}}}, \quad \psi_{it-1}^j = \frac{(v_{it}^{j1})^{\frac{\beta}{\chi}}}{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{k=1}^J (v_{it}^{k1})^{\frac{\beta}{\chi}}}.$$

Thus,

$$\frac{(\tilde{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it+1}^{j1})^{\frac{\beta}{\chi}}}{(\tilde{\Xi}_{it-1})^{\frac{1}{\chi}} + \sum_{j=1}^J (v_{it}^{j1})^{\frac{\beta}{\chi}}} = \psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}.$$

Putting it all together, we get

$$\dot{u}_{it} = \left(\frac{\dot{G}_{it}}{\dot{\mathcal{L}}_{it}}\right)^\gamma \left(\frac{\dot{w}_{it}}{\dot{P}_{it}}\right)^{1-\gamma} \left[ \psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^\chi.$$

Next, we want to show (B.1)

$$\dot{v}_{it}^{ja} = \dot{c}_{it}^{ja} \left[ \varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}} \right]^\chi.$$

Recall the level equation for  $v_{it}^{ja}$  (18):

$$V_{it}^{ja} = \ln(c_{it}^{ja}) + \chi \ln \left[ \exp(V_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + \exp(U_{it+1})^{\frac{\beta}{\chi}} \right],$$

Define

$$v_{it}^{ja} \equiv \exp(V_{it}^{ja}).$$

Then,

$$v_{it}^{ja} = c_{it}^{ja} [(v_{it+1}^{ja})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}]^{\chi}.$$

Using the dot (ratio) notation between  $t - 1$  and  $t$ , I have

$$\dot{v}_{it}^{ja} \equiv \frac{v_{it}^{ja}}{v_{it-1}^{ja}} = \dot{c}_{it}^{ja} \left[ \frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}}{(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}} \right]^{\chi}$$

Recall the continuation probability (19)

$$\varsigma_{it}^{ja} = \frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}},$$

Hence,

$$\dot{v}_{it}^{ja} = \dot{c}_{it}^{ja} \left[ \varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}} \right]^{\chi}.$$

Next, I want to show (B.2):

$$\dot{\Xi}_{it} = \left( \sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{-\frac{1}{\nu}} \right)^{\nu}.$$

Recall the level form of  $\Xi_{it}$ , (9),

$$\Xi_{it} = \log \left[ \sum_{n=1}^N \exp \left( \beta U_{nt+1} - m_{int} \right)^{\frac{1}{\nu}} \right]^{\nu},$$

Equivalently, we can write:

$$\tilde{\Xi}_{it} \equiv \exp(\Xi_{it}) = \left[ \sum_{n=1}^N \exp \left( \beta U_{nt+1} - m_{int} \right)^{\frac{1}{\nu}} \right]^{\nu}.$$

We have:

$$\dot{\Xi}_{it} = \frac{\tilde{\Xi}_{it}}{\tilde{\Xi}_{it-1}} = \left[ \frac{\sum_{n=1}^N \exp \left( \beta U_{nt+1} - m_{int} \right)^{\frac{1}{\nu}}}{\sum_{n=1}^N \exp \left( \beta U_{nt} - m_{int-1} \right)^{\frac{1}{\nu}}} \right]^{\nu}.$$

Inside the numerator sum, for each  $n$ :

$$\exp \left( \beta U_{nt+1} - m_{int} \right)^{\frac{1}{\nu}} = \underbrace{\exp \left( \beta U_{nt} - m_{int-1} \right)^{\frac{1}{\nu}}}_{\text{period } (t-1) \text{ baseline}} \times (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{-\frac{1}{\nu}}.$$

where

$$\dot{m}_{int} \equiv \frac{\exp m_{int}}{\exp m_{int-1}}.$$

Collecting terms to get the final bracket

$$\frac{\sum_{n=1}^N \exp(\beta U_{nt+1} - m_{int})^{\frac{1}{\nu}}}{\sum_{n=1}^N \exp(\beta U_{nt} - m_{int-1})^{\frac{1}{\nu}}} = \sum_{n=1}^N \frac{\exp(\beta U_{nt} - m_{int-1})^{\frac{1}{\nu}}}{\sum_{n'} \exp(\beta U_{n't} - m_{in't-1})^{\frac{1}{\nu}}} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{-\frac{1}{\nu}}.$$

After factoring out the denominator sum from the ratio, we recognize:

$$\mu_{int-1} = \frac{\exp(\beta U_{nt} - m_{int-1})^{\frac{1}{\nu}}}{\sum_{n'} \exp(\beta U_{n't} - m_{in't-1})^{\frac{1}{\nu}}}.$$

Therefore,

$$\dot{\Xi}_{it} = \left[ \sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{-\frac{1}{\nu}} \right]^\nu.$$

We want to show (B.4):

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}}.$$

Recall the probability of continuing (versus exiting) is:

$$\varsigma_{it}^{ja} = \frac{\exp\left(\frac{\beta}{\chi} V_{it+1}^{ja+1}\right)}{\exp\left(\frac{\beta}{\chi} V_{it+1}^{ja+1}\right) + \exp\left(\frac{\beta}{\chi} U_{it+1}\right)}.$$

Focus on the ratio, we can write

$$\begin{aligned} \varsigma_{it}^{ja} &= \frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}} \\ &= \frac{v_{it}^{ja+1}}{(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}} \frac{(\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}}{(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}}} \end{aligned}$$

Notice that the first term in the product equals  $\varsigma_{it-1}^{ja} = \frac{(v_{it}^{ja+1})^{\frac{\beta}{\chi}}}{(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}}$ .

Hence, the expression inside the denominator,

$$\frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}}{(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}},$$

can be simplified by factoring out  $(v_{it}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}$  from numerator and denominator:

$$\frac{(v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (u_{it+1})^{\frac{\beta}{\chi}}}{(v_{it}^{ja})^{\frac{\beta}{\chi}} + (u_{it})^{\frac{\beta}{\chi}}} = \varsigma_{it-1}^{ja} (v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + [1 - \varsigma_{it-1}^{ja}] (\dot{u}_{it+1})^{\frac{\beta}{\chi}},$$

Putting these pieces together implies

$$\varsigma_{it}^{ja} = \varsigma_{it-1}^{ja} (v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} / \left\{ \varsigma_{it-1}^{ja} (v_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + [1 - \varsigma_{it-1}^{ja}] (\dot{u}_{it+1})^{\frac{\beta}{\chi}} \right\},$$

which matches the expression in (B.4).

Next, I derive (B.5) and (B.6):

$$\psi_{it}^j = \frac{\psi_{it-1}^j (v_{it+1}^{j,1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (v_{it+1}^{j',1})^{\frac{\beta}{\chi}}}, \quad \psi_{it}^0 = \frac{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}}}{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (v_{it+1}^{j',1})^{\frac{\beta}{\chi}}},$$

In the model, the share of workers in location  $i$  who choose sector  $j$  ( $j > 0$ ) vs. staying a worker ( $j = 0$ ) follows a multinomial–logit type formula. At time  $t$ , we can write:

$$\psi_{it}^j = \frac{\exp(\beta V_{it+1}^{j1})^{\frac{1}{\chi}}}{\exp(\Xi_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it+1}^{j',1})^{\frac{1}{\chi}}}, \quad \psi_{it}^0 = \frac{\exp(\Xi_{it})^{\frac{1}{\chi}}}{\exp(\Xi_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it+1}^{j',1})^{\frac{1}{\chi}}}.$$

By factoring out  $\exp(\beta V_{it}^{j1})^{1/\chi}$  from numerator and  $\exp(\Xi_{it-1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it+1}^{j',1})^{\frac{1}{\chi}}$  from the denominator, we recognize the old share  $\psi_{it-1}^j$ .

$$\psi_{it}^j = \underbrace{\frac{\exp(\beta V_{it}^{j1})^{\frac{1}{\chi}}}{\exp(\Xi_{it-1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it}^{j',1})^{\frac{1}{\chi}}}}_{\psi_{it-1}^j} \frac{(v_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\underbrace{\frac{\exp(\Xi_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it+1}^{j',1})^{\frac{1}{\chi}}}{\exp(\Xi_{it-1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \exp(\beta V_{it+1}^{j',1})^{\frac{1}{\chi}}}}_{\frac{1}{\chi}}^{\frac{1}{\chi}}}.$$

Simplifying the denominator ratio follows similarly to the steps in  $\varsigma_{it}^{ja}$ . Hence, we have derived (B.5).

Analogously, for  $j = 0$ :

$$\psi_{it}^0 = \frac{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}}}{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (v_{it+1}^{j',1})^{\frac{\beta}{\chi}}}.$$

Let's derive  $\mu_{int}$  or (B.7):

$$\mu_{int} = \frac{\mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{-\frac{1}{\nu}}}{\sum_{c=1}^N \mu_{ict-1} (\dot{u}_{ct+1})^{\frac{\beta}{\nu}} (\dot{m}_{ict})^{-\frac{1}{\nu}}}.$$

Recall the migration share  $\mu_{int}$  is similarly a logit share:

$$\mu_{int} = \frac{\exp(\beta U_{nt+1} - m_{int})^{\frac{1}{\nu}}}{\sum_{c=1}^N \exp(\beta U_{ct+1} - m_{ict})^{\frac{1}{\nu}}},$$

We can factor out period  $(t - 1)$  terms. Specifically, in the numerator:

$$\exp(\beta U_{nt+1} - m_{int})^{\frac{1}{\nu}} = \exp(\beta U_{nt})^{\frac{1}{\nu}} \exp(m_{int-1})^{\frac{-1}{\nu}} \times (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} \times (\dot{m}_{int})^{-\frac{1}{\nu}}.$$

Hence the ratio from  $t - 1$  to  $t$  picks up  $(\dot{u}_{nt+1})^{\beta/\nu} (\dot{m}_{int})^{-1/\nu}$ . After factoring out the denominator sum, we recognize  $\mu_{int-1}$ . Collecting terms yields (B.7).

## B.2 Proof of Proposition 2

**Definition of Hat Variables:** To handle counterfactuals, we rewrite every relevant variable in terms of its ratio to the baseline economy. In particular, define

$$\hat{y}_{t+1} \equiv \frac{\dot{y}'_{t+1}}{\dot{y}_{t+1}},$$

where

$$\dot{y}'_{t+1} = \frac{y'_{t+1}}{y'_t} \quad \text{and} \quad \dot{y}_{t+1} = \frac{y_{t+1}}{y_t}.$$

All subsequent equilibrium objects (value functions, entry rates, trade shares, wages, etc.) are expressed in this ratio (“hat”) notation, capturing the ratio of counterfactual outcomes to baseline outcomes.

