Openness to Foreign Firms, Industrialization and Aggregate Growth *

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Abstract

This paper investigates the aggregate impact of foreign firm openness reforms on resource misallocation, structural transformation, and aggregate productivity in Vietnam. The analysis uses firm-level data and a multi-sector general equilibrium model that features firm heterogeneity in distortions and productivity. Empirically, I document two key findings associated with the reforms. First, there is evidence of significant reductions in key measures of distortions towards foreign firms and improvements in their productivity over time. Second, by exploiting the staggered rollout of reforms across different locations, the paper employs the staggered difference-in-difference estimation method by Callaway and Sant'Anna (2021) to provide evidence of significant "spillover" effects from manufacturing reforms on the agriculture and services sectors. Quantitatively, the reduction in distortions towards foreign firms account for 62% of the observed productivity growth in the manufacturing sector and 40% of the observed aggregate productivity growth. "Spillover" effects play a crucial role, contributing approximately 70% of the overall aggregate impact of the reforms.

Keywords: Firms, FDI barriers, productivity, disortions, misallocation, technology, spillover, structural transformation.
JEL classification: O11, O14, O4.

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1 Introduction

Understanding the impact of foreign direct investment (FDI) and activities of multinational enterprises (MNEs) on economic growth and development has been a long-standing question in academic literature, yet it remains a puzzling issue. While theoretical models suggest that financial openness, including FDI, can provide more capital at a lower cost and stimulate growth in developing countries (McGrattan and Prescott, 2009; Burstein and Monge-Naranjo, 2009), empirical research has often found limited evidence linking FDI to sustained economic growth (Alfaro, 2017; Kose et al., 2009). My study seeks to contribute to this ongoing debate by examining the role of openness to foreign firms in driving economic growth, specifically in the context of major policy reforms aimed at reducing barriers to foreign firms' operation in Vietnam's manufacturing sector during the early 2000s.

The economic reforms in Vietnam have been associated with a period of sustained high growth and rapid industrialization, offering a valuable context to explore the broader implications of FDI. This study addresses key research questions: What types of policies were implemented as part of these reforms? What are the quantitative impacts of these policies on aggregate economic outcomes? If successful, through which channels do these reforms contribute to economic growth? By answering these questions, the study aims to provide a clearer understanding of how FDI-related reforms can influence economic development.

This paper provides evidence consistent with the reforms' objectives, showing a decline in various measures of distortions faced by foreign firms in Vietnam's manufacturing sector over time. The reforms primarily focused on reducing barriers to the operation of foreign firms. To assess the quantitative impact of these reforms, I develop a multi-sector general equilibrium model that incorporates firm heterogeneity within the manufacturing sector. The results indicate that reducing distortions toward foreign firms substantially improves productivity, with manufacturing productivity increasing by 3.34 percentage points and aggregate productivity by 1.75 percentage points—accounting for approximately 60% and 40% of the observed growth, respectively. The reforms quantitatively contribute to aggregate productivity growth through three key channels: (1) static cost of misallocation, where reducing distortions improves the allocation of resources between domestic and foreign firms; (2) dynamic cost of misallocation, where reducing distortions toward more productive foreign firms encourages technology upgrading investments, resulting in the entry of higher-quality foreign firms; and (3) indirect "spillover" effects, where reforms in one sector boost productivity in non-reformed sectors, thereby amplifying the overall impact on aggregate productivity growth.

Vietnam provides a unique and relevant context for this study, having transitioned from a closed to a market-oriented economy since 1986. Over the years, Vietnam has implemented several major policy reforms, including trade reforms, financial liberalization reforms, and a series of amendments to the Foreign Investment Law. A significant milestone in Vietnam's economic liberalization was its admission to the World Trade Organization (WTO) in 2007, which required the country to undergo the most comprehensive set of market liberalization and FDI openness reforms in the early 2000s. The landmark legislation of this period was the Unified Investment Law in 2005, which removed unequal treatment between foreign and domestic firms in the manufacturing sector. However, despite these reforms, significant barriers to FDI remain in sectors other than manufacturing. During this period, Vietnam consistently experienced high economic growth, strong industrialization, and a massive influx of FDI firms, with most entry occurring in the manufacturing sector.

I compiled data for empirical analysis from several sources: firm-level data from the Vietnam Enterprise Survey, covering all registered firms; household-level data from the Vietnam Household Living Standard Survey; and manually collected data on all industrial zones in Vietnam. I document three main stylized facts. First, at the aggregate level, Vietnam has demonstrated a rapid catch-up in labor productivity compared to developed economies, a significant structural transformation from agriculture to manufacturing and services, and a notable expansion of foreign direct investments in the manufacturing sector over the past two decades. Second, there has been a significant reduction in two key measures of distortions—average distortions between foreign and domestic firms and correlated distortions with productivity within foreign firms—alongside improvements in foreign firm-level productivity. Third, by exploiting the staggered rollout of FDI openness reforms in the manufacturing sector through the establishment of industrial zones across various locations, I find empirical evidence of significant "spillover" effects, including reductions in agricultural employment and expansions in the services sector following the establishment of the first industrial zones at the location level.

To investigate the quantitative role of reforms in reducing misallocation distortions towards foreign firms, I develop a multi-sector model incorporating production heterogeneity in manufacturing sector with distortions, technological upgrading, and firm entry, building on the work of Duarte and Restuccia (2010), Hopenhayn (1992), and Restuccia and Rogerson (2008). This model features a closed economy with three sectors: agriculture, manufacturing, and services, each producing homogenous goods within their sector. Preferences in the model drive structural transformation through two key effects: an income effect on agricultural consumption and a substitution effect between manufacturing and services. In the manufacturing sector, firms have access to a decreasing returns technology with labor input. Firm productivity is determined by two sources: productivity-enhancing investments, which involve the costly adoption of advanced technologies, and an exogenous component drawn from a specific distribution. The model includes two types of firms—domestic and foreign—that face different costs for technology upgrading, distinct distributions of exogenous productivity, and different distortion structures. Firms enter the market by paying a fixed entry cost in labor units and then realize their type (domestic or foreign). Based on their firm type, they make decisions about technology investment and draw their exogenous productivity and distortion components. Production decisions are made according to these factors, and firms exit the market at an exogenous rate. Agricultural and services goods are produced by representative firms using linear labor technology. A novel feature of this model is that productivity in agriculture and services includes both an exogenous component and a "spillover" effect from the manufacturing sector. The analysis focuses on a stationary competitive equilibrium, where the distribution of resource allocations and firm types are stationary.

I parameterize distortions to include a systematic component correlated with firm productivity and a random component drawn from a log-normal distribution. The model is calibrated to both micro-level (producer-level) and aggregate data for the Vietnamese economy in 2000 and 2015 as two benchmark economies. Key parameters that govern distortions and productivity are estimated directly from firm-level data. The parameters for productivity "spillover" from manufacturing to agriculture and services are estimated using a staggered difference-in-difference analysis, leveraging the staggered rollout of industrial zones as a proxy for reforms targeting foreign firms over time. Critical parameters related to technological upgrading costs for foreign and domestic firms in manufacturing, as well as the exogenous components of agricultural and services productivity, are jointly calibrated to match observed sectoral employment shares and aggregate productivity. The model well replicates untargeted moments, including productivity growth in agriculture and services, as well as the productivity growth of foreign and domestic firms within the manufacturing sector. This serves as a validity check for the model's ability to account for structural transformation and productivity growth in Vietnam during the sample period from 2000 to 2015.

I next use the calibrated model to quantitatively assess the impacts of reforms aimed at reducing distortions toward foreign firms on productivity growth and structural transformation. The first set of counterfactual experiments focuses on the changes to the distortions affecting foreign firms, with all other parameters held constant. Thera are two important sources of distortions: the average level of distortions that foreign firms face relative to domestic firms and the eiasticity of distortions to productivity across foreign firms. The reduction of both types accounts for a substantial portion of the observed growth at both the sectoral and aggregate levels. Specifically, these reductions explain 62% of the productivity growth in manufacturing, 23% in agriculture, 78% in services, and 40% of the aggregate productivity growth. Further decomposition reveals that while the reduction in average distortions towards foreign firms has a notable impact (contributing 17% to manufacturing productivity growth and 12% to aggregate productivity growth), the reduction in correlated distortions have an even larger role, contributing 45% to manufacturing and 28% to aggregate productivity growth. The second set of counterfactual experiments examines the effect of the reforms through the "spillover" effects on structural transformation patterns and aggregate productivity growth. The results indicate that omitting the "spillover" effects (as in most standard structural transformation models) would lead to a drastically different and inconsistent outcome compared to the patterns in the actual data. Without the "spillover" effect, the model predicts a lack of labor reallocation away from agriculture and a substantial reduction in the size of the manufacturing sector. Consequently, excluding the "spillover" channel would underestimate the impact of the reforms on aggregate productivity growth by 70%, as the reformed sector's size significantly shrinks and there is no growth in the other two sectors.

This paper is closely related to four strands of literature. First, this paper contributes to the literature studying the impact of Foreign Direct Investment (FDI) and Multinational Enterprises (MNEs) on developing countries (e.g. Alfaro (2017) and Kose et al. (2009) for survey of the literature). Extensive literature has studied the impact of FDI on productivity both theoretically and empirically. Macro papers such as McGrattan and Prescott (2009), Burstein and Monge-Naranjo (2009) suggest that the inflows of FDI will induce growth in developing countries via supply of capital, technology transfers and knowledge spillovers. However, there has been mixed and little empirical evidence on the relationship between FDI openness and growth across countries (e.g. Harrison and Rodríguez-Clare (2010), Hansen and Rand (2006), Alfaro and Chen (2018)). There's also mixed evidence on the spillover effects of FDI on domestic firms, suggesting that FDI spillover effects are dependent on various characteristics and institutions of host countries (e.g. Kee (2015), Newman et al. (2015), Abebe et al. (2022), Alfaro-Ureña et al. (2022)). A related paper studying FDI in Vietnam context is

McCaig et al. (2022) who provide causal evidence on Vietnam- United States Bilateral Trade Agreement 2001 on the expansion and entry of FDI firms in Vietnam. Different from their work, my paper focuses on a comprehensive set of policies reforms towards FDI openness and assess quantitative macroeconomic impacts of these reforms. I make three contributions to this literature. First, this paper provides evidence from Vietnam that reforms aimed at reducing distortions and barriers to foreign firms can generate substantial gains in aggregate productivity. Second, by considering the dynamic impacts of distortions on firms' decisions to invest in technology, the reduction of distortions for foreign firms further enhances aggregate productivity by attracting more productive entrants. Third, the paper demonstrates the "spillover" effects of sector-specific reforms on other sectors and aggregate growth, suggesting that the overall impact on productivity growth is significantly larger than the effect on the reformed sector alone.

Second, this paper closely relates to the literature studying resource misallocation (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009) and the associated literature on producer dynamics, technology adoption and aggregate productivity (Parente and Prescott, 1994; Bhattacharya et al., 2013; Hsieh and Klenow, 2014; Bento and Restuccia, 2017). This paper makes three key contributions. First, it links specific policies affecting foreign firms to sources of misallocation. A closely related study, Bau and Matray (2023), provides causal evidence on the impact of FDI openness reforms in India on reducing capital misallocation. This paper supports and extends those findings by examining how reductions in distortions towards foreign firms in Vietnam correlate with reforms, using a general equilibrium framework to assess the quantitative impacts of FDI barriers on growth and development. Second, whereas most previous studies (e.g., Restuccia and Rogerson (2008), Hsieh and Klenow (2009)) focus on cross-country comparisons or hypothetical scenarios, this paper evaluates the costs of misallocation in the context of actual reforms and growth experiences. Third, unlike most research that analyzes misallocation within a single sector, this paper assesses the effects of within-sector reforms on sectoral composition and aggregate outcomes, offering a broader perspective on their impact beyond the reformed sector.

Third, this paper contributes to the broader literature on the determinants of structural transformation and its implications for growth and development (Kongsamut et al., 2001; Gollin et al., 2002; Ngai and Pissarides, 2007; Duarte and Restuccia, 2010; Boppart, 2014; Herrendorf et al., 2014; Comin et al., 2021). I make two key contributions to this literature. First, while previous studies typically link structural transformation to sectoral-level productivity, this paper is among the first to connect micro-level distortions and reforms to sectoral productivity and structural transformation. The model presented in this paper provides a framework for assessing the quantitative impacts of sector-specific reforms on both structural transformation and aggregate growth. Second, I offer new evidence on the "spillover" effects of productivity from one sector to others, demonstrating that these effects are crucial for understanding the broader impact of sector-specific reforms on industrialization and aggregate growth. This finding highlights the importance of further exploring the channels driving intersectoral linkages.

Lastly, this paper contributes to the literature on policies affecting economic development in Vietnam. Previous studies have examined agriculture policies Ayerst et al. (2020), Benjamin and Brandt (2004), Le (2020), Ayerst et al. (2023), trade policies McCaig and Pavcnik (2015), McCaig and Pavcnik (2018), McCaig and Pavcnik (2021), and FDI barriers Athukorala and Tran (2012). Unlike these studies, this paper focuses on the macro-level perspective of FDI barrier policies. It connects a comprehensive set of trade and FDI reforms aimed at removing FDI barriers, links these reforms to evidence on policy effectiveness, and demonstrates the substantial aggregate impact of FDI openness through a general equilibrium framework.

This paper is structured as follows. Section 2 presents the context of FDI barriers and the policy reforms that were implemented in Vietnam over time. Section 3 outlines the data sources and variable contruction used in the study. The stylized facts are presented in Section 4, followed by the model in Section 5 and calibration in Section 6. In Section 7, I provide counterfactual results that show the quantitative impacts of FDI barrier removal. Finally, Section 8 concludes the paper.

2 Institutional Context in Vietnam

This section reviews the institutional framework of Vietnam with a focus on barriers to foreign direct investment (FDI), and analyzes the major policy reforms implemented in the early 2000s to address these barriers.

2.1 Institutional Context and Reforms on Foreign Investment Law

Since the implementation of the first Foreign Investment Law in 1987, several reforms have been implemented to lower barriers and attract FDI firms. In 1990 and 1996, significant amendments were made to the law, including the extension of tax holidays for investments in priority sectors, the establishment of export processing zones with special incentives for export-oriented FDI firms, and the delegation of investment project approvals to local authorities (Athukorala and Tran, 2012).

Despite repeated efforts to implement reforms, substantial barriers persisted for Foreign Direct Investment (FDI) to enter and operate in Vietnam during the early 2000s. Compared to the standard requirements followed by domestic firms, FDI firms faced many extra barriers. In 2005, the introduction of the Unified Investment Law (2005) represented a crucial milestone in overcoming these barriers. This landmark legislation facilitated the rapid elimination of barriers to FDI firms, eliminating major disparities between FDI and domestic firms.

The Unified Investment Law (2005) addressed two main sets of barriers that impeded the flow of FDI into Vietnam: barriers to approval and registration process and barriers to operation activities. The reform consisted of important changes in both the legal framework and its execution. The legal framework has been modified to simplify procedures, provide more detailed guidance, reduce bureaucratic paperwork, and standardize and codify regulations (Do, 2014). Meanwhile, implementation has involved delegating approval and monitoring authority from the centralized government to the provincial level. This decentralization of authority has been critical in successfully implementing reforms, as it provides provinces with incentives to attract and facilitate the regulatory process for foreign direct investment (FDI) firms (Vo and Nguyen, 2012). Provinces now have a more significant role in the approval and monitoring of FDI projects, which has resulted in more efficient and streamlined procedures, and a reduction in red tape.

Barriers to approval and registration process. The approval and registration process for Foreign Direct Investment (FDI) firms in Vietnam was challenging, as evidenced by the centralized government-level approval of most investment projects, which required numerous licenses and permits from different departments (Do, 2014). Additionally, the process was lengthy and inefficient, leading to uncertainties and delays. The laws surrounding FDI were too general, lacking clear guidelines for interpretation and implementation among government state agencies involved in project appraisal and management. The prolonged and complex process made it challenging for investors to forecast the outcome of their investment, which could lead to further costs and risks.

One key change introduced by the Unified Investment Law (2005) is the introduction of a simplified and decentralized investment approval system to reduce approval and registration costs, opening up access to Vietnamese market (UNCTAD, 2008). The new three-tier process included business registration for projects under 1 million USD, approval at the provincial level for projects between 1 million USD and 20 million USD, and approval from the central government for projects exceeding this amount. Projects under 300 billion dong (20 million USD) were exempt from formal approval if they were not in a restricted sector (Athukorala and Tran, 2012).

Barriers to operation activities. The operation activities of Foreign Direct Investment (FDI) firms in Vietnam were restricted by various barriers, including heavy regulation and strict monitoring of operating activities. FDI firms had to comply with local content requirements and export performance requirements, which limited their operations. The regulations also required FDI firms to commit to the initial agreement as specified in the registration process. Any changes to their operations or products required government reapproval, which could lead to further delays and increased costs and added to the uncertainty faced FDI firms Do (2014). In addition, FDI firms faced limited access to the domestic market, as special licenses were required to access it. Incentives were mostly offered to export-oriented FDI firms only.

The 2005 Unified Investment Law abolished the requirements for FDI firms to use domestic inputs (local content requirement) and the export performance requirement. The law also provided investors with complete freedom in choosing the form of their business entities, allowing them to perform reorganization, mergers, and acquisitions activities to support their business objectives (Do, 2014). In addition, the 2005 Unified Investment codified and standardized investment regulations for both domestic and foreign firms into one set of regulations, providing equal treatment to both domestic and foreign firms. The law also introduced more flexible dispute resolution procedures, allowing foreign investors the freedom to choose between a domestic or an international arbitration body in the event of an investment dispute.

The above barriers exposed FDI firms Vietnam to various economic costs that can impede their entry and operations. These costs include higher legal fees and regulatory costs, which can be attributed to the complex regulatory environment and red tape in the country (UNCTAD, 2008). Another cost is the challenge of dealing with bureaucracy and corruption, which can add significant time and expense to a business's operations. Additionally, FDI firms face high uncertainty in obtaining approvals for various business activities, which can result in delays and increase costs. The strict monitoring from the government adds to the costs of operations and makes FDI firms more vulnerable to business shocks. Additionally, the local content requirement and economic performance requirement pose high variable costs for various types of inputs, making it more expensive for FDI firms to operate in the Vietnamese market. The high cost of accessing the domestic market is another barrier that discourages FDI firms from expanding their operations in Vietnam.

2.2 Implementation of FDI Reforms in Manufacturing Sector

While changes in the law are crucial, effective implementation is essential, as emphasized by Vo and Nguyen (2012). The manufacturing sector is distinctive because its production and operations are tied to specific geographical locations. This spatial specificity makes it easier for the government to monitor and implement reforms within designated areas, allowing for targeted adjustments and reducing political concerns about foreign firms' influence on a national scale.

Most reforms aimed at foreign firms are concentrated within industrial zones (IZs) and export processing zones (EPZs), which are designated areas offering special incentives and regulations. These zones are central to Vietnam's strategy for attracting more foreign direct investment (FDI) firms and enhancing their productivity and efficiency. By focusing reforms within these zones, the government can create a more favorable environment for foreign firms and boost their economic contributions.

In addition to legislative reforms, the central government has progressively authorized the establishment of more industrial zones. The number of these zones has grown dramatically, from just 1 in 1991 to 65 in 2000, and more than 325 by 2015. Initially, the first industrial zones were set up as experimental projects in regions distant from the central government. Observing their success, the central government expanded the policy to include more locations over time.

Furthermore, regulatory authority for managing industrial zones has been decentralized to local governments, which has significantly enhanced both their power and incentives. This decentralization empowers local governments to customize regulations and approve investment projects, allowing them to tailor policies to better attract foreign firms. With increased authority, local governments can create more favorable conditions for FDI by reducing barriers and streamlining processes. Additionally, this shift in power provides local governments with strong incentives to attract foreign investment. As foreign firms enter these zones, they generate employment opportunities and stimulate the local economy, which directly benefits local communities and enhances the political standing of local officials. This also fosters greater competition among local governments to enhance the business environment and attract more FDI.

2.3 International Trade Reforms

This process began with Vietnam's accession to the ASEAN Free Trade Area in 1995 and continued with the signing of the Vietnam-United States Bilateral Trade Agreement in 2001. These agreements led to a significant reduction in tariffs, both in terms of average import-weighted duty rates and maximum tariff rates. By the end of 2007, less than 1% of total tariff lines have rates above 50%, with about a third of all tariff lines having zero tariffs (Athukorala, 2006).

The reduction in tariffs resulting from trade reforms represents a major advantage for FDI firms in Vietnam. As FDI firms are often highly involved in both import and export activities, the high tariffs that previously existed represented a significant cost to these firms in terms of inputs and outputs. The reduction in tariffs, as a result of trade reforms, serves to lower these costs and provide a more favorable environment for FDI in the country.