**Equilibrium Conditions for  $t > 1$ .**

$$\widehat{v}_{it}^{ja} = \widehat{c}_{it}^{ja} \left[ \varsigma_{it-1}^{ja} \dot{\varsigma}_{it}^{ja} \left( \widehat{v}_{it+1}^{ja+1} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja})' (1 - \dot{\varsigma}_{it}^{ja}) (\widehat{u}_{it+1})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.21})$$

$$\widehat{\Xi}_{it} = \left( \sum_{n=1}^N \mu'_{int-1} \dot{\mu}_{int} (\widehat{u}_{nt+1})^{\frac{\beta}{\nu}} (\widehat{m}_{int})^{\frac{-1}{\nu}} \right)^{\nu} \quad (\text{B.22})$$

$$\widehat{u}_{it} = \widehat{c}_{it} \left[ \psi'_{it-1}^0 \dot{\psi}_{it}^0 (\widehat{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi'_{it-1}^{j'} \dot{\psi}_{it}^{j'} (\widehat{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.23})$$

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}^{ja} \dot{\varsigma}_{it}^{ja} (\widehat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} \dot{\varsigma}_{it}^{ja} (\widehat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (1 - \dot{\varsigma}_{it}^{ja}) (\widehat{u}_{it+1})^{\frac{\beta}{\chi}}} \quad (\text{B.24})$$

$$\psi'_{it}^j = \frac{\psi'_{it-1}^j \dot{\psi}_{it}^j (\widehat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi'_{it-1}^0 \dot{\psi}_{it}^0 (\widehat{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi'_{it-1}^{j'} \dot{\psi}_{it}^{j'} (\widehat{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}} \quad (\text{B.25})$$

$$\mu'_{int} = \frac{\mu'_{int-1} \dot{\mu}_{int} (\widehat{u}_{nt+1})^{\frac{\beta}{\nu}} (\widehat{m}_{int})^{\frac{-1}{\nu}}}{\sum_{n'=1}^N \mu'_{in't-1} \dot{\mu}_{in't} (\widehat{u}_{n't+1})^{\frac{\beta}{\nu}} (\widehat{m}_{in't})^{\frac{-1}{\nu}}} \quad (\text{B.26})$$

**Equilibrium Conditions for  $t = 1$ .** A parallel set of conditions applies at  $t = 1$  since at  $t = 0$  there is no policy change and agents learn about policy sequences at time  $t = 1$ . Concretely,

$$\widehat{v}_{i1}^{ja} = \widehat{c}_{i1}^{ja} \left[ \varsigma_{i1}^{ja} \left( \widehat{v}_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} \left( \widehat{v}_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{i1}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\widehat{u}_{i2})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.27})$$

$$\widehat{\Xi}_{i1} = \left( \sum_{n=1}^N \mu_{in1} (\widehat{u}_{n1})^{\frac{\beta}{\nu}} (\widehat{u}_{n2})^{\frac{\beta}{\nu}} (\widehat{m}_{in1})^{\frac{-1}{\nu}} \right)^{\nu} \quad (\text{B.28})$$

$$\widehat{u}_{i1} = \widehat{c}_{i1} \left[ \psi_{i1}^0 (\widehat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'} (\widehat{v}_{i1}^{j'1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{j'1})^{\frac{\beta}{\chi}} \right]^{\chi} \quad (\text{B.29})$$

$$\varsigma_{i1}^{ja} = \frac{\varsigma_{i1}^{ja} (\widehat{v}_{i1}^{ja+1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{i1}^{ja} (\widehat{v}_{i1}^{ja+1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{i1}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\widehat{u}_{i2})^{\frac{\beta}{\chi}}} \quad (\text{B.30})$$

$$\psi'_{i1}^j = \frac{\psi_{i1}^j (\widehat{v}_{i1}^{j1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{j1})^{\frac{\beta}{\chi}}}{\psi_{i1}^0 (\widehat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'} (\widehat{v}_{i1}^{j'1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{j'1})^{\frac{\beta}{\chi}}} \quad (\text{B.31})$$

$$\mu'_{in1} = \frac{\mu_{in1} (\widehat{u}_{n1})^{\frac{\beta}{\nu}} (\widehat{u}_{n2})^{\frac{\beta}{\nu}} (\widehat{m}_{in1})^{\frac{-1}{\nu}}}{\sum_{n'=1}^N \mu_{in'1} (\widehat{u}_{n'1})^{\frac{\beta}{\nu}} (\widehat{u}_{n'2})^{\frac{\beta}{\nu}} (\widehat{m}_{in'1})^{\frac{-1}{\nu}}} \quad (\text{B.32})$$

**Evolution of Population and Employment.** The next block of equations tracks how workers

and entrepreneurs groups evolve across periods in hat form:

$$L'_{it+1} = \sum_{n=1}^N \mu'_{nit} \psi'_{nt}^0 L'_{nt} + \sum_{j=1}^J \sum_{a=1:\mathcal{A}} \left(1 - \varsigma_{it}^{ja}\right) E'^{ja}_{it}. \quad (\text{B.33})$$

$$E'^{j\mathcal{A}}_{it+1} = \varsigma_{it}^{j\mathcal{A}} E'^{j\mathcal{A}}_{it} + \varsigma_{it}^{j\mathcal{A}-1} E'^{j\mathcal{A}-1}_{it} \quad (\text{B.34})$$

$$E'^{ja+1}_{it+1} = \varsigma_{it}^{ja} E'^{ja}_{it} \quad (\text{B.35})$$

$$E'^{j1}_{it+1} = \psi'^j_{it} L'_{it} \quad (\text{B.36})$$

**Temporary Equilibrium:** Finally, we impose market clearing, price indices, and budget constraints in hat form:

$$\widehat{P}_{it}^j = \left( \sum_n \lambda + 1_{nit-1}^j \dot{\lambda}_{nit}^j \widehat{E}_{nt}^j (\widehat{x}_{nt}^j)^{1-\sigma} \right)^{1/(1-\sigma)} \quad (\text{B.37})$$

$$\widehat{P}_{it+1} = \prod_{j=1}^J (\widehat{P}_{it+1}^j)^{\alpha^j} \quad (\text{B.38})$$

$$\widehat{r}_{it+1} = \widehat{w}_{it+1} \left( \frac{\sum_j \frac{1-\xi^j}{\xi^j} L'^j_{it+1}}{\sum_j \frac{1-\xi^j}{\xi^j} L'^j_{it}} / \frac{\sum_j \frac{1-\xi^j}{\xi^j} L^j_{it+1}}{\sum_j \frac{1-\xi^j}{\xi^j} L^j_{it}} \right) \quad (\text{B.39})$$

$$\widehat{p}_{int+1}^j = \widehat{x}_{it+1}^j = (\widehat{w}_{it+1})^{\xi^j} (\widehat{r}_{it+1})^{1-\xi^j} \quad (\text{B.40})$$

$$\lambda + 1_{int+1}^j = \lambda + 1_{int}^j \dot{\lambda}_{int+1}^j \widehat{E}_{it+1}^j (\widehat{x}_{it+1}^j)^{1-\sigma} (\widehat{P}_{nt+1}^j)^{\sigma-1} \quad (\text{B.41})$$

Also, I write the equilibrium conditions in counterfactual economy

$$\pi'^j_{it+1} = \frac{1}{\sigma} \sum_{n=1}^N \frac{\lambda + 1_{int+1}^j}{E'^j_{it+1}} X'_{nt+1} \quad (\text{B.42})$$

$$X'^j_{it+1} = \alpha^j \left( P'_{it+1} G'_{it+1} + \sum_{j=1}^J \widehat{w}_{it+1} \dot{w}_{it+1} L'^j_{it+1} w'_{it} L'^j_{it} + \sum_{ja} (E'^{ja}_{it+1} (1 - \tau'^a_{it+1})) \pi'^j_{it+1} \right) \quad (\text{B.43})$$

$$P'_{it} G'_{it} = \omega'_{it} \sum_{j=1}^J \left( \sum_a (E'^{ja}_{it} \tau'^{sa}_{it}) \pi'^j_{it} + \frac{1-\xi^j}{\xi^j} \widehat{w}_{it+1} \widehat{L}^j_{it+1} \dot{w}_{it+1} \widehat{L}^j_{it+1} w'_{it} L'^j_{it} \right) + \Omega'_{it} \Lambda'_t \quad (\text{B.44})$$

$$\Lambda'_t = (1 - \omega'_{it}) \sum_{j=1}^J \left( \sum_a (E'^{ja}_{it} \tau'^{sa}_{it}) \pi'^j_{it} + \frac{1-\xi^j}{\xi^j} \widehat{w}_{it+1} \widehat{L}^j_{it+1} \dot{w}_{it+1} \widehat{L}^j_{it+1} w'_{it} L'^j_{it} \right) \quad (\text{B.45})$$

$$\widehat{w}_{it+1} \widehat{L}^j_{it+1} = \frac{\xi^j \frac{\sigma-1}{\sigma}}{w'_{it} L'^j_{it} \dot{w}_{it+1} \widehat{L}^j_{it+1}} \sum_{n=1}^N \lambda + 1_{int+1}^j X'_{nt+1}^j \quad (\text{B.46})$$

**Deriving temporary equilibrium:** We want to derive (B.37). Write the sectoral price index at time  $t$  in the counterfactual economy based on (B.11):

$$\dot{P}'_{it+1}^j = \left( \sum_n \lambda + 1_{nit}^j \dot{E}'_{nt+1}^j (\dot{p}'_{nit+1})^{1-\sigma} \right)^{1/(1-\sigma)}$$

Substituting the dot version of pricing equation (B.15) and notice that

$$\dot{\lambda}_{int+1}^j (\dot{P}'_{nt+1}^j)^{1-\sigma} = \dot{E}_{it+1}^j \dot{x}_{it+1}^j$$

we have

$$\dot{P}'_{it+1}^j = (\dot{P}'_{it+1}^j)^{1-\sigma} \left( \sum_n \lambda + 1_{nit}^j \dot{\lambda}_{nit+1}^j \widehat{E}_{nt+1}^j (\widehat{x}_{nt+1}^j)^{1-\sigma} \right)^{1/(1-\sigma)}$$