The trade reforms in Vietnam have undergone a gradual evolution concurrent with reforms in the Foreign Investment Law. These reforms have had a multifaceted impact beyond the mere reduction of trade barriers, necessitating greater accountability from the Vietnamese government. Notably, Vietnam's accession to the World Trade Organization (WTO) in 2007 brought forth substantial benefits, including improved market access, heightened foreign investment, and increased global economic integration. Accession to the WTO required Vietnam to undertake a series of comprehensive reforms and demonstrate its commitment to implementing international trade rules and regulations, such as safeguarding intellectual property rights, ensuring transparency in government procurement, and lowering trade barriers. Vietnam had to also establish a legal and regulatory framework consistent with WTO rules, involving the revision of its trade-related legislation, customs, and trade procedures. Moreover, Vietnam had to build institutional capacity to ensure full compliance with WTO rules, necessitating the strengthening of its administrative capabilities, the development of new regulations, and the training of government officials (UNCTAD, 2008).

Due to the lack of firm-level data on trade, this paper does not document or model trade reforms. However, it is important to acknowledge that reducing trade barriers is a significant policy measure in the context of lowering barriers for foreign firms. Foreign firms, which are more engaged in international trade compared to domestic firms, face substantial costs from both export and import tariffs. These trade barriers constitute a portion of the measured distortions affecting foreign firms. While this paper abstracts from modeling trade as part of these barriers, it remains a crucial component of the policy reforms towards openness to foreign firms in Vietnam.

3 Data

The data used in this paper are combined from multiple sources. The main dataset for my analysis is a firm-level dataset called Vietnam Annual Enterprise Survey. I also employed other data sources for aggregate variables.

3.1 Data Sources

Vietnam Annual Enterprise Survey is annual enterprise survey conducted by General Statistics Office (GSO) since 2000, covering all registered firms. The survey provides firm-level information about financial statements and characteristics. The information used in this study are firm's industry (3-digit Vietnam Standard Industrial Classification (VSIC) equivalent to 3-digit North American Industry Classification System (NAICS)), revenue, employment, labor compensation (wages and benefits), fixed assets, ownership. I define capital stock as the book value of fixed asset net of depreciation. Due to the lack of data on intermediate inputs, I impute value-added at firm level from the firm-level revenue and industry-level value-added share. The imputation assumes that firms in the same industry have the same value-added share. I used the industry-level producer price indices (PPIs) to deflate the value-added, use the manufacturing producer price index (PPI) to deflate capital and use consumer price index (CPI) to deflate wages.

The Vietnam Household Living Standard Survey (VHLSS) is a household survey conducted by the General Statistics Office (GSO) biennially from 2002 to 2018. It provides detailed household-level information on income, consumption, and demographic characteristics. I use this data to construct measures of agricultural employment and productivity, as well as average household income at the province level.

Vietnam Industrial Zone Database is a manually collected dataset on all industrial zones in Vietnam. The dataset provides information on the location, size, and year of establishment of each industrial zone. I use this data to construct a measure of the number of industrial zones in each province.

Vietnam Statistical Yearbook is annual publication by the General Statistics Office, comprises basic data reflecting the general socio-economic dynamic and situation of the whole country, socio-economic regions, and localities. Producer price indices (PPIs) at industry level and consumer price index (CPI) used in this study are from this source.

GGDC/UNU-WIDER's Economic Transformation Database provide comprehensive, long-term, and internationally comparable sectoral data on output and employment in 51 countries between 1990 and 2018. This paper uses data on value-added and employment at sectoral level for Vietnam, Korea, Japan and Taiwan.

Penn World Table version 10.01 is a database with information on relative levels of income, output, input and productivity, covering 183 countries between 1950 and 2019. I use data on PPP aggregate output and employment.

3.2 Variable Construction

We use the data to describe the distribution of firm-level productivity and measures of misallocation. We construct two variables that measure firm-level productivity and distortion. We refer to firm-level distortions as the firm's wedge since it is a model-based measure of the difference between the firm's realized market allocation and the hypothetical first-best allocation, in which wedges are equalized across firms. In this regard, the measure is the same as the marginal revenue product of factor inputs in Hsieh and Klenow (2009). We derive model-based measures of productivity and wedges as:

$$\mathrm{TFP}_{i,t} = \frac{y_{i,t}}{\ell_{i,t}^{\gamma}}, \qquad\qquad wedge_{i,t} = \frac{y_{i,t}}{\ell_{i,t}}. \tag{1}$$

We construct measures of output y and employment ℓ. We measure output as the firm's operating revenue deflated by producer price index at sectoral level. We do not use value added because we find that material costs are not consistently reported in the Enterprise Survey over time. Employment is measured as the number of employees hired by the firm.

4 Stylized Facts

This section presents the stylized facts on the growth and industrialization experience of Vietnam during the period 2000 to 2015. I first show the overall patterns of aggregate growth and structural transformation in Vietnam since 1986 since 1986 to provide a broader historical perspective. Next, the analysis focuses on the manufacturing sector in Vietnam. I document the expansion of foreign direct investment (FDI) firms within this sector and present evidence of the reduction in two key measures of distortions affecting foreign firms: the average distortions faced by foreign firms relative to domestic firms and the correlated distortions within foreign firms. Additionally, I examine the growth in firm-level TFP distribution among foreign and domestic firms in the manufacturing sector during this period. Finally, I provide evidence on the "spillover" effects of reforms aimed at foreign firms in the manufacturing sector, demonstrating how these reforms have broader and larger implications for structural transformation, aggregate growth, and average household income beyond the reformed sectors.

4.1 Economic Growth and Structural Transformation in Vietnam

Since the Doi Moi reform in 1986, Vietnam has undergone a transition from a centrally planned economy to a market-oriented one. The country's labor productivity has grown at a consistent rate of 4% annually, closing the gap with leading economies. As shown in Figure 1a, the relative labor productivity of Vietnam has increased from around 3.6% compared to the United States in 1990 to around 10% in 2020. Along with China, Vietnam has experienced convergence towards the United States and the frontier Asian economies (Japan, Korea, and Taiwan) between 1990 and 2020. Figure 1b demonstrates that Vietnam is undergoing a continuous process of structural transformation and industrialization, with a decline in the share of employment in agriculture from around 77% to 38%, leading to an increase in the services and industry sectors.

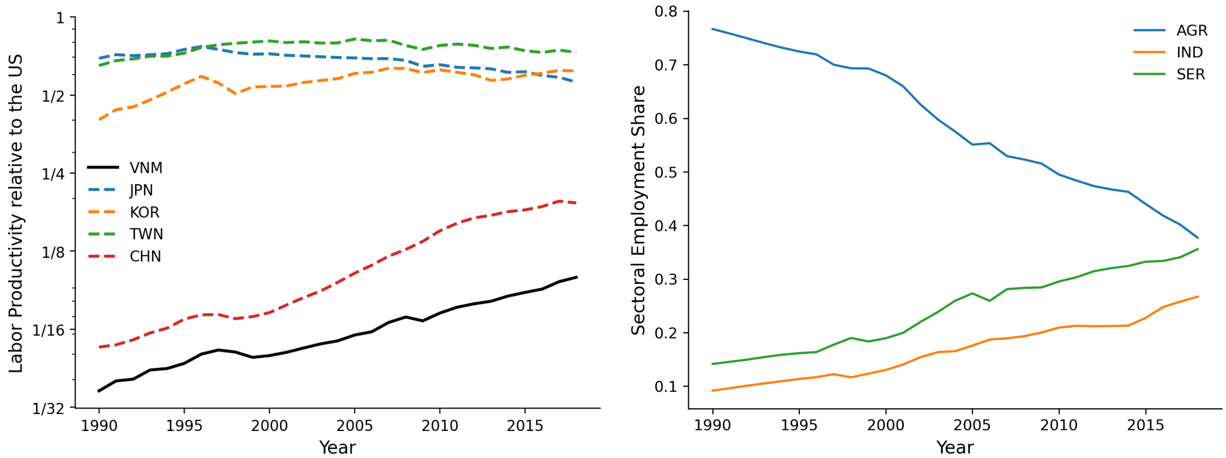
4.2 Foreign Direct Investments (FDI) inflows in Vietnam

Foreign Direct Investments (FDI) inflows in Vietnam. In 1986, Vietnam saw the onset of foreign direct investments (FDI) following the Doi Moi. Figure 2a demonstrates a rapid increase in net inflows of FDI during the 1990s, reaching nearly 3-4 billion USD (in constant 2010 values) from nearly 0. This aligns with Vietnam's gradual policy changes aimed at attracting FDI during this period. However, the inflows of FDI slowed down during the late 1990s and early 2000s, settling at around 2 billion USD (constant 2010). After major policy reforms in the years 2000-2006, FDI inflows saw a substantial surge, reaching 10-14 billion USD (constant 2010) from 2006 onwards.

Figure 1: Growth and Structural Transformation in Vietnam

(a) Labor Productivity relative the United States

(b) Structural Transformation



Notes: Data on labor productivity are computed from PPP output and employment data in the PWT 10.01. Data on sectoral employment shares are from the GGDC/UNU-WIDER's Economic Transformation Database.

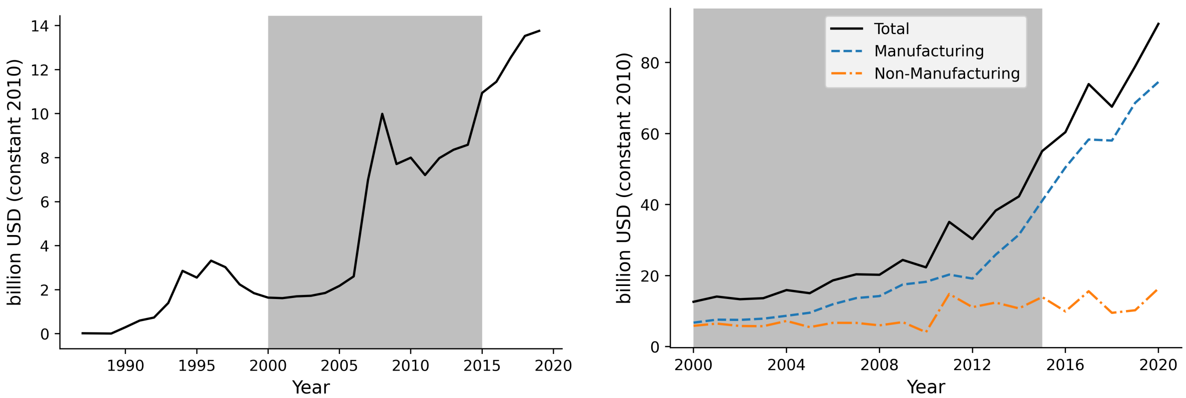
The rise in capital by FDI firms since 2006 is shown in Figure 2b to have been primarily driven by FDI in the manufacturing sector. While the total capital stocks of FDI firms in Vietnam exhibit a similar pattern between manufacturing and non-manufacturing sectors until 2006, the capital stocks of FDI firms in manufacturing have significantly increased since 2006, while remaining relatively flat in other non-manufacturing sectors. This is consistent with the policy reforms that targeted the manufacturing sector and attracted more FDI into the sector. Other sectors, including agriculture, construction, mining, utilities, and services, have seen little change in FDI.

FDI's contribution to industrialization in Vietnam. The manufacturing sector in Vietnam has experienced substantial growth over the past two decades. Between 2000 and 2020, the employment share of manufacturing rose from 5% to 10%. The focus of this paper is on the formal manufacturing sector, which accounts for around 70% of total employment in the industry. This is due to the available data coverage of formal establishments. Over the same period, formal manufacturing in Vietnam saw a significant increase in employment,

Figure 2: Foreign Direct Investments into Vietnam over time

(a) Foreign direct investment net inflows

(b) Capital of foreign firms by sectors



Notes: Data on net inflows (current U.S. Dollars) of foreign direct investment (FDI) used in this study are from the International Monetary Fund's Balance of Payments database. To account for inflation, the Consumer Price Index provided by the U.S. Bureau of Labor Statistics is used to convert the series into constant 2010 U.S. dollars. The aggregate capital of FDI firms by sector is obtained by summing the capital of all FDI firms in the Vietnam Annual Enterprise Survey. This value is then adjusted for inflation using the Vietnam's Producer Price Index in manufacturing and converted into constant 2010 U.S. dollars using the exchange rate between the Vietnamese Dong and the U.S. Dollar. The shaded area represents the sample period from 2000 to 2015.

rising from around 1.4 million workers to around 6.9 million workers, an increase of 4.9-fold. The capital in the sector also experienced a 9-fold increase from 2000 to 2020.

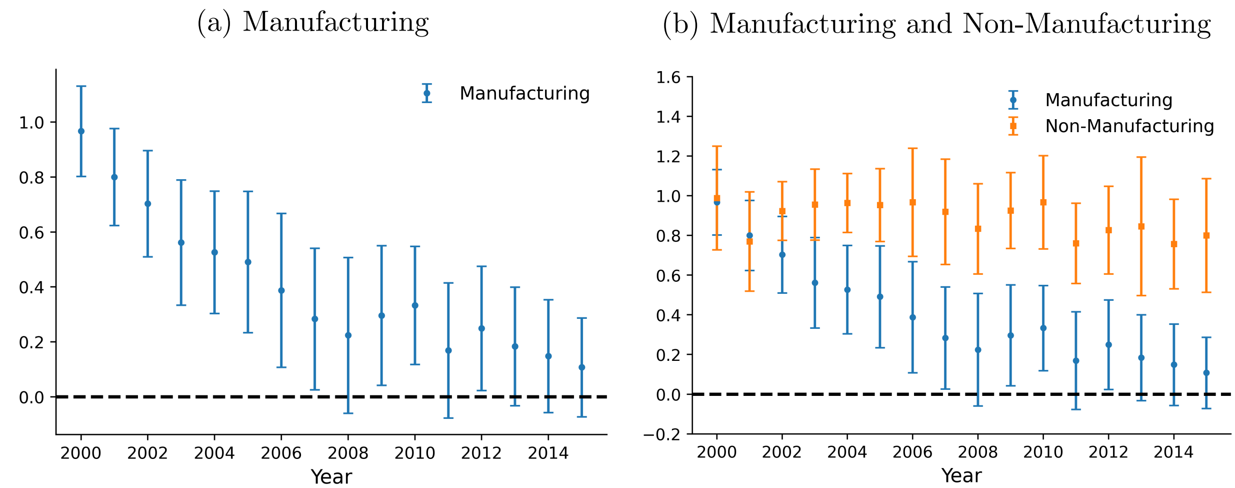
The growth of the formal manufacturing sector in Vietnam has been largely influenced by foreign direct investment (FDI). FDI has contributed significantly to both employment and capital growth, accounting for 75% of the increase in employment and 64% of the increase in capital. The employment share of FDI firms in the formal manufacturing sector has also increased dramatically over the past two decades, rising from 20% in 2000 to 60% in 2020. These numbers highlight the significant impact that FDI has had on the industrialization process in Vietnam.

4.3 Distortions and Productivity in Manufacturing

In this subsection, I document stylized facts on the changes in two key measures of distortions and productivity for foreign and domestic firms in Vietnam from 2000 to 2015. First, I provide evidence of the convergence in the average distortion levels between foreign and domestic firms in the manufacturing sector. Next, I examine the evolution of the elasticity of distortions to productivity within both foreign and domestic firms over time. Lastly, I present the changes in the distribution of total factor productivity (TFP) among foreign and domestic firms in the manufacturing sector.

Distortions between foreign and domestic groups. Without output and labor distortions between the 2 groups, the wedges are equalized between foreign and domestic firms. This result can be generalized to any Cobb-Douglas production function using labor and other inputs.

Figure 3: MRPL (log) difference between foreign and domestic firms



Notes: The dots represent the estimated values of parameters β_t in regression (2). The band represents the 95% confidence interval.

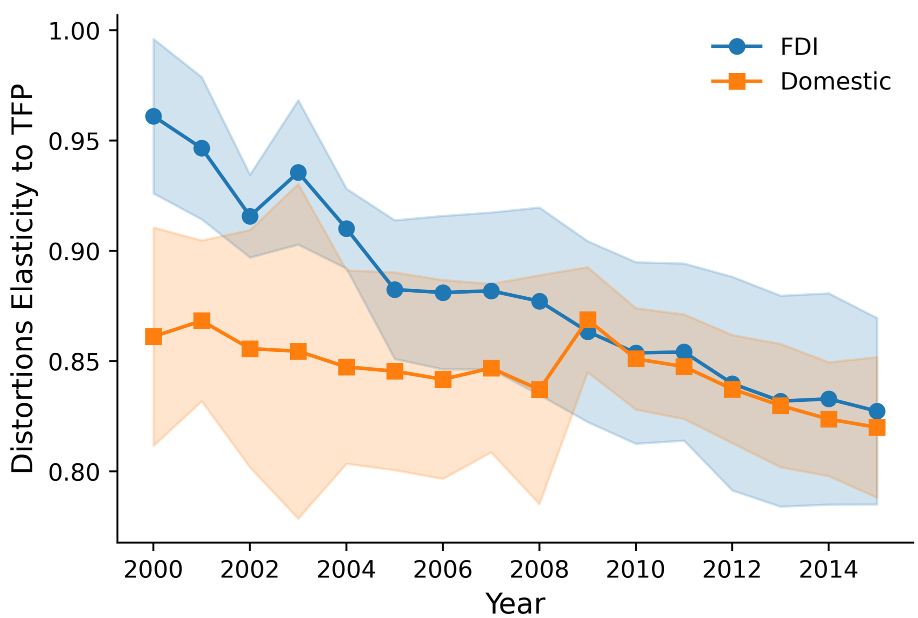
The objective is to estimate the difference in the wedges of foreign relative to domestic firms over time. Two sets of regressions are conducted: firms in manufacturing and firms in non-manufacturing sectors. Identification is achieved by regressing the log of wedges on foreign-year dummies while controlling for sector-year fixed effects:

$$\log(Wedge_{it}) = \sum_t \beta_t \, foreign_{it} + \sum_t \sum_j \gamma_{jt} \, Sector_{jt} + \epsilon_{it}. \tag{2}$$

Figure 3 shows the estimated value of the log difference in the wedges between foreign and domestic firms over time. There's evidence of the convergence of measured wedges of foreign firms to domestic levels in manufacturing sectors over time. This convergence trend also persists for each cohort of firms observed over time. However, significant disparities in the wedges between foreign and domestic firms still exist in non-manufacturing sectors.

Correlated distortions within group. An important measure of misallocation highlighted in previous literature is correlated distortions (e.g., Restuccia and Rogerson (2008), Restuccia and Rogerson (2017), Bento and Restuccia (2017), Ayerst et al. (2024)). Correlated distortions refer to the relationship between distortions and productivity. These distortions not only lead to resource misallocation among incumbent firms but also have dynamic consequences, impacting firm dynamics and technology adoption. The literature has identified several sources of specific policies and institutions that create a systematic relationship between wedges and productivity, such as firing taxes (Hopenhayn, 2014), financial frictions (Buera et al., 2013), and size-dependent regulations (Guner et al., 2008).

Figure 4: Distortion elasticity to TFP: Foreign and Domestic Firms



Notes: The dots represent the estimated values for parameters ρ_t in the regression (3) for domestic and foreign firms, respectively. The band represents the 95% confidence interval.

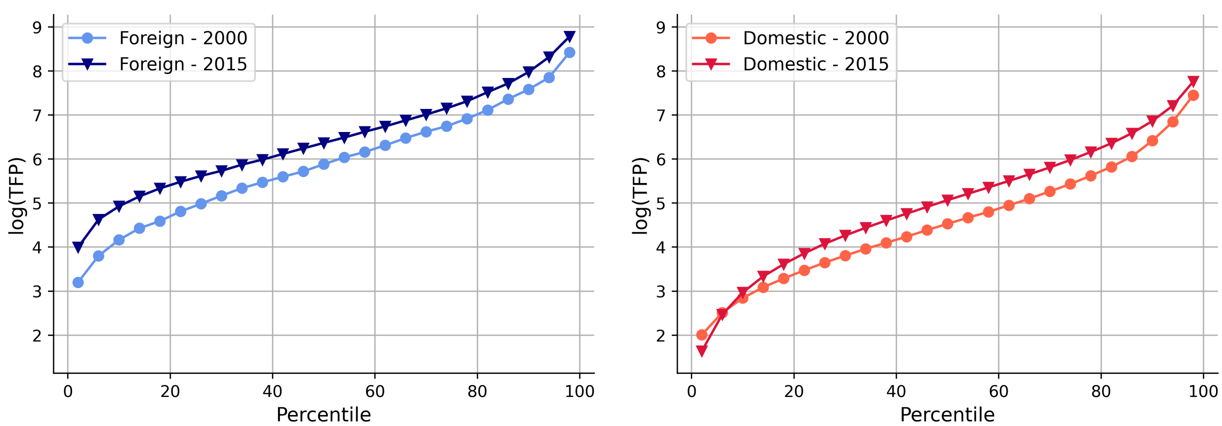
Following standard practices in the literature, the measure of correlated distortions is the elasticity of distortions with respect to productivity. I estimate this using the following regression:

$$\log(Wedge_{it}) = \sum_t \rho_t \log(TFP_{it}) + \sum_t \sum_j \gamma_{jt}\, Sector_{jt} + \epsilon_{it}. \tag{3}$$

This regression is run separately for two subsamples: foreign and domestic firms. Figure 4 shows the estimated elasticity of wedges with respect to productivity for these two groups within the manufacturing sector over time. The elasticity of distortions is significantly higher for foreign firms compared to domestic firms. However, it decreases notably for foreign firms, from 0.95 in 2000 to around 0.85 in 2015, while the distortion elasticity for domestic firms remains relatively stable at around 0.75 during this period.