Hence,

$$\widehat{P}'_{it}^j = \left( \sum_n \lambda + 1_{nit-1}^j \dot{\lambda}_{nit}^j \widehat{E}_{nt}^j (\widehat{x}_{nt}^j)^{1-\sigma} \right)^{\frac{1}{1-\sigma}},$$

To get (B.38), we have

$$\widehat{P}'_{it+1} \equiv \frac{\dot{P}'_{it+1}}{\dot{P}'_{it+1}} = \prod_{j=1}^J (\widehat{P}'_{it+1}^j)^{\alpha^j}$$

Next, we turn to (B.39). Consider

$$\dot{r}'_{it+1} = \dot{w}'_{it+1} \frac{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it+1}^j}{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it}^j}.$$

Then,

$$\widehat{r}_{it+1} = \widehat{w}_{it+1} \frac{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it+1}^j}{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it}^j} \frac{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it+1}^j}{\sum_j \frac{1-\xi^j}{\xi^j} L'_{it}^j}.$$

Next, I get (B.40)

$$\widehat{p}'_{int+1}^j = \frac{\dot{p}'_{int+1}}{\dot{p}_{int}} = \widehat{x}_{it+1}^j = (\widehat{w}_{it+1})^{\xi^j} (\widehat{r}_{it+1})^{1-\xi^j}$$

To write the trade share (B.41), we start with (B.16):

$$\dot{\lambda}_{int+1}^j = \dot{E}'_{it+1}^j \left( \frac{\dot{p}'_{int+1}}{\dot{P}'_{nt+1}^j} \right)^{1-\sigma} = \dot{\lambda}_{int+1}^j \widehat{E}_{it+1}^j \left( \frac{\widehat{p}'_{int+1}}{\widehat{P}'_{nt+1}^j} \right)^{1-\sigma}.$$

**Deriving the value functions for  $t = 1$  (right after a policy change)** Let's derive solutions for period  $t = 1$ . First, recall that at  $t = 0$  (before policy change):

$$V_{i0}^{ja} = \log c_{i0}^{ja} + \chi \log \left[ \exp \left( V_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i1})^{\frac{\beta}{\chi}} \right]$$

After policy change at  $t = 1$ :

$$V'_{i1}^{ja} = \log c'_{i1}^{ja} + \chi \log \left[ \exp \left( V'_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i2})^{\frac{\beta}{\chi}} \right]$$

Taking the difference:

$$V'_{i1}^{ja} - V_{i0}^{ja} = \log \frac{c'_{i1}^{ja}}{c_{i0}^{ja}} + \chi \log \left[ \frac{\exp \left( V'_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i2})^{\frac{\beta}{\chi}}}{\exp \left( V_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i1})^{\frac{\beta}{\chi}}} \right]$$

Recall  $\varsigma_{i0}^{ja}$  represents the continuation probability:

$$\varsigma_{i0}^{ja} = \frac{\exp \left( V_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}}}{\exp \left( V_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i1})^{\frac{\beta}{\chi}}}$$

Using this, we can rewrite the bracket term:

$$\frac{\exp \left( V'_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i2})^{\frac{\beta}{\chi}}}{\exp \left( V_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} + \exp(U_{i1})^{\frac{\beta}{\chi}}} = \varsigma_{i0}^{ja} \frac{\left( v'_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}}}{\left( v_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}}} + (1 - \varsigma_{i0}^{ja}) \frac{(u_{i2})^{\frac{\beta}{\chi}}}{(u_{i1})^{\frac{\beta}{\chi}}}$$

However, at  $t = 0$  there is no policy change yet, so  $v'_{i0}^{ja} = v_{i0}^{ja}$ , and

$$\dot{v}'_{i1}^{ja} = \frac{v'_{i1}^{ja}}{v_{i0}^{ja}}, \quad \widehat{v}_{i1}^{ja} = \frac{\dot{v}'_{i1}^{ja}}{\dot{v}_{i1}^{ja}} = \frac{v'_{i1}^{ja}}{v_{i1}^{ja}}$$

Using these results and taking exponentials of both sides yields:

$$\dot{v}'_{i1}^{ja} = \frac{c'_{i1}^{ja}}{c_{i0}^{ja}} \left[ \varsigma_{i0}^{ja} (\widehat{v}_{i1}^{ja+1})^{\frac{\beta}{\chi}} (\dot{v}'_{i2}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{i0}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\dot{u}'_{i2})^{\frac{\beta}{\chi}} \right]^{\chi}$$

Taking the ratio  $\widehat{v}_{i1}^{ja} = \frac{\dot{v}'_{i1}^{ja}}{\dot{v}_{i1}^{ja}}$ :

$$\widehat{v}_{i1}^{ja} = \frac{\dot{v}'_{i1}^{ja}}{\dot{v}_{i1}^{ja}} = \widehat{c}_{i1}^{ja} \left[ \frac{\varsigma_{i0}^{ja} \left( \widehat{v}_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} (\dot{v}'_{i2}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{i0}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\dot{u}'_{i2})^{\frac{\beta}{\chi}}}{\varsigma_{i0}^{ja} (\dot{v}_{i2}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{i0}^{ja}) (\dot{u}_{i2})^{\frac{\beta}{\chi}}} \right]^{\chi},$$

where

$$\widehat{c}_{i1}^{ja} = \left( \frac{\widehat{G}_{i1}}{\widehat{M}_{i1}} \right)^\gamma \left( \frac{1 - \tau_{i1}^{\prime a} \widehat{\pi}_{i1}^j}{1 - \tau_{i1}^a \widehat{P}_{i1}} \right)^{1-\gamma}.$$

Applying (B.4) yields

$$\widehat{v}_{i1}^{ja} = \widehat{c}_{i1}^{ja} \left[ \varsigma_{i1}^{ja} \left( \widehat{v}_{i1}^{ja+1} \right)^{\frac{\beta}{\chi}} \left( \widehat{v}_{i2}^{ja+1} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{i1}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\widehat{u}_{i2})^{\frac{\beta}{\chi}} \right]^\chi.$$

Thus, we have obtained (B.21):

$$\widehat{v}_{i1}^{ja} = \widehat{c}_{i1}^{ja} \left[ \varsigma_{i1}^{ja} \left( \widehat{v}_{i1}^{ja} \right)^{\frac{\beta}{\chi}} \left( \widehat{v}_{i2}^{ja} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{i1}^{ja}) (\widehat{u}_{i1})^{\frac{\beta}{\chi}} (\widehat{u}_{i2})^{\frac{\beta}{\chi}} \right]^\chi$$

Next, I want to show (B.28). First, recall for  $t = 1$ , before policy change:

$$\Xi_{i1} = \log \left[ \sum_{n=1}^N \exp(\beta U_{n2} - m_{in1})^{\frac{1}{\nu}} \right]^\nu$$

After policy change:

$$\Xi'_{i1} = \log \left[ \sum_{n=1}^N \exp(\beta U'_{n2} - m'_{in1})^{\frac{1}{\nu}} \right]^\nu$$

Taking the ratio  $\widehat{\Xi}_{i1} = \frac{\exp(\Xi'_{i1})}{\exp(\Xi_{i1})}$ :

$$\widehat{\Xi}_{i1} = \left( \frac{\sum_{n=1}^N \exp(\beta U'_{n2} - m'_{in1})^{\frac{1}{\nu}}}{\sum_{n=1}^N \exp(\beta U_{n2} - m_{in1})^{\frac{1}{\nu}}} \right)^\nu$$

Notice that  $\exp(\beta U'_{n1}) = (u'_{n1})^\beta = (u_{n1})^\beta (\widehat{u}_{n1})^\beta$ . Also,  $\exp(-m'_{in1}) = \exp(-m_{in1})(\widehat{m}_{in1})^{-1}$ .

Therefore:

$$\widehat{\Xi}_{i1} = \left( \sum_{n=1}^N \frac{\exp(\beta U_{n2} - m_{in1})^{\frac{1}{\nu}}}{\sum_{c=1}^N \exp(\beta U_{c2} - m_{ic1})^{\frac{1}{\nu}}} (\widehat{u}_{n1})^{\frac{\beta}{\nu}} (\widehat{u}_{n2})^{\frac{\beta}{\nu}} (\widehat{m}_{in1})^{\frac{-1}{\nu}} \right)^\nu$$

Recognizing that the first fraction is  $\mu_{in1}$ , we get (B.28):

$$\widehat{\Xi}_{i1} = \left( \sum_{n=1}^N \mu_{in1} (\widehat{u}_{n1})^{\frac{\beta}{\nu}} (\widehat{u}_{n2})^{\frac{\beta}{\nu}} (\widehat{m}_{in1})^{\frac{-1}{\nu}} \right)^\nu$$

$$\widehat{u}_{i1} = \widehat{c}_{i1} \left[ \psi_{i1}^0 (\widehat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'} (\widehat{v}_{i1}^{j'1})^{\frac{\beta}{\chi}} (\widehat{v}_{i2}^{j'1})^{\frac{\beta}{\chi}} \right]^\chi$$

Let's derive (B.23) for  $\hat{u}_{i1}$ . At  $t = 1$ , recall the value function without policy change:

$$U_{i1} = \log c_{i1} + \chi \log \left[ \exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}} \right]$$

After policy change:

$$U'_{i1} = \log c'_{i1} + \chi \log \left[ \exp(\Xi'_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V'_{i2}^{j1})^{\frac{\beta}{\chi}} \right]$$

Taking ratio  $\hat{u}_{i1} = \frac{\exp(U'_{i1})}{\exp(U_{i1})}$  yields

$$\hat{u}_{i1} = \hat{c}_{i1} \left[ \frac{\exp(\Xi'_{i1})^{1/\chi} + \sum_{j=1}^J \exp(V'_{i2}^{j1})^{\frac{\beta}{\chi}}}{\exp(\Xi_{i1})^{1/\chi} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}} \right]^{\chi}$$

At  $t = 1$ , consider the ratio

$$\frac{\exp(\Xi'_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V'_{i2}^{j1})^{\frac{\beta}{\chi}}}{\exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}}.$$

We define “old” (baseline) shares at  $t = 1$ :

$$\psi_{i1}^0 \equiv \frac{\exp(\Xi_{i1})^{\frac{1}{\chi}}}{\exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}}, \quad \psi_{i1}^j \equiv \frac{\exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}}{\exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{k=1}^J \exp(V_{i2}^{k1})^{\frac{\beta}{\chi}}}.$$