Figure 5: TFP (in log) by percentiles: Foreign and Domestic Firms during 2000-2015

(a) Foreign Firms (b) Domestic Firms



Notes: The figure plots 25 percentile points from the 1st to the 99th. The left panel shows the TFP distribution of foreign firms in 2000 and 2015. The right panel shows the TFP distribution of domestic firms in 2000 and 2015.

TFP distribution of foreign and domestic firms. Figure 5 shows the TFP distribution of foreign and domestic firms in 2000 and 2015. The figures plot TFP across percentiles, from the 1st to the 99th. In both periods, foreign firms exhibit a better TFP distribution compared to domestic firms. On average, foreign firms have a TFP that is 1.77 log points higher than domestic firms in 2000, and 1.86 log points higher in 2015. The TFP distribution improves over time for both domestic and foreign firms, with an average annualized growth rate of approximately 2.74% and 3.63% for domestic and foreign firm, respectively.

4.4 Evidence on "Spillover" Effects to Agriculture and Services

On an aggregate level, there is evidence of both industrialization and increased productivity in manufacturing, occurring alongside reforms targeting foreign firms in the manufacturing sector. In the standard structural transformation literature, an increase in manufacturing productivity typically leads to a decrease in the size of the manufacturing sector due to substitution effects, assuming no productivity improvements in other sectors. If this holds true, the impact of reforms in the manufacturing sector would be limited, as sector sizes would remain relatively unchanged.

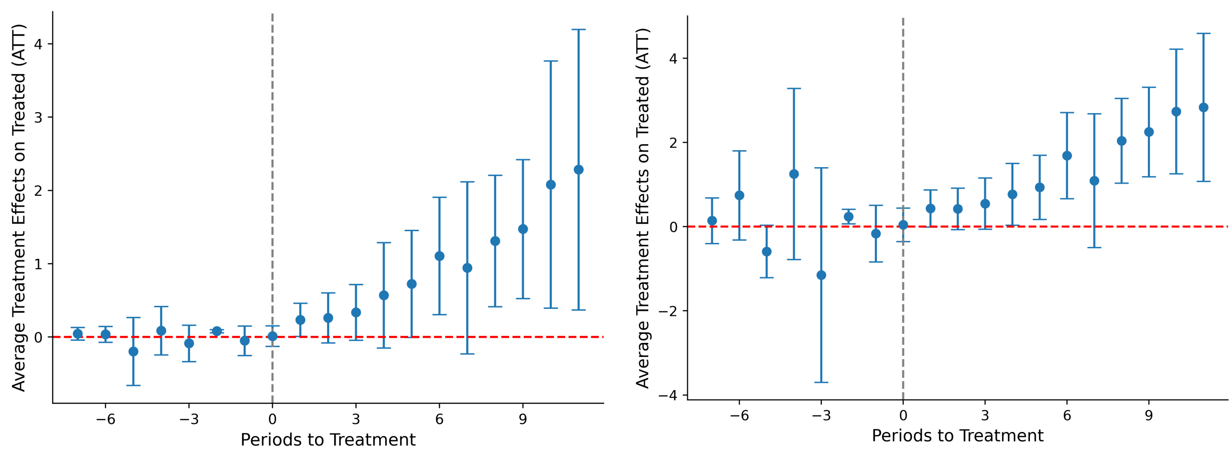
However, more evidence is needed to determine whether these reforms have influenced the size of the manufacturing and other sectors. This paper leverages the staggered rollout of policies aimed at reducing distortions across different locations in Vietnam over time, specifically through the establishment of industrial zones. A staggered difference-in-difference analysis will be conducted following the estimation method by Callaway and Sant'Anna (2021) to provide evidence on the impacts of these manufacturing reforms on structural transformation and overall income. Detailed discussions on identification and estimation strategy are provided in B.

The findings show that reforms in manufacturing, through the establishment of industrial zones, lead not only to the expansion of foreign firms but also to structural transformation patterns consistent with aggregate trends, including significant reductions in agricultural employment and the expansion of services. Additionally, the establishment of industrial zones in manufacturing sectors corresponds with a significant increase in average household income at the local level.

Direct effect on foreign firms. Figure 6 shows the staggered diff-in-diff estimation of treatment effects of establishing the first industrial zone (IZ) at district level. Before the establishment of the first IZ, there are no statistically significant differences in the number and employment of foreign manufacturing firms between treated and not-yet-treated locations, indicating no pre-existing trends among the treated units. After the establishment of the first IZ, there's statistically significant increases in the number and employment of foreign manufacturing firms. The effects is persistent and increases over time following the treated period.

Figure 6: ATT on Number and Employment of Foreign Manufacturing Firms

(a) Number of Manufacturing Firms (log) (b) Manufacturing Employment (log)



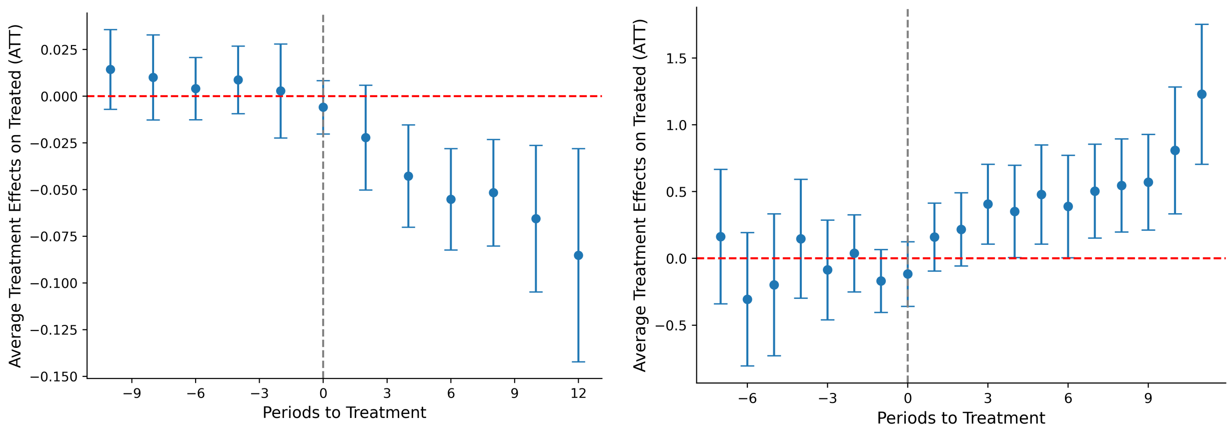
Notes: The dots represent the estimated average treatment effect on the treated (ATT) of establishing the first industrial zone (IZ) at the district level. The band represents the 95% confidence interval. The dash line represents zero treatment effect. The x-axis represents the years before and after the establishment of the first Industrial Zone.

"Spillover" effects on agricultural and services sectors. Figure 7 shows the staggered diff-in-diff estimation of average treatment effects on the treated (ATT) of establishing the first industrial zone (IZ) at local level. Two seperate regressions are conducted for agricultural and services sectors. Due to the different data availablilty, while the outcomes for agricutlture is employment share at province level, the outcomes for services is number of employment at district level.

Figure 7: ATT on Employment in Agriculture and Services

(a) Agricultural Employment Share

(b) Services Employment (log)

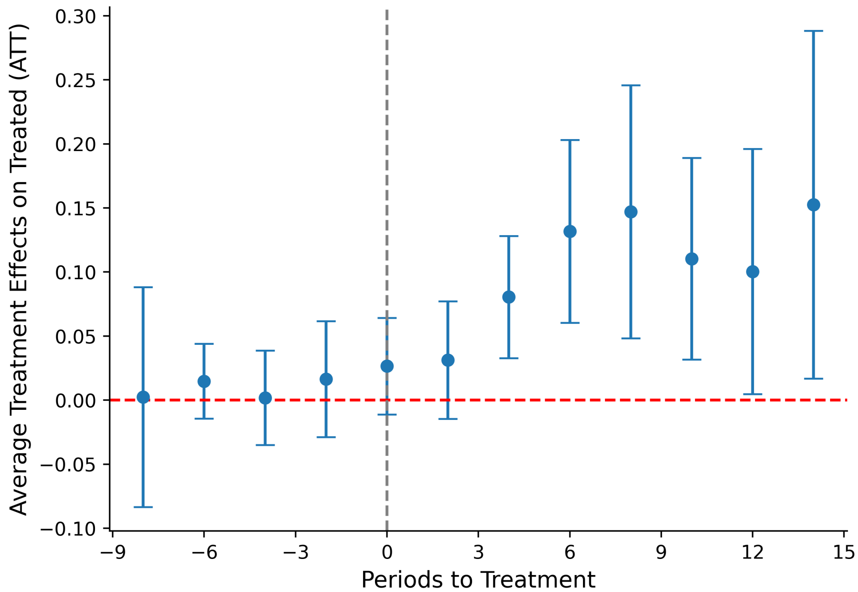


Notes: The dots represent the estimated average treatment effect on the treated (ATT) of establishing the first industrial zone (IZ) at the province level in panel (a) and district level in Panel (b). The band represents the 95% confidence interval. The dash line represents zero treatment effect. The x-axis represents the years before and after the establishment of the first Industrial Zone.

Figure 7a presents the staggered difference-in-differences (diff-in-diff) estimation of the treatment effects of establishing the first industrial zone (IZ) on the agricultural employment share at the provincial level. Prior to the establishment of IZs, there are no statistically significant differences in agricultural employment shares between treated and not-yet-treated locations, indicating no pre-existing trends among the treated units. However, after the first IZ is established, there is a statistically significant decline in the agricultural employment share in the treated provinces. This effect is persistent and intensifies over time following the treatment period.

Figure 7b shows the estimation of the average treatment effect on the treated (ATT) for the services employment share. Similar to the agricultural sector, there are no statistically significant differences in services employment between treated and not-yet-treated locations before the establishment of IZs. After the first IZ is established, a statistically significant increase in services employment is observed. This effect is also persistent and grows stronger over time following the treatment period.

Figure 8: ATT on Household Income (log)



Notes: The dots represent the estimated average treatment effect on the treated (ATT) of establishing the first industrial zone (IZ) at the province level. The band represents the 95% confidence interval. The dash line represents zero treatment effect. The x-axis represents the years before and after the establishment of the first Industrial Zone.

Effects on household income. Figure 8 shows the staggered diff-in-diff estimation of treatment effects of establishing the first industrial zone (IZ) at province level. Before the establishment of the first IZ, there are no statistically significant differences in the average household income between treated and not-yet-treated provinces. After the establishment of the first IZ, there's statistically significant increase in the average household income at the treated province. The effects is persistent and increases over time following the treated period.

5 Model

I develop a multi-sector general equilibrium consisting of agriculture, manufacturing and services. Firms are representative in agriculture and services sectors. Manufacturing sector consists of domestic and foreign firms different in productivity and distortions. I focus on a stationary competitive equilibrium of the model in order to examine the impacts of the reforms on long-term aggregate outcomes.

5.1 Economic Environment

In each period, three commodities are produced: agriculture (a), manufacturing (m) and services (s).

Preferences and Endowments. The economy is populated by an infinitely-lived representative household of measure one. The household is endowed with one unit of time each period and supply labor inelastically to the market. The household has Stone-Geary preferences over agricultural (C_a) and non-agricultural goods (C_n):

$$U(C_a, C_n) = alog(C_a - \bar{a}) + (1 - a)log(C_n),$$

where a and $1 - a$ are utility weights for agricultural and non-agricultural consumption, $\bar{a}$ is the subsistence consumption of agricultural goods. Consumption of non-agricultural good C_n follows a standard CES aggregation over manufacturing and services consumption:

$$C_n = \left(C_m^{\frac{\sigma-1}{\sigma}} + C_s^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 0$ is the elasticity of substitution between manufacturing and services. According to findings from Huneeus and Rogerson (2023) and Nguyen (2024), there's a limited income effect between manufacturing and services in the early stages of development. Therefore, I abstract from any income effect between manufacturing and services in this analysis.

Technologies in agriculture and services. Agricultural (Y_a) and services (Y_s) goods are produced by a mass of representative firms following constant returns to scale production functions:

$$Y_i = A_i L_i, \quad i \in \{a, s\}, \tag{4}$$

where A_i is labor productivity in sector i, L_i is labor input in sector i. The sectoral labor productivity is equal to

$$log(A_i) = log(Z_i) + \phi_i log(Z_m) \tag{5}$$

where Z_i is a sector-specific exogenous technology parameter; Z_m is the labor productivity of manufacturing; and ϕ_i captures the productivity "spillover" effect from manufacturing to sector i. The parameter A_i corresponds to labor productivity in the data and changes over time could be driven by changes in sector TFP or capital intensity. This source of variation is not critical for my analysis and there's a limitation on the capital stock data for agricultural and services sectors.

Technologies in manufacturing. At each date, a homogeneous manufactured good is produced by a mass of firms operating under decreasing returns to scale, described by the production function:

$$y_i = a_i^{1-\gamma} \ell_i^{\gamma}, \quad \gamma \in (0, 1),$$

where y_i is the output, ℓ_i is the labor input, and a_i is the productivity of firm i. The productivity a_i of firm i consists of two components:

$$\log(a_i) = \log(z_i) + \log(s_i),$$

where z_i represents an exogenous component of the firm's productivity, drawn from a distribution after entry, and s_i is an endogenous component of productivity, which is chosen by the firm upon entry by incurring a technology investment cost.

There are two types of firms in the manufacturing sector: foreign and domestic, which differ in their productivity distributions and the cost structure of technology investment. Firm type is determined upon entry. Domestic and foreign firms draw the exogenous component of productivity from the distributions $F(z)$ and $F^*(z)$, respectively. To achieve a productivity level of s, domestic firms incur a technology investment cost by hiring $\left(\psi^{\frac{1}{1-\gamma}} s\right)^{\kappa}$ units of labor, while foreign firms incur a cost of hiring $\left(\psi^{*\frac{1}{1-\gamma}} s^{*}\right)^{\kappa}$ units of labor.

Entry and Exit in Manufacturing. Firms exit the market at an exogenous rate λ each period. New entrants pay an entry cost c_e, measured in units of labor. After paying the entry cost, firms draw a probability P_f of being a foreign firm and a probability $1 - P_f$ of being a domestic firm. The parameter P_f represents a government policy that determines the fraction of foreign firms in the economy. I denote the mass of entrants by E, the mass of operating domestic firms by M, and the mass of operating foreign firms by M^*.

Upon realizing their firm type, firms decide whether to invest in productivity s_i by incurring a technology investment cost. Next, firms draw the exogenous component of productivity z_i, which depends on their firm type.

5.2 Market Structure

Agriculture and services good markets. I assume a continuum of homogeneous firms in agricultural and services sectors that are competitive in output and factor markets. At each date, given the price p_i of commodity i and wage rate w, a representative firm in sector $i \in \{a, s\}$ chooses the labor input L_i to maximize profits.

$$\underset{L_i}{max} \quad p_i A_i L_i - w L_i, \quad i \in \{a, s\}.$$

Manufacturing Good Market. Firms face idiosyncratic distortions, modeled as proportional revenue taxes τ_i, following Restuccia and Rogerson (2008). In line with Bento and Restuccia (2017) and Restuccia (2019), I assume these idiosyncratic distortions have a systematic component related to the firm's productivity — $a_i^{-\rho}$ for domestic firms and $a_i^{-\rho^*}$ for foreign firms — along with a firm-specific random component ϵ_i. Specifically, the firm-level distortions $\tau_i(z_i, \epsilon_i)$ and $\tau_i^*(z_i, \epsilon_i)$ for domestic and foreign firms, respectively, are given by:

$$
\begin{aligned}
1-\tau(a_i,\epsilon_i) &= \left(\frac{a_i^{-\rho}\epsilon_i}{1-\bar{\tau}}\right)^{1-\gamma}, \quad \text{if firm } i \text{ is domestic,}\\
1-\tau^*(a_i,\epsilon_i) &= \left(\frac{(1-\theta)a_i^{-\rho^*}\epsilon_i}{1-\bar{\tau}^*}\right)^{1-\gamma}, \quad \text{if firm } i \text{ is foreign,}
\end{aligned}
$$

where ρ and ρ^* are the elasticities of distortions with respect to the firm's TFP within each group, determining the systematic component of distortions. The term ϵ_i represents the random component of distortions, drawn from an i.i.d. distribution. Intuitively, ρ and ρ^* distort the productivity gradient of firm size, while ϵ_i captures the effect of distortions on firm size that is independent of the firm's productivity. The parameter $1-\theta$ captures the average difference in distortion levels between foreign and domestic firms. Taxes are collected by the government and redistributed as a lump-sum transfer T to households.

To separate the effects of distortions into those correlated within groups, captured by (ρ, ρ^*), and the overall distortion levels between the two groups, captured by $1-\theta$, I follow an approach in Bento and Restuccia (2017) by normalizing the distortions using the average distortion terms $1-\bar{\tau}$ and $1-\bar{\tau}^*$, which are weighted by revenue for domestic and foreign firms, respectively:

$$
\begin{aligned}
\frac{1}{1-\bar{\tau}} &= \int_z\int_\epsilon \frac{1}{(sz)^{-\rho}\epsilon}\frac{y}{\bar{Y}}\, dF(z)\, dG(\epsilon),\\
\frac{1}{1-\bar{\tau}^*} &= \int_z\int_\epsilon \frac{1}{(sz)^{-\rho^*}\epsilon}\frac{y^*}{\bar{Y}^*}\, dF^*(z)\, dG^*(\epsilon),
\end{aligned}
$$

where $\bar{Y}$ and $\bar{Y}^*$ denote the average output of domestic and foreign firms in manufacturing sector in equilibrium.

5.3 Equilibrium

I consider a stationary competitive economy in which households and firms take prices as given, prices are constant, and the distribution of resource allocations and firm types are stationary. The price of the manufacturing good is normalized to one.

Incumbent firms in manufacturing. An incumbent firm is characterized by productivity a and distortion τ. Each period, the firm chooses the optimal labor ℓ to maximize expected per-period profit $\pi(a, \tau)$:

$$\pi(a_i, \tau_i) = \max_{\ell \geq 0} \quad (1 - \tau_i) a_i^{1-\gamma} \ell^{1-\gamma} - w\ell.$$

The solution to the firm's problem implies the optimal labor and output decisions:

$$\begin{aligned} \ell(a_i, \tau_i) &= (1 - \tau_i)^{\frac{1}{1-\gamma}} a_i \left(\frac{\gamma}{w}\right)^{\frac{1}{1-\gamma}}, \\ y(a_i, \tau_i) &= (1 - \tau_i)^{\frac{\gamma}{1-\gamma}} a_i \left(\frac{\gamma}{w}\right)^{\frac{\gamma}{1-\gamma}}. \end{aligned}$$

Note that domestic and foreign firms face different elasticities of distortion with respect to TFP, denoted by ρ and ρ^*, respectively. As a result, the productivity gradient of firm size will differ between domestic and foreign firms.

The operating value of an incumbent firm is

$$W(a, \tau) = \pi(a, \tau) + (1 - \lambda) \frac{W(a, \tau)}{1 + r} = \frac{\pi(a, \tau)}{1 - R}, \tag{6}$$

where $R = (1 - \lambda)/(1 + r)$.