Since there is no policy change at time 0, we can write

$$\exp(\Xi'_{i1}) = \exp(\Xi_{i1}) \hat{\Xi}_{i1}, \quad \exp(V'_{i2}^{j1}) = \exp(V_{i2}^{j1}) \hat{v}_{i1}^{j1} \hat{v}_{i2}^{j1}.$$

Then,

$$\begin{aligned} \frac{\exp(\Xi'_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V'_{i2}^{j1})^{\frac{\beta}{\chi}}}{\exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}} &= \frac{\exp(\Xi_{it})^{\frac{1}{\chi}} \hat{\Xi}_{i1}^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}} (\hat{v}_{i1}^{j1})^{\frac{\beta}{\chi}} (\hat{v}_{i2}^{j1})^{\frac{\beta}{\chi}}}{\exp(\Xi_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \exp(V_{i2}^{j1})^{\frac{\beta}{\chi}}} \\ &= \psi_{i1}^0 (\hat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{i1}^j (\hat{v}_{i1}^{j1})^{\frac{\beta}{\chi}} (\hat{v}_{i2}^{j1})^{\frac{\beta}{\chi}}. \end{aligned}$$

Hence, we obtained (B.29):

$$\hat{u}_{i1} = \hat{c}_{i1} \left[ \psi_{i1}^0 (\hat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'} (\hat{v}_{i1}^{j'1})^{\frac{\beta}{\chi}} (\hat{v}_{i2}^{j'1})^{\frac{\beta}{\chi}} \right]^{\chi}$$

For  $\psi'_{i1}^j$  (B.31), let's start with the flow equation after policy change:

$$\psi'_{i1}^j = \frac{(v'_{i2}^{j1})^{\frac{\beta}{\chi}}}{\Xi'_{i1}^{\frac{1}{\chi}} + \sum_{j'=1}^J (v'_{i2}^{j'1})^{\frac{\beta}{\chi}}}$$

Taking the ratio  $\frac{\psi'_{i1}^j}{\psi_{i1}^j}$ :

$$\frac{\psi'_{i1}^j}{\psi_{i1}^j} = \frac{(v'_{i2}^{j1}/v_{i2}^{j1})^{\frac{\beta}{\chi}}}{\psi_{i1}^0(\Xi'_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'}(\frac{v'_{i2}^{j'1}}{v_{i2}^{j1}})^{\frac{\beta}{\chi}}}$$

Using the hat notation,  $\frac{v'_{i2}^{j1}}{v_{i2}^{j1}} = \hat{v}_{i2}^{j1}\hat{v}_{i1}^{j1}$  and  $\Xi'_{i1} = \hat{\Xi}_{i1}$ :

$$\psi'_{i1}^j = \frac{\psi_{i1}^j(\hat{v}_{i2}^{j1})^{\frac{\beta}{\chi}}(\hat{v}_{i1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{i1}^0(\hat{\Xi}_{i1})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{i1}^{j'}(\hat{v}_{i2}^{j1})^{\frac{\beta}{\chi}}(\hat{v}_{i1}^{j1})^{\frac{\beta}{\chi}}}$$

Similarly, I also get (B.30)

$$\varsigma_{i1}^{ja} = \frac{\varsigma_{i1}^{ja}(\hat{v}_{i2}^{ja+1})^{\frac{\beta}{\chi}}(\hat{v}_{i1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{i1}^{ja}(\hat{v}_{i1}^{ja+1})^{\frac{\beta}{\chi}}(\hat{v}_{i2}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{i1}^{ja})(\hat{u}_{i2})^{\frac{\beta}{\chi}}(\hat{u}_{i1})^{\frac{\beta}{\chi}}}$$

To get the migration flows (B.32), consider

$$\mu'_{in1} = \frac{\exp(\beta U_{n2} - m_{in1})^{1/\nu}}{\sum_{n=1}^N \exp(\beta U_{n2} - m_{in1})^{1/\nu}}.$$

Dividing it by  $\mu_{in1}$  yields

$$\frac{\mu'_{in1}}{\mu_{in1}} = \frac{\frac{(u'_{n2})^{\beta/\nu}(m'_{in1})^{-1/\nu}}{(u_{n2})^{\beta/\nu}(m_{in1})^{-1/\nu}}}{\sum_{n=1}^N \frac{(u'_{n2})^{\beta/\nu}(m'_{in1})^{-1/\nu}}{\sum_{n=1}^N (u_{n2})^{\beta/\nu}(m_{in1})^{-1/\nu}}} = \frac{\hat{u}_{n2}^{\beta/\chi}\hat{u}_{n1}^{\beta/\chi}\hat{m}_{in1}^{-1/\nu}}{\sum_{n=1}^N \mu_{n1}\hat{u}_{n2}^{\beta/\chi}\hat{u}_{n1}^{\beta/\chi}\hat{m}_{in1}^{-1/\nu}}$$

Or

$$\mu'_{in1} = \frac{\mu_{in1}\hat{u}_{n1}^{\beta/\chi}\hat{u}_{n2}^{\beta/\chi}\hat{m}_{in1}^{-1/\nu}}{\sum_{n=1}^N \mu_{n1}\hat{u}_{n2}^{\beta/\chi}\hat{u}_{n1}^{\beta/\chi}\hat{m}_{in1}^{-1/\nu}}$$

**Deriving the value functions for  $t > 1$ :** Let's begin with deriving  $\hat{v}_{it}^{ja}$  for  $t > 1$ , (B.21). First, recall the dot equation for time  $t$ , (B.1):

$$\dot{v}_{it}^{ja} = \dot{c}_{it}^a \left[ \varsigma_{it-1}^{ja} \left( \dot{v}_{it+1}^{ja'} \right)^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}} \right]^{\chi}$$

Taking the ratio  $\hat{v}_{it}^{ja} = \frac{\dot{v}'_{it}^{ja}}{\dot{v}_{it}^{ja}}$ :

$$\hat{v}_{it}^{ja} = \hat{c}_{it}^{ja} \left[ \frac{\varsigma_{it-1}^{ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} \right]^{\chi}$$

For the bracket term, I can write

$$\frac{\varsigma_{it-1}^{ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} = \frac{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}} (\hat{u}_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}}$$

Notice that from (B.4), we have

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}}.$$

Hence,

$$\frac{\varsigma_{it-1}^{ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} = \varsigma_{it-1}^{ja} \dot{\varsigma}_{it}^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (1 - \dot{\varsigma}_{it}^{ja}) (\hat{u}_{it+1})^{\frac{\beta}{\chi}}$$

Therefore,

$$\hat{v}_{it}^{ja} = \hat{c}_{it}^{ja} \left[ \varsigma_{it-1}^{ja} \dot{\varsigma}_{it}^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (1 - \dot{\varsigma}_{it}^{ja}) (\hat{u}_{it+1})^{\frac{\beta}{\chi}} \right]^{\chi}$$

Following similar steps, I obtain (B.21).

Let's derive  $\hat{\Xi}_{it}$  for  $t > 1$ , (B.22). First, recall the dot equation for time  $t$ , (B.2):

$$\dot{\Xi}_{it} = \left( \sum_{n=1}^N \mu_{in,t-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}} \right)^\nu$$

Taking the ratio  $\hat{\Xi}_{it} = \frac{\dot{\Xi}'_{it}}{\dot{\Xi}_{it}}$ :

$$\hat{\Xi}_{it} = \left( \frac{\sum_{n=1}^N \mu'_{int-1} (\dot{u}'_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}'_{int})^{\frac{-1}{\nu}}}{\sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}} \right)^\nu$$

For the bracket term, I can write

$$\frac{\sum_{n=1}^N \mu'_{int-1} (\dot{u}'_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}'_{int})^{\frac{-1}{\nu}}}{\sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}} = \sum_{n=1}^N \frac{\mu'_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}} (\hat{m}_{int})^{\frac{-1}{\nu}}}{\sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}}$$

Notice that from (B.7), we have

$$\mu_{int} = \frac{\mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}}{\sum_{c=1}^N \mu_{ict-1} (\dot{u}_{ct+1})^{\frac{\beta}{\nu}} (\dot{m}_{ict})^{\frac{-1}{\nu}}}$$

Hence,

$$\frac{\sum_{n=1}^N \mu'_{int-1} (\dot{u}'_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}'_{int})^{\frac{-1}{\nu}}}{\sum_{n=1}^N \mu_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\dot{m}_{int})^{\frac{-1}{\nu}}} = \sum_{n=1}^N \mu'_{int-1} \dot{\mu}_{int} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} (\hat{m}_{int})^{\frac{-1}{\nu}}$$

Therefore,

$$\hat{\Xi}_{it} = \left( \sum_{n=1}^N \mu'_{int-1} \dot{\mu}_{int} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} (\hat{m}_{int})^{\frac{-1}{\nu}} \right)^\nu$$

Next, let's derive  $\hat{u}_{it}$  for  $t > 1$ , (B.23). First, recall the dot equation for time  $t$ , (B.3):

$$\dot{u}_{it} = \left( \frac{\dot{G}_{it}}{\dot{\mathcal{L}}_{it}} \right)^{\gamma_i} \left( \frac{\dot{w}_{it}}{\dot{P}_{it}} \right)^{1-\gamma_i} \left[ \psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \right]^\chi$$

Taking the ratio  $\hat{u}_{it} = \frac{\dot{u}'_{it}}{\dot{u}_{it}}$ :

$$\hat{u}_{it} = \hat{c}_{it} \left[ \frac{\psi_{it-1}^0 (\dot{\Xi}'_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}'_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}} \right]^\chi$$

For the bracket term, I can write

$$\frac{\psi_{it-1}^0 (\dot{\Xi}'_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}'_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 (\dot{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}} = \psi_{it-1}^0 \dot{\psi}_{it}^0 (\hat{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j=1}^J \psi_{it-1}^j \dot{\psi}_{it}^j (\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}},$$

since from (B.6), we have

$$\psi_{it}^0 = \frac{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} (\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}.$$

Therefore,

$$\hat{u}_{it} = \hat{c}_{it} \left[ \psi_{it-1}^0 \dot{\psi}_{it}^0 (\hat{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} \dot{\psi}_{it}^{j'} (\hat{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}} \right]^\chi$$

Next, let's derive  $\varsigma_{it}^{ja}$  for  $t > 1$ , (B.24). First, apply the dot equation for the counterfactual share:

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}^{'ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{'ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{'ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}$$

For the numerator, I can write:

$$\varsigma_{it-1}'^{ja} \left( \dot{v}_{it+1}^{ja+1} \right)^{\frac{\beta}{\chi}} = \varsigma_{it-1}'^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} = \varsigma_{it-1}'^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} \frac{\varsigma_{it-1}^{ja}}{\varsigma_{it-1}^{ja}} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}$$

Thus,

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}'^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja}} \frac{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} \frac{\varsigma_{it-1}'^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}'^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}'^{ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}$$

Notice that the second term on the right-hand side is

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}'^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}}.$$

Therefore,

$$\varsigma_{it}^{ja} = \varsigma_{it-1}'^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} \varsigma_{it}^{ja} \left[ \frac{\varsigma_{it-1}'^{ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}'^{ja}) (\dot{u}'_{it+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} \right]^{-1}$$

Applying similar steps as we just did for the two terms in the bracket, we get for instance

$$\frac{\varsigma_{it-1}'^{ja} (\dot{v}'_{it+1}^{ja+1})^{\frac{\beta}{\chi}}}{\varsigma_{it-1}^{ja} (\dot{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}^{ja}) (\dot{u}_{it+1})^{\frac{\beta}{\chi}}} = \varsigma_{it-1}'^{ja} \varsigma_{it}^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}}$$

Finally,

$$\varsigma_{it}^{ja} = \frac{\varsigma_{it-1}'^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} \varsigma_{it}^{ja}}{\varsigma_{it-1}'^{ja} \varsigma_{it}^{ja} (\hat{v}_{it+1}^{ja+1})^{\frac{\beta}{\chi}} + (1 - \varsigma_{it-1}'^{ja}) (1 - \varsigma_{it}^{ja}) (\hat{u}_{it+1})^{\frac{\beta}{\chi}}}$$

which is (B.24).

Let's derive  $\psi'_{it}^j$  for  $t > 1$ , (B.25). First, apply the dot equation (B.5) for the counterfactual share:

$$\psi'_{it}^j = \frac{\psi'_{it-1}^j (\dot{v}'_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi'^0_{it-1} \Xi'^{\frac{1}{\chi}}_{it} + \sum_{j'=1}^J \psi'^{j'}_{it-1} (\dot{v}'_{it+1}^{j'1})^{\frac{\beta}{\chi}}}$$

For the numerator, I can write:

$$\psi'_{it-1}^j (\dot{v}'_{it+1}^{j1})^{\frac{\beta}{\chi}} = \psi'_{it-1}^j (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} (\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} = \psi'_{it-1}^j (\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \frac{\psi'_{it-1}^j}{\psi'_{it-1}^j} (\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}$$

Thus,

$$\psi'_{it}^j = \frac{\psi'_{it-1}(\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^j} \frac{\psi_{it-1}^j(\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}} \frac{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}$$

Notice that the second term on the right-hand side is (B.5):

$$\psi_{it}^j = \frac{\psi_{it-1}^j(\dot{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}$$

Therefore,

$$\psi'_{it}^j = \psi'_{it-1}(\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}} \dot{\psi}_{it}^j \left[ \frac{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}} \right]^{-1}$$

Applying similar steps as before for the terms in the bracket, we get:

$$\frac{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}}}{\psi_{it-1}^0 \dot{\Xi}_{it}^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'}(\dot{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}} = \psi_{it-1}^0 \dot{\psi}_{it}^0 (\widehat{\Xi}_{it})^{\frac{1}{\chi}}$$

Finally,

$$\psi'_{it}^j = \frac{\psi'_{it-1} \dot{\psi}_{it}^j (\hat{v}_{it+1}^{j1})^{\frac{\beta}{\chi}}}{\psi_{it-1}^0 \dot{\psi}_{it}^0 (\widehat{\Xi}_{it})^{\frac{1}{\chi}} + \sum_{j'=1}^J \psi_{it-1}^{j'} \dot{\psi}_{it}^{j'} (\hat{v}_{it+1}^{j'1})^{\frac{\beta}{\chi}}}$$

which is (B.25).

Let's derive  $\mu'_{int}$  for  $t > 1$ , (B.26). Using (B.7) for the counterfactual case:

$$\mu'_{int} = \frac{\mu'_{int-1} \left( \dot{u}'_{nt+1} \right)^{\frac{\beta}{\nu}} (m'_{int})^{\frac{-1}{\nu}}}{\sum_{c=1}^N \mu'_{ict-1} \left( \dot{u}'_{ct+1} \right)^{\frac{\beta}{\nu}} (m'_{ict})^{\frac{-1}{\nu}}}$$

For the numerator terms:

$$\mu'_{int-1} \left( \dot{u}'_{nt+1} \right)^{\frac{\beta}{\nu}} = \mu'_{int-1} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} = \mu'_{int-1} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} \frac{\mu_{int-1}}{\mu_{int-1}} (\dot{u}_{nt+1})^{\frac{\beta}{\nu}}$$

Similar treatment for the mobility cost term:

$$(m'_{int})^{\frac{-1}{\nu}} = (\dot{m}_{int})^{\frac{-1}{\nu}} (\hat{m}_{int})^{\frac{-1}{\nu}}$$

Substituting back and using (B.7):

$$\mu'_{int} = \frac{\mu'_{int-1} (\hat{u}_{nt+1})^{\frac{\beta}{\nu}} (\hat{m}_{int})^{\frac{-1}{\nu}}}{\sum_{n'=1}^N \mu'_{in't-1} \dot{\mu}_{int-1} (\hat{u}_{n't+1})^{\frac{\beta}{\nu}} (\hat{m}_{in't})^{\frac{-1}{\nu}}} \dot{\mu}_{int}$$

This result gives us (B.26).

## C Solution Algorithm

### C.1 Algorithm to Solve for the Baseline Economy

*Inputs and Data:*

- Baseline data at  $t = 0$  (year 2019):  $\{L_{i0}, E_{i0}^{ja}, \mu_{in,0}, \varsigma_{i0}^{ja}, \psi_{i0}^j, \lambda_{in0}^j\}$ .
- Model parameters:  $\{\beta, \chi, \nu, \sigma, \xi^j, \alpha^j, \gamma\}$ .
- A maximum number of global iterations MaxIt and convergence tolerance tol.

*Initialize:*

- Choose initial guesses for  $\{\dot{v}_{it+1}^{ja}\}_{t=1}^T$  for some large  $T$ .
- Set iteration counter  $\ell = 0$  and a large  $\epsilon > \text{tol}$ .

**While**  $\ell < \text{MaxIt}$  **and**  $\epsilon > \text{tol}$ :

1. Update Agent Distributions for Each Period  $t$ :

- Using the current guesses, update  $\varsigma_{it}^{ja}, \psi_{it}^j, \mu_{int}, \dot{\Xi}_{it}$  via Eqs. (B.2), (B.4)–(B.7).
- Compute the new levels of  $\{L_{it+1}, E_{it+1}^{ja}\}$  via Eqs. (B.8) - (B.10).

2. Within-Period Static Equilibrium (Inner Loop):

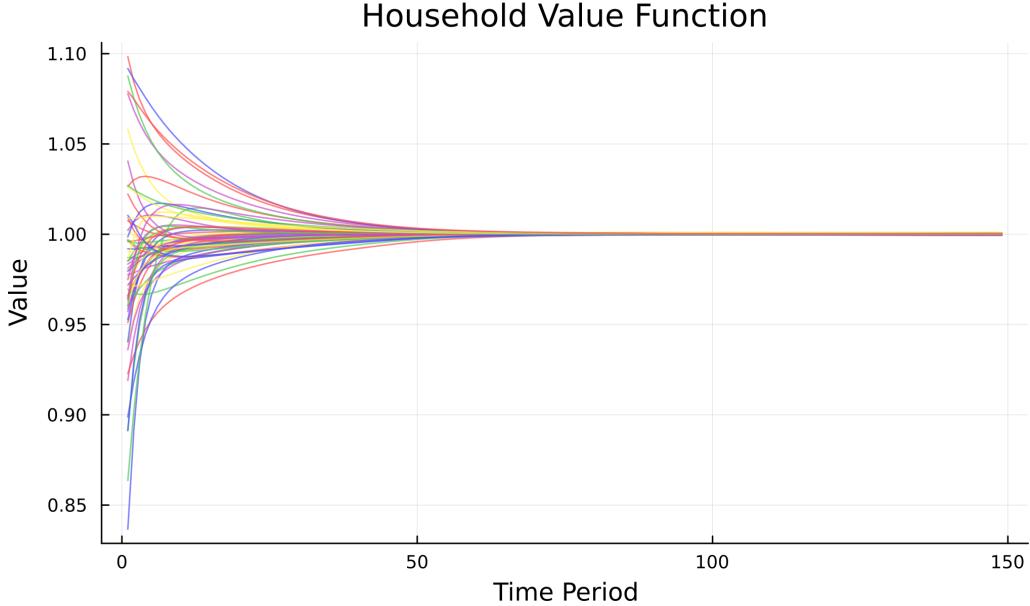
For each  $t = 1, \dots, T$ , call a subroutine inner( $L_t, E_t, \dots$ ) that:

- (a) Guesses factor-price changes  $\dot{w}_{it} \cdot \dot{L}_{it}$  or  $\dot{w}_{it}$  directly, and forms initial guesses for the demand vector  $\{X_{it}^j\}$ .
  - (b) Iterates until goods and labor markets clear, satisfying Eqs. (B.11)–(B.20).
  - (c) Returns converged  $\dot{w}_{it}, \dot{r}_{it}, \dot{P}_{it}, \dots$
3. Update Value Functions: Using the newly found  $\dot{w}_t, \dot{P}_t$ , etc., update  $\dot{u}_{it}$  from Eq. (B.3),  $\dot{v}_{it}^{ja}$  from Eqs. (B.1)
  4. Check Convergence: Define  $\epsilon \equiv \max \left\{ \max_{it} \|\mu_{it}^{(\text{new})} - \mu_{it}^{(\text{old})}\|, \max_{i,j,a,t} \|\dot{v}_{it}^{j(\text{new})} - \dot{v}_{it}^{j(\text{old})}\| \right\}$ . If  $\epsilon < \text{tol}$ , then stop; otherwise set  $\ell = \ell + 1$ , update the guesses as below, and return to Step 1.

5. Update Guesses: Take a fraction  $\iota \in (0, 1]$  of the newly computed value functions. For instance:

$$\dot{v}_{it}^{ja} \leftarrow \iota \dot{v}_{it}^{jL,(\text{new})} + (1 - \iota) \dot{v}_{it}^{jL,(\text{old})}, \quad \dot{u}_{it} \leftarrow \iota \dot{u}_{it}^{(\text{new})} + (1 - \iota) \dot{u}_{it}^{(\text{old})}, \dots$$

Figure A1: Value Function  $\dot{U}_{it+1} = U_{it+1}/U_{it}$



*Notes:* This figure shows the value function in time difference for households from the end of the data period to the steady state.