Entering firms in manufacturing. A firm that enters the market draws probability P^* of being foreign firm and probability $P = 1 - P^*$ of being domestic firm. Domestic firm will decides the level of technology investment to maximize the expected value:

$$\begin{aligned} V &= \max_{s \geq 0} \quad \mathbb{E}_{z,\epsilon} \left[W(sz, \tau(sz, \epsilon)) \right] - \left(\psi^{\frac{1}{1-\gamma}} s \right)^{\kappa} w \\ &= \max_{s \geq 0} \quad \int_z \int_\epsilon W(sz, \tau(sz, \epsilon)) dG(\epsilon) dF(z) - \left(\psi^{\frac{1}{1-\gamma}} s \right)^{\kappa} w, \end{aligned}$$

Foreign firm will decides the level of technology investment to maximize the expected value:

$$\begin{aligned} V^* &= \max_{s^* \geq 0} \quad \mathbb{E}_{z^*, \epsilon^*}\left[W(s^* z^*, \tau^*(s^* z^*, \epsilon^*))\right] - \left(\psi^{* \frac{1}{1-\gamma}} s^*\right)^{\kappa} w \\ &= \max_{s^* \geq 0} \quad \int_{z^*}\int_{\epsilon^*} W(s^* z^*, \tau^*(s^* z^*, \epsilon^*)) dG^*(\epsilon^*) dF^*(z^*) - \left(\psi^{* \frac{1}{1-\gamma}} s^*\right)^{\kappa} w, \end{aligned}$$

At the beginning of each period, the entry value is given by

$$V_e = (1 - P^*)V + P^* V^* - c_e w \leq 0. \tag{7}$$

In equilibrium, potential entrants will enter the market to the point where there is no positive value of entering.

Firm distribution. As I abstract from firm dynamics other than entry and exit, the firm distribution in equilibrium is the same as the distribution of entrants over firm type j (domestic or foreign), exogenous productivity (z) and random component of distortions (ϵ). I denote the mass of firms as $\mu(j, z, \epsilon)$. The law of motion for $\mu(j, z, \epsilon)$ is given by

$$\mu'(j, z, \epsilon) = \begin{cases} (1-\lambda)\mu(j, z, \epsilon) + E(1 - P^*) dF(z) dG(\epsilon) & \text{if } j = \text{Domestic}, \\ (1-\lambda)\mu(j, z, \epsilon) + EP^* dF^*(z) dF^*(z) dG^*(\epsilon) & \text{if } j = \text{Foreign}. \end{cases}$$

The stationary distribution is given by

$$\mu(j, z, \epsilon) = \begin{cases} \frac{E}{\lambda}(1 - P^*) dF(z) dG(\epsilon) \equiv \mu(z, \epsilon) & \text{if } j = \text{Domestic}, \\ \frac{E}{\lambda} P^* dF^*(z) dG^*(\epsilon) \equiv \mu^*(z, \epsilon) & \text{if } j = \text{Foreign}. \end{cases} \tag{8}$$

In a stationary equilibrium, the masses of domestic (M) and foreign (M^*) firms are given by

$$M = \frac{(1 - P^*)E}{\lambda} \quad \text{and} \quad M^* = \frac{P^* E}{\lambda}. \tag{9}$$

Definition of equilibrium. A stationary competitive equilibrium comprises wage w and prices (p_a, p_m, p_s); income I and consumption (C_a, C_m, C_s) for households; production labor for agriculture L_a and services L_s; decision and value functions for manufacturing firms: labor demand $\ell(a, \tau)$, output $y(a, \tau)$, profits $\pi(a, \tau)$, value of incumbent firm $W(a, \tau)$, technology investment productivity of domestic entrant s, technology investment productivity of foreign entrant s^*, value of domestic entrant V, value of foreign entrant V^*, value of entry V_e, a distribution of domestic firm $\mu(z, \epsilon)$, a distribution of foreign firm $\mu^*(z, \epsilon)$, mass of domestic firms M, mass of foreign firms M^* and mass of entrants E; government transfer T such that:

(i) Given prices, income I and transfers T, the allocation C solves the household's problem.

(ii) Given prices and wage, decision function $\ell(a, \tau)$ solves the incumbent firm's problem, determining the optimal per-period profits $\pi(a, \tau)$, output $y(a, \tau)$ and incumbent's value $W(a, \tau)$.

(iii) Given prices and wages, the technology investment decisions s and s^* solve the problems for domestic and foreign entrant firms, respectively, determining the value of domestic entrants V and foreign entrants V^*.

(iv) Free-entry condition holds: $V_e = 0$.

(v) Invariant distribution of firms μ given by equation (8), which implies the mass of firms is constant and given by equation (9).

(vi) Goods markets clear:

$$Y_a = C_a; \quad Y_s = C_s,$$

$$M \int_z \int_\epsilon y(sz, \tau(sz, \epsilon)) dG(\epsilon) dF(z) + M^* \int_z \int_\epsilon y(s^* z, \tau(s^* z, \epsilon)) dG^*(\epsilon) dF^*(z) = C_m.$$

(vii) Labor market clears:

$$
\begin{aligned}
L_a + L_s + M & \int_z \int_\epsilon \ell(sz, \tau(sz, \epsilon)) dG(\epsilon) dF(z) \\
& + M^* \int_z \int_\epsilon \ell(s^* z, \tau(s^* z, \epsilon)) dG^*(\epsilon) dF^*(z) \\
& + E\left[(1 - P^*)\left(\psi^{\frac{1}{1-\gamma}} s\right)^\kappa + P^* \left(\psi^{*\frac{1}{1-\gamma}} s^*\right)^\kappa\right] + Ec_e = 1.
\end{aligned}
$$

$(viii)$ Government budget balances:

$$
\begin{aligned}
M \int_z \int_\epsilon & \tau(sz, \epsilon) y(sz, \tau(sz, \epsilon)) dG(\epsilon) dF(z) \\
& + M^* \int_z \int_\epsilon \tau(s^* z, \epsilon) y(s^* z, \tau(s^* z, \epsilon)) dG^*(\epsilon) dF^*(z) = T.
\end{aligned}
$$

Proposition 1. Equilibrium wage is characterized by the following free entry condition of firms in manufacturing sector:

$$
(1 - P^*)\frac{\kappa + \rho - 1}{\kappa} + P^* \frac{\kappa + \rho^* - 1}{\kappa} = c_e w. \tag{10}
$$

In equilibrium, the wage rate is decreasing in the elasticity of distortions within domestic firms ρ and foreign firms ρ^*.

Proposition 2. Technology investment productivities of domestic s and foreign entrants s^* are given by:

$$
s = \left[\frac{\Omega(1-\rho)\mathbb{E}[z^{1-\gamma\rho}]\mathbb{E}[\epsilon^\gamma]}{\psi^{\frac{\kappa}{1-\gamma}} \kappa w^{\frac{1}{1-\gamma}}}\right]^{\frac{1}{\kappa+\rho-1}} \quad \text{and} \quad s^* = \left[\frac{\Omega(1-\rho^*)\theta\mathbb{E}[z^{*1-\gamma\rho^*}]\mathbb{E}[\epsilon^{*\gamma}]}{\psi^{*\frac{\kappa}{1-\gamma}} \kappa w^{\frac{1}{1-\gamma}}}\right]^{\frac{1}{\kappa+\rho^*-1}}, \tag{11}
$$

where $\Omega = (1-\gamma)/(1-R)\gamma^{\frac{1}{1-\gamma}}$. *In equilibrium, the technology investment productivities of domestic and foreign entrants are increasing in the elasticity of distortions within each group ρ and ρ^*.*

6 Calibration and Estimation

I calibrate a distorted benchmark economy to match micro and aggregate data for Vietnam in two periods: 2000 and 2015. I parameterize the distribution of log z, log z^*, log ϵ and log ϵ^* to be normal with zero means and standard deviations σ_z, σ_z^*, σ_ϵ, and σ_ϵ^*, respectively.

The model requires the calibration of 21 parameters. For the manufacturing sector, six key parameters govern technology: the decreasing returns to scale γ, the curvature parameter of the technology upgrading cost function κ, the level of the technology upgrading cost function for domestic firms ψ and for foreign firms ψ^*, and the dispersion in the exogenous component of productivity for domestic firms σ_z and for foreign firms σ_z^*.

In terms of market structures, entry, and exit in the manufacturing sector, six additional parameters are calibrated: the productivity elasticity of distortions within domestic firms ρ and within foreign firms ρ^*, the dispersion in random components of distortions within domestic firms σ_ϵ and within domestic firms σ_ϵ^*, the relative distortions between foreign and domestic firms θ, the exogenous firm exit rate λ, the real interest rate r, and the fraction of foreign firms in the manufacturing sector P^*.

The model also includes parameters related to household preferences and the technology of agriculture and services. Household preferences are captured by three parameters: the agricultural consumption weight a, the subsistence level of agricultural consumption $\bar{a}$, and the elasticity of substitution between manufacturing and services σ. The technology of agriculture and services is governed by four parameters: the productivity spillover elasticity from manufacturing to agriculture ϕ_a and to services ϕ_s, the exogenous component of agricultural productivity A_a, and the exogenous component of services productivity A_s.

My calibration strategy involves three steps. First, I normalize or assign values from outside evidence to a set of eight parameters. Second, I estimate the two productivity spillover parameters, ϕ_a and ϕ_s, using a staggered difference-in-difference estimation. This estimation leverages the staggered rollouts of policy reforms toward foreign firms, particularly through the establishment of industrial zones across different locations over time. Third, I calibrate the remaining twelve parameters to match the key macro and micro moments in the data for Vietnam in the years 2000 and 2015.

6.1 External Calibration

A set of eight parameters are either normalized or assigned values based on outside evidence. The decreasing returns to scale is set to $\gamma = 0.8$, a common value in the misallocation literature (Guner et al., 2008; Restuccia and Rogerson, 2008). The exit rate is set to $\lambda = 0.10$ (Davis et al., 1998), the real interest rate to $r = 0.04$, and the curvature of the technology investment cost function to $\kappa = 2$ (Acemoglu et al., 2018). I normalize the cost of entry to $c_e = 1$.

Parameters related to preferences are assigned values typically used in the structural transformation literature (Duarte and Restuccia, 2010; Comin et al., 2021; Huneeus and Rogerson, 2023): the agricultural consumption weight $a = 0.02$, the subsistence level of agricultural consumption $\bar{a} = 0.5$, and the elasticity of substitution between manufacturing and services $\sigma = 0.4$.

6.2 Estimation of Sectoral Productivity "Spillover" Parameters

I employ the establishment of Industrial Zones (IZs) by the central government at different locations over time as the basis for my identification strategy to evaluate their effects on the local economy. Leveraging this staggered roll-out, I adopt a Staggered Diff-in-Diff estimation approach, following the method outlined by Callaway and Sant'Anna (2021). The core idea is to designate provinces/districts in periods with no IZs as the control group.