## C.2 Algorithm to Solve for the Counterfactual Economy

The goal is to compute all counterfactual variables  $(\mathcal{S}'_t, \mu'_{t-1}, \varsigma'_{t-1}, \psi'_{t-1}, \lambda'_t)$  by expressing them in hat notation relative to the baseline. These “hat” variables satisfy equilibrium conditions analogous to (B.21)–(B.46).

1. Load Baseline Data and Parameters.
  - From period 0 to large  $T$ , the baseline provides arrays for employment  $L_{it}$ , migration shares  $\mu_t$ , firm entry  $\psi_t$ , stay rates  $\varsigma_t$ , and trade shares  $\lambda_t$ .
  - We also take as given the relevant structural parameters  $(\beta, \sigma, \nu, \chi)$ .
2. Construct Policy Ratios and Initialize *Hat* Variables.
  - For each policy instrument (taxes, budget shares, or migration costs) and each period  $t \geq 1$ , form the ratio of the *counterfactual* policy to the baseline policy, yielding  $\hat{\mathcal{P}}_t$  (e.g.  $\hat{m}_{ijt}, \hat{\tau}_{it}$ , etc.).

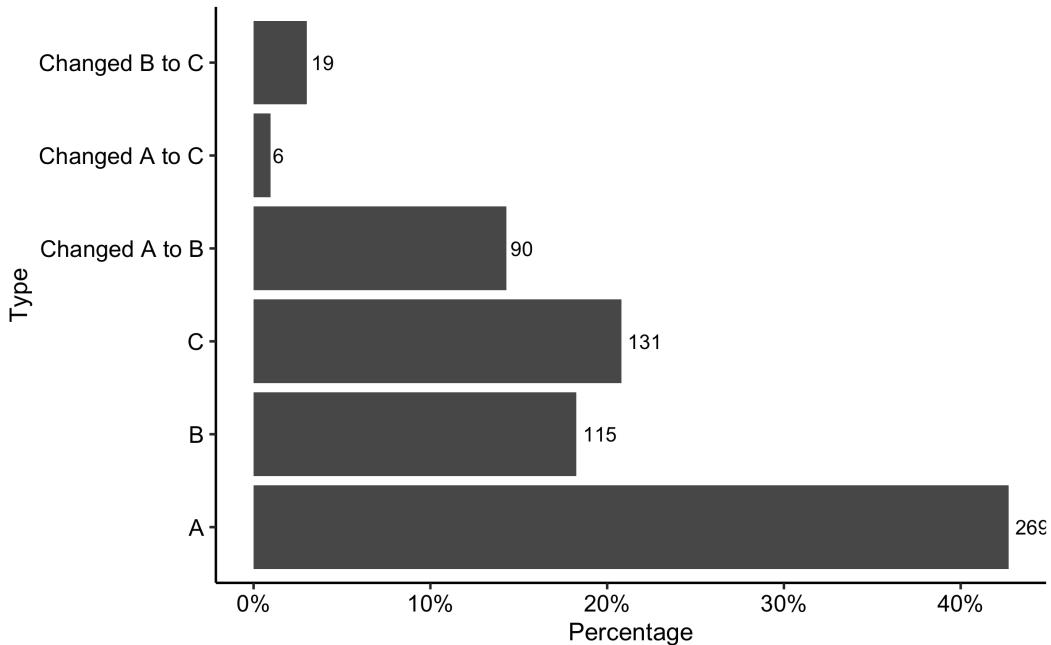
- Initialize the main hat variables at guess values (often 1.0):  $\hat{u}_{it}^{(0)}, \hat{v}_{ijat}^{(0)}$
3. Outer Iteration: Updating Migration, Stay, and Entry.
- (a) *Migration Shares.* Use the worker-value conditions (B.22)–(B.26) to update  $\hat{\mu}_{int}$  based on the baseline  $\mu_{int}$  and the policy ratio  $\hat{m}_{int}$
  - (b) *Stay vs. Exit (Firm Survival).* Update  $\hat{\varsigma}_{it}^{js}$  by the ratio  $\hat{\varsigma}_{it}^{js}$ , balancing the expected value from staying vs. switching to outside options  $\hat{u}_{it+1}$  (equations (B.24) and (B.30)).
  - (c) *Entry Shares.* Similarly, update  $\hat{\psi}_{it}^j$  via (B.25), reflecting the ratio of an entrepreneur's next-period value  $\hat{v}_{it+1}^{j1}$  to a worker's  $\hat{\Xi}_{it}^{\frac{1}{\lambda}}$ , etc.
  - (d) *Employment and Firm Stocks.* Evolve  $\hat{E}_{it+1}^j$  and  $\hat{L}_{it+1}$  from period  $t$  to  $t+1$  by combining newly entering firms, surviving old firms, and workers who exit.
4. Inner Iteration: Market Clearing for Each  $t$ . For each period  $t$ , given guesses for  $\{\hat{L}_{it}, \hat{E}_{it}^j, \dots\}$ , solve simultaneously for:
- *Factor prices*  $\hat{w}_{it}$  that satisfy a hat version of the labor- and capital-market clearing conditions ((B.39), (B.46)).
  - *Trade shares*  $\hat{\lambda}_{it}^j$  from (B.37)–(B.41).
  - *Budget constraints* for both local and national government, e.g. (B.43)–(B.45), in hat form.
  - Update  $\hat{P}_{it}$  (the location's composite price index) and  $\hat{X}_{it}^j$  (sectoral expenditure), ensuring consistency with equilibrium spending shares.
- The code typically uses an iterative wage update loop to find  $\hat{w}_{it}$  that clears markets, then recomputes  $\hat{\lambda}_{it}^j$  until convergence.
5. Convergence and Output: If the outer loop changes in  $\hat{u}, \hat{v}$  are below tolerance, terminate. Otherwise, update the guesses and go back to step 3.

In sum, because all equations are written in *ratios* to the baseline, the algorithm never requires knowing the baseline fundamentals in levels. Instead, it solves a system of hat equations that yield the counterfactual time paths  $(L', E', \mu', \varsigma', \dots)$  from period  $t = 1$  onward, conditional on policy changes  $\hat{\mathcal{P}}_t$ .

## D Appendix Figures and Tables

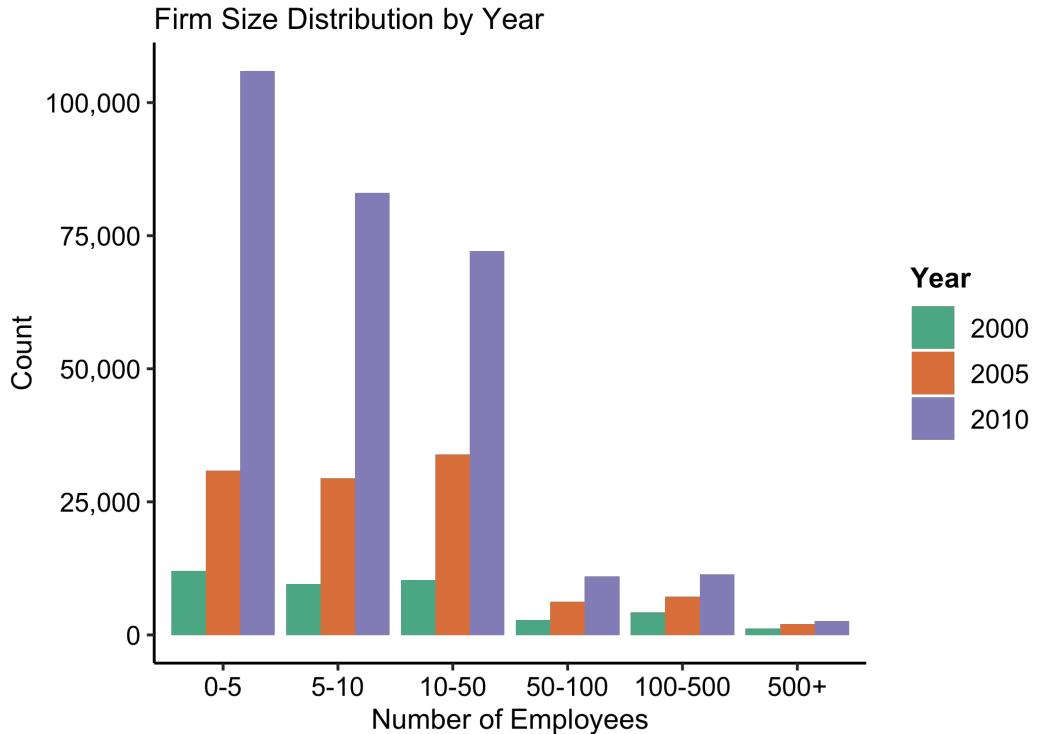
### D.1 Figures

Figure A2: Distribution of Policy Labels



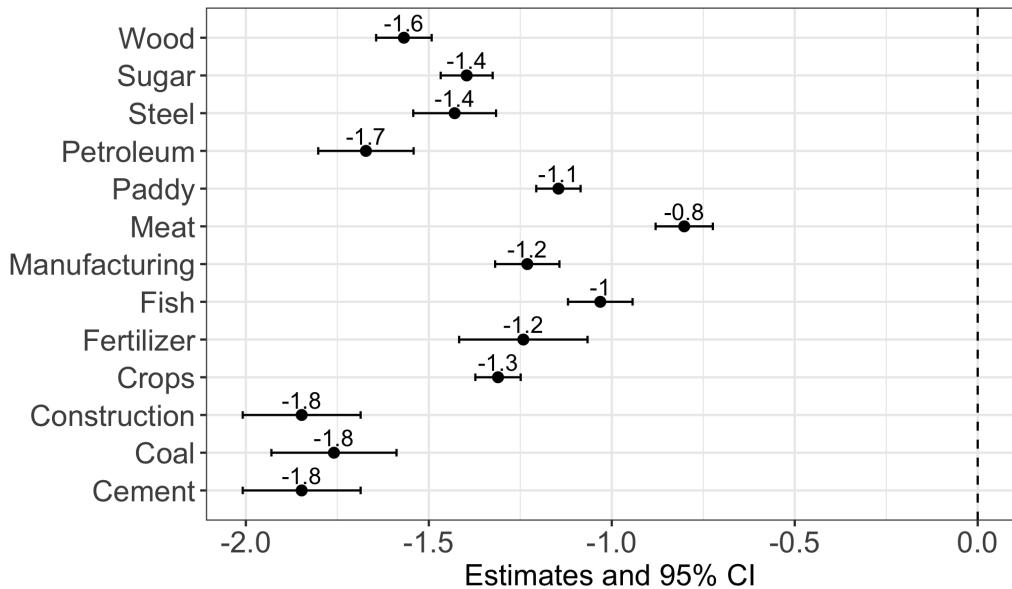
Sources: Decrees 164/2003/NĐ-CP and 88/2004/TT-BTC;

Figure A3: Firm Size Distribution 2000, 2005, and 2010



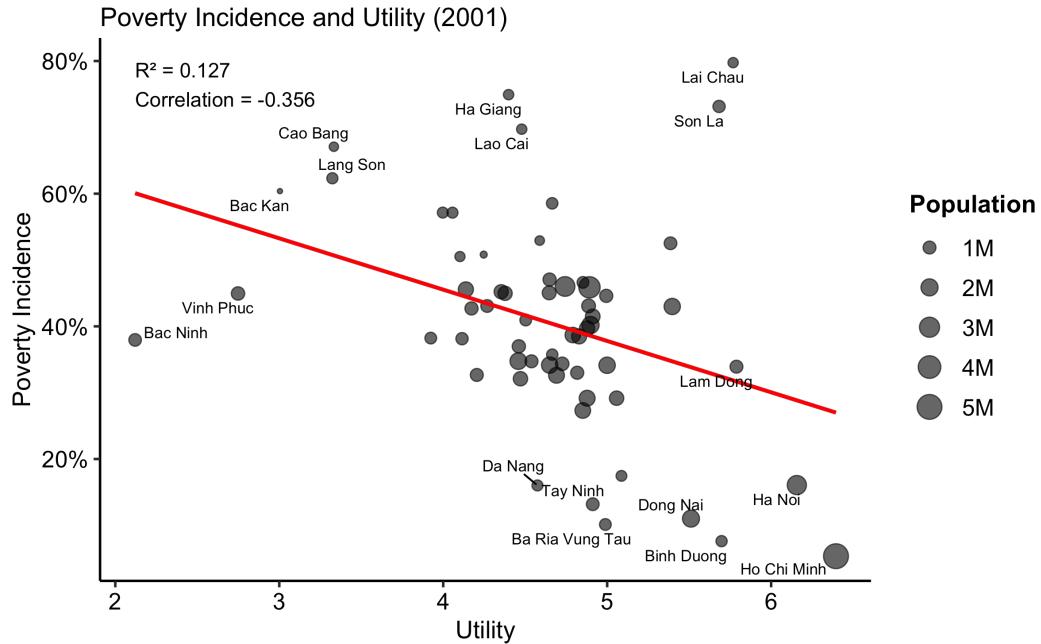
Source: Annual Establishment Surveys (2000, 2005, 2010)

Figure A4: Estimates of Distance Elasticities  $(1 - \sigma)\kappa^j$



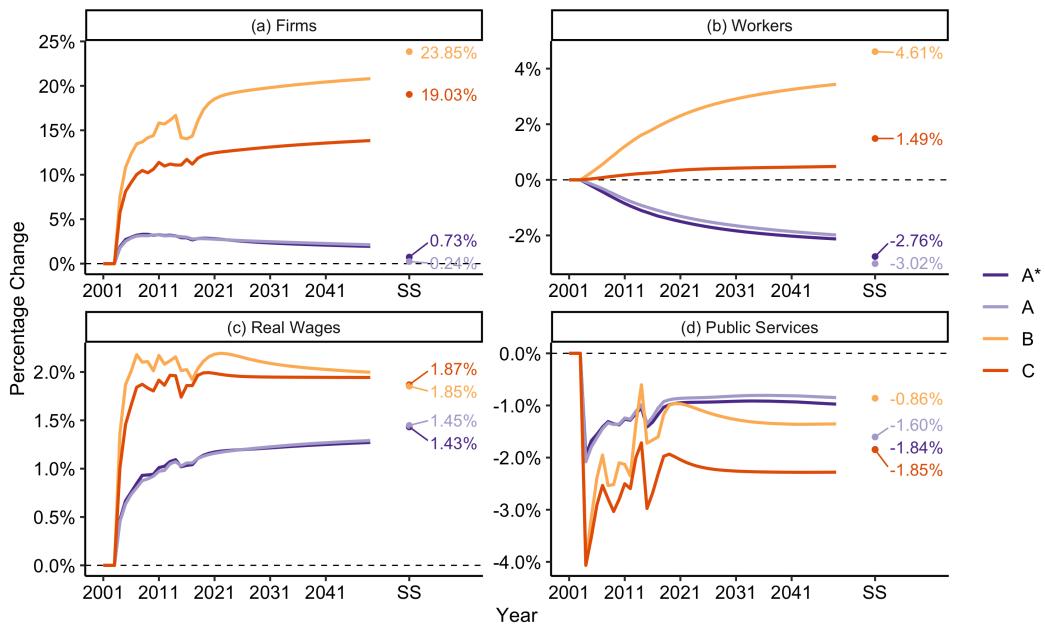
Notes: Data come from JICA (2000). Standard errors are clustered at the origin-destination level.

Figure A5: Estimated Expected Utility 2001 and Poverty Incidence 1999



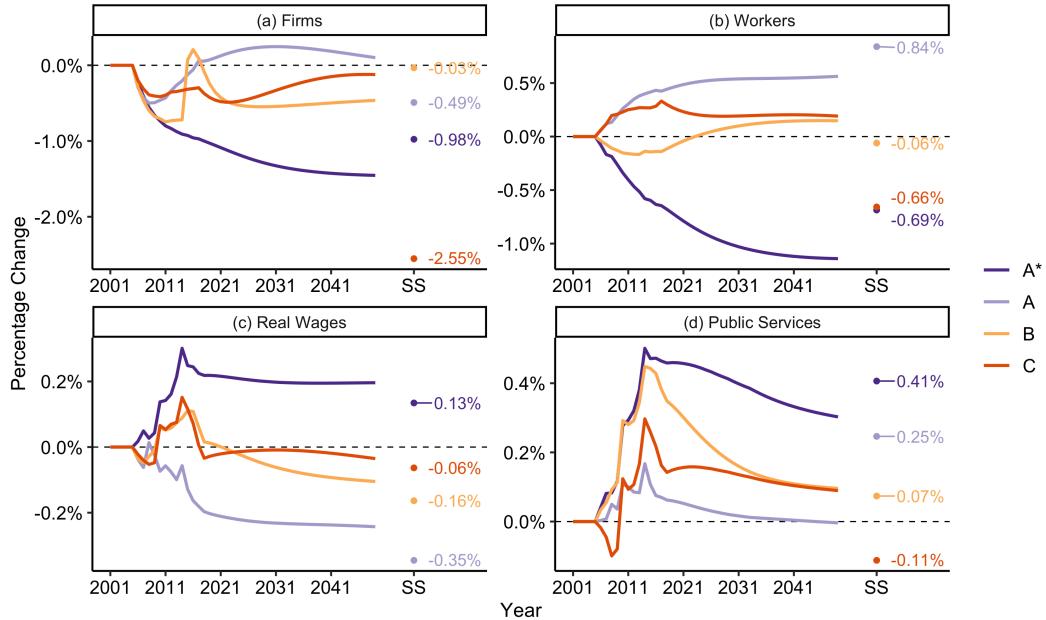
Notes: This figure shows the correlation between the poverty incidence in 1999 from Minot et al. (2003) and the expected utility averaging from 2001 to 2003 for each province.

Figure A6: Effects of 2003 Tax Policy Alone



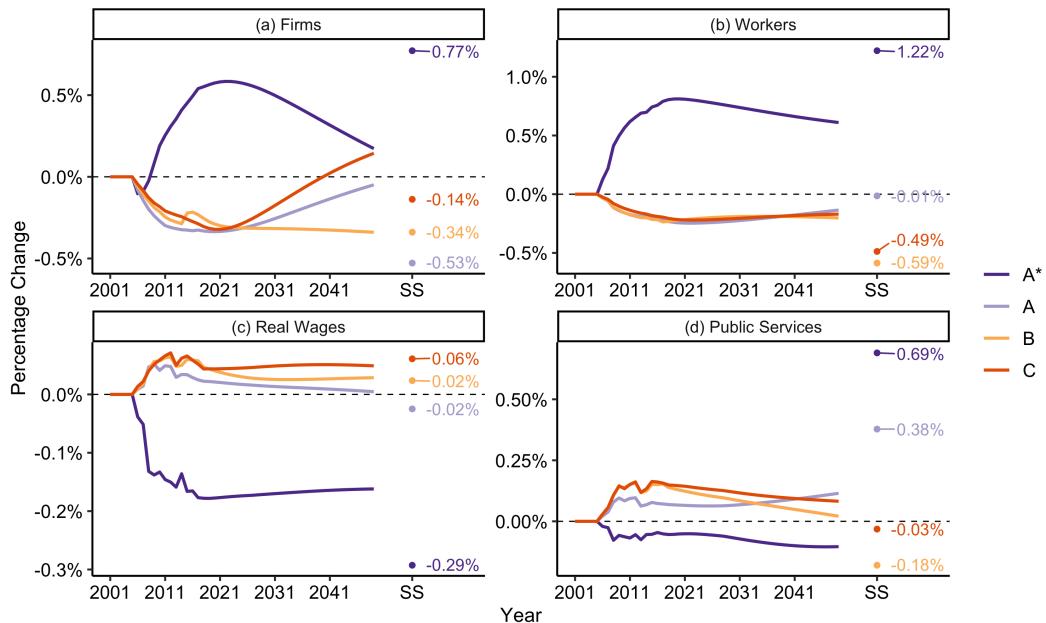
Notes: This figure is similar to Figure 8 but with 2003 tax policy alone.