The productivity spillover parameters ϕ_a and ϕ_s are estimated from the staggered difference in difference estimation. The productivity spillover from manufacturing to agriculture is estimated to be $\phi_a = 0.22$, whereas the productivity spillover from manufacturing to services is estimated to be $\phi_s = 0.32$.

Table 1 shows the staggered difference in difference estimation of the treatment effects of

Table 1: Staggered Diff-in-Diff Estimation of Treatment Effects on Sectoral Productivity

Dep. Var.	(1) $log(LP_m)$	(2) $log(LP_s)$	(3) $log(LP_a)$
First IZ	0.657^{***}	0.212^{***}	0.145^{***}
	(0.295)	(0.096)	(0.043)
N	7100	7100	438
Controls	Yes	Yes	Yes
Region FE	Yes	Yes	Yes

Notes: Unit of observations in regression 1-2 is district-year and in regression 3 is province-year. Estimation of treatment effect follows Callaway and Sant'Anna (2021). Controls include log distance to sea, log population, log area and log initial wage. Significance levels are denoted as *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.1$. Standard errors, clustered at the region levels, are shown in parentheses.

establishing the first industrial zone (IZ) on sectoral labor productivity at the local levels. After the establishment of the first IZ, there's statistically significant increase in productivity in manufacturing and services in the treated districts. Agricultural productivity is also found to increase significantly following the establishment of IZ at province level.

As the establishment of IZs only directly affects the manufacturing sector, I infer that the increases in productivity in agriculture and services are spillover from increase in manufacturing productivity. The productivity spillover elasticity from manufacturing to services is estimated to be 0.32 (0.212/0.657), whereas the productivity spillover elasticity from manufacturing to agriculture is estimated to be 0.22 (0.145/0.657).

6.3 Calibration

The eight parameters θ, ρ, ρ^*, σ_ϵ, σ^*_ϵ, σ_z, σ^*_z, and P^* are estimated directly from corresponding data moments. Specifically, θ is matched to the average ratio of wedges between foreign and domestic firms estimated in the data. The distortion elasticities with respect to productivity, ρ and ρ^*, are estimated by regressing the log of the measured wedge on the log of the measured TFP, as specified in the regression equation (3). The standard deviations of the random distortion components, σ_ϵ and σ^*_ϵ, are obtained from the standard deviations of the residuals in this regression. The standard deviations of the exogenous productivity components, σ_z and σ_z^*, are directly measured from the standard deviation of the log TFP of domestic and foreign firms. The share of foreign firms, P^*, is calculated directly from firm-level data, remaining around 10% during this period.

Table 2: Estimation from Data Moments in 2000 and 2015

Parameter	Corresponding Moments	Value	
		2000	2015
θ	Distortions ratio of FF/DF	0.55	0.20
ρ	Distortions elasticity of DF	0.85	0.83
ρ^*	Distortions elasticity of FF	0.93	0.84
σ_z	sd(log TFP) of DF	5.56	6.23
σ_z^*	sd(log TFP) of FF	4.80	4.80
σ_ϵ	sd(log distortions | log TFP) of DF	1.32	1.34
σ_ϵ^*	sd(log distortions | log TFP) of FF	1.24	1.80
P^*	Share of FF firms	0.10	0.10

Table 2 presents the calibrated parameter values along with the model and data moments for the Vietnamese economy in 2000 and 2015. The average distortions affecting foreign firms relative to domestic firms, denoted by θ, have decreased from 0.55 to 0.20 over time. This decline signifies a substantial reduction in the average level of distortions between foreign and domestic groups.

The calibrated parameter values for distortion elasticities, ρ and ρ^*, range from 0.83 to 0.93. These values align with findings from other studies using different Orbis datasets, such as Ayerst et al. (2024) for Vietnam, and are consistent with the distortion elasticities observed in Vietnam's farms as reported in Ayerst et al. (2023), where elasticities range from 0.80 to 0.90. It is noteworthy that distortion elasticities and dispersion are generally higher for foreign firms compared to domestic firms.

Over time, the correlated distortions within foreign firms have decreased from 0.93 to 0.84, while those within domestic firms have slightly decreased from 0.85 to 0.83. Despite these reductions, correlated distortions remain high for both foreign and domestic firms.

In an efficient economy, the elasticity of wedges to TFP should be zero, whereas measured elasticities in more developed countries are typically found to be less than 0.50 (Bento and Restuccia, 2017; Fattal-Jaef, 2022; Ayerst et al., 2024).

The standard deviation of random components of distortions, σ_ϵ and σ_ϵ^*, have increased over time, from 1.32 to 1.34 for domestic firms and from 1.24 to 1.80 for foreign firms. The standard deviation of exogenous productivity components, σ_z and σ_z^*, have increased over time, from 5.56 to 6.23 for domestic firms and remained constant at 4.80 for foreign firms. The share of foreign firms, P^*, has remained constant at 10% over time.

The remaining four parameters — A_a, A_s, ψ, and ψ^* — are jointly calibrated to match moments from Vietnamese data for the years 2000 and 2015. The targeted moments include: (1) the agricultural employment share, (2) the services employment share, (3) aggregate labor productivity, and (4) the employment share of foreign manufacturing firms. These parameters are intended to capture the structural transformation and aggregate growth of Vietnamese economy during this period. Specifically, the agricultural employment share decreased from 0.70 to 0.45, the services employment share increased from 0.20 to 0.40, and aggregate labor productivity rose from 1.00 to 1.90. Additionally, the employment share of foreign manufacturing firms substantially increased from 0.03 to 0.09.

Table 3: Calibration to Vietnamese economy in 2000 and 2015

Parameter	Value	Targeted moments	Model	Data
Year 2000				
A_a	0.62	Agricultural employment share	0.70	0.70
A_s	1.13	Services employment share	0.20	0.20
ψ	1.37	Aggregate labor productivity	1.00	1.00
ψ^*	0.41	FF employment share	0.03	0.03
Year 2015				
A_a	0.83	Agricultural employment share	0.45	0.45
A_s	1.08	Services employment share	0.40	0.40
ψ	0.88	Aggregate labor productivity	1.90	1.90
ψ^*	0.28	FF employment share	0.09	0.09

Table 3 reports the calibrated parameter values alongside the model and data moments for the Vietnamese economy in 2000 and 2015. The exogenous component of agricultural productivity increased from 0.62 to 0.83, while the exogenous component of services productivity decreased from 1.13 to 1.08. The technology upgrading cost level for domestic firms was found to be higher compared to foreign firms in both periods, reflecting the higher productivity distribution of foreign firms. Specifically, the technology upgrading cost level for domestic firms decreased from 1.37 to 0.88, whereas for foreign firms, it decreased from 0.41 to 0.28.

6.4 Model Validation

As the calibration primarily targets sectoral employment shares and aggregate growth, sectoral labor productivity growth and firm-level TFP growth are not directly targeted. Table 4 reports the changes in productivity implied by the model alongside data values for validation. This includes annualized growth rates of aggregate labor productivity, as well as labor productivity growth rates for manufacturing, agriculture, and services, and the growth of average TFP for foreign and domestic firms.

The model closely aligns with the data for these untargeted moments. Specifically, the model-generated growth rates for labor productivity in manufacturing, agriculture, and services are 5.39%, 3.14%, and 1.27%, respectively, which are very close to the observed data. The average TFP growth rates for foreign and domestic firms are 3.54% and 2.59%, respectively, also closely matching the data. Additionally, the model implies growth rates of 1.96% for the exogenous component of agricultural productivity and -0.03% for services productivity. This indicates that the productivity "spillover" effects are significant drivers of observed productivity growth in these sectors, accounting for approximately 37% and 124%, respectively.

Table 4: Productivity Growth (2000-2015): Model vs. Data

	Y	LP_m	LP_a	LP_s	$\bar{a}_m$	$\bar{a}^*_m$	A_a	A_s
Ratio (2015/2000)	1.90	2.20	1.59	1.22	1.47	1.68	1.34	0.95
Growth (%) - Model	4.37	5.39	3.14	1.27	2.59	3.54	1.96	-0.03
Growth (%) - Data	4.37	5.11	3.87	1.29	2.74	3.62	–	–

Notes: Y denotes aggregate labor productivity, LP_m denotes labor productivity in manufacturing, LP_a denotes labor productivity in agriculture, and LP_s denotes labor productivity in services. $\bar{a}_m$ and $\bar{a}^*_m$ denote the average TFP growth rates for domestic and foreign firms, respectively. A_a and A_s denote the exogenous component of agricultural and services productivity, respectively.

7 Counterfactual Experiments

In this section, based on the calibrated economies for 2000 and 2015, I will focus on three sets of counterfactual experiments to assess: (1) the aggregate impacts of reforms aimed at reducing FDI barriers; (2) the decomposition of these impacts on structural transformation and aggregate productivity into "spillover" effects and direct effects; and (3) the overall effects of "spillover" effects on structural transformation and productivity growth in Vietnam's industrialization and growth experience between 2000 and 2015.

The first counterfactual experiment assesses the aggregate impacts of reforms by sequentially removing distortions in the manufacturing sector. This involves decomposing the productivity gains at both sectoral and aggregate levels by reducing correlated distortions within foreign firms and adjusting the level of distortions between foreign and domestic firms, while keeping other factors constant as in the 2000 benchmark economy. This allows us to isolate the aggregate impacts of reducing distortions towards foreign firms from other factors unrelated to the reforms. The contribution of the reforms to aggregate productivity growth is calculated by comparing the productivity growth in the counterfactual economy with that in the benchmark economy of 2015. Additionally, the effects of the reforms are decomposed into two types: reductions in distortions between foreign and domestic firms, and reductions in productivity-correlated distortions within foreign firms.

The second set of counterfactual experiments provides a different decomposition of the impacts of reforms aimed at reducing distortions towards foreign firms, specifically focusing on the role of "spillover" effects. Similar to the first set of experiments, these counterfactuals involve reducing distortions to their 2015 levels while keeping other factors constant as in the 2000 benchmark economy. However, these counterfactual experiments take a further steps of shutting down the "spillover" effects to the agriculture and services sectors. The results will show the relative importance of the "spillover" effects of the FDI openness reforms on structural transformation and aggregate productivity growth.

The third counterfactual experiment aims to assess the overall impact of "spillover" effects on structural transformation and productivity growth in Vietnam between 2000 and 2015. Unlike the first two experiments, this set allows all factors to shift to their 2015 values. The