Figure A7: Effects of 2005 Ho Khau Alone



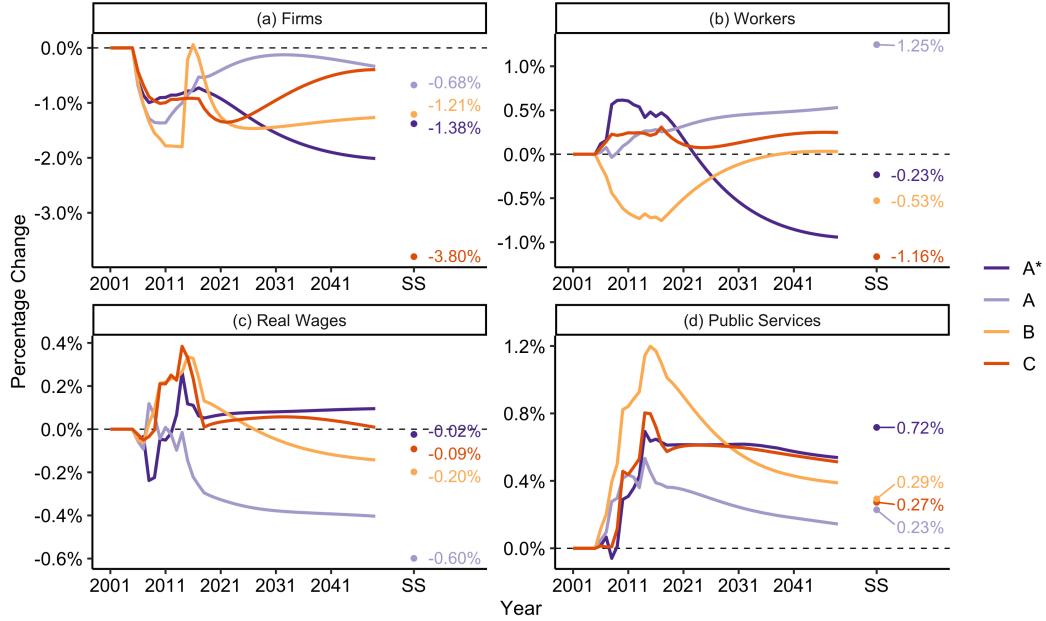
Notes: This figure is similar to Figure 8 but with 2005 Ho Khau alone.

Figure A8: Effects of Easing Migration to A\*



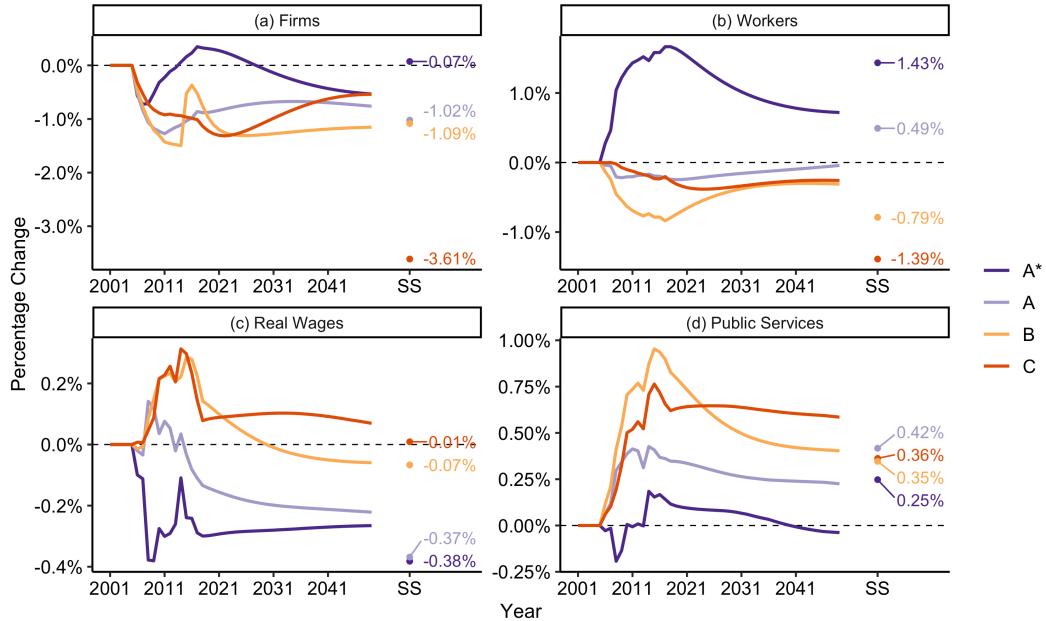
Notes: This figure is similar to Figure 8 but with A\* Access alone.

Figure A9: Effects of Easing Migration to non-A\*



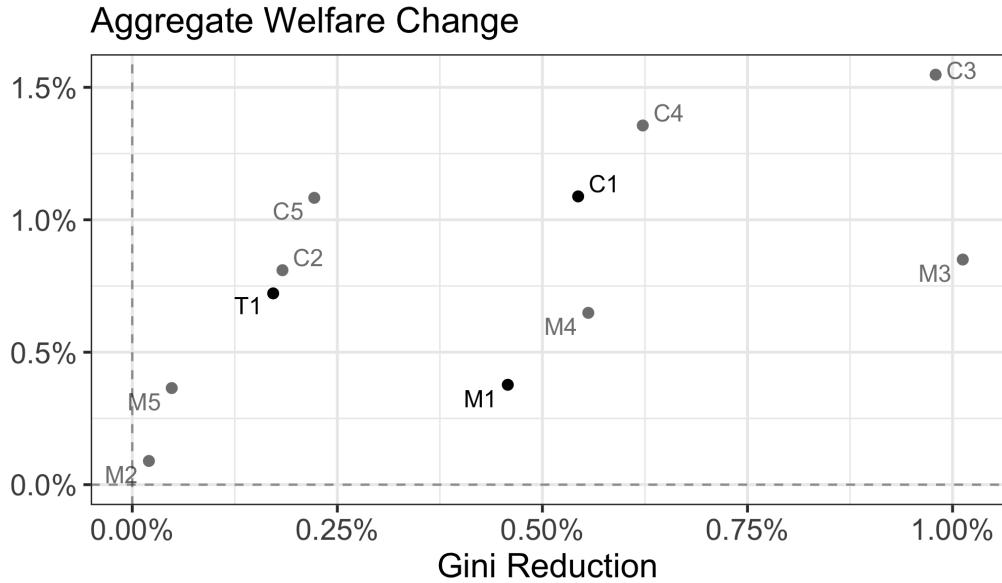
Notes: This figure is similar to Figure 8 but with non-A\* Access alone.

Figure A10: Effects of Uniform Migration Cost Reduction



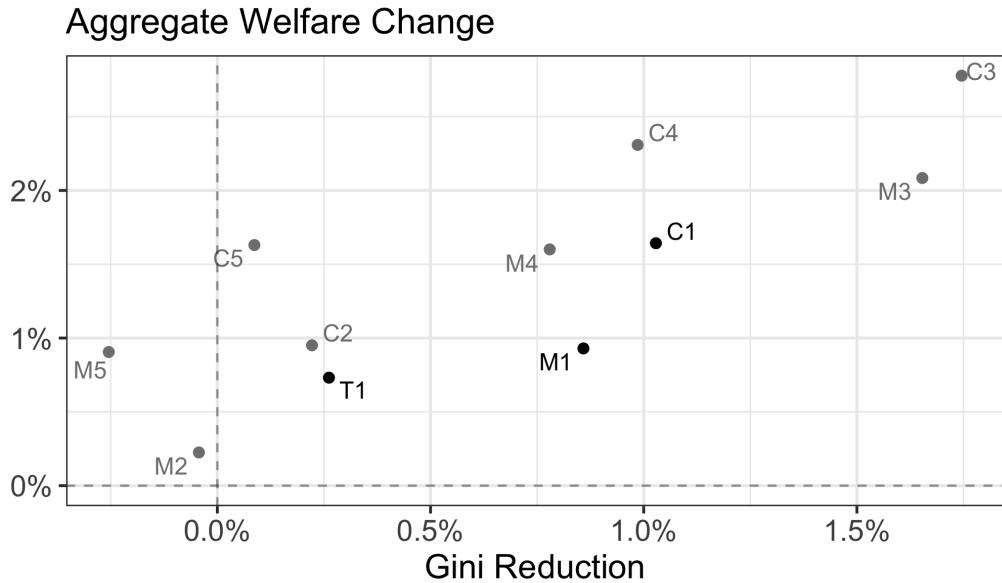
Notes: This figure is similar to Figure 8 but with Uniform Access alone.

Figure A11: Aggregate Welfare vs. Spatial Inequality: Robustness  $\nu = 1.1$



Notes: This figure is similar to Figure 12 but with migration elasticity parameter set to  $\nu = 1.1$  (lower than baseline  $\nu = 1.6$ ).

Figure A12: Aggregate Welfare vs. Spatial Inequality: Robustness  $\nu = 2.85$



Notes: This figure is similar to Figure 12 but with migration elasticity parameter set to  $\nu = 2.85$  (higher than baseline  $\nu = 1.6$ ).

## D.2 Tables

Table A1: Summary Statistics Grouped by Tax Policy Labels

Characteristic	Overall N = 611	A* N = 74	A N = 200	B N = 193	C N = 144
Incidence of Poverty	0.42 (0.21)	0.21 (0.16)	0.31 (0.12)	0.44 (0.14)	0.66 (0.16)
Pop. per Acre	6.46 (23.16)	37.88 (57.36)	4.27 (3.30)	1.19 (1.09)	0.43 (0.81)
Ethnic Minority (%)	0.23 (0.33)	0.03 (0.08)	0.02 (0.05)	0.22 (0.26)	0.66 (0.31)
Urban Share (%)	0.22 (0.29)	0.52 (0.46)	0.26 (0.30)	0.16 (0.18)	0.10 (0.09)
Literate Pop.15+ (%)	0.87 (0.13)	0.94 (0.03)	0.93 (0.03)	0.89 (0.06)	0.72 (0.18)
Average Wage (Million VND)	8.58 (3.78)	12.35 (4.86)	8.51 (3.58)	8.04 (3.28)	7.48 (2.76)
Agriculture Share (%)	0.34 (0.13)	0.19 (0.18)	0.31 (0.13)	0.37 (0.08)	0.42 (0.06)

1 1

*Sources:* Data from Annual Establishment Surveys (2000-2003) for row 6, and [Minot et al. \(2003\)](#) for the remaining rows.

*Notes:* Presented as Mean (Standard Deviation). Average wage calculations cover the period from 2000 to 2003.

Table A2: 2000 Multi-Plant Firm Shares

	Shares of Multi-plant	Firms	Sales	Employment
All	0.011	0.078		0.077
SOE	0.068	0.136		0.119
Private	0.002	0.006		0.018
Foreign	0.006	0.006		0.013

\* *Source:* Annual Establishment Surveys, 2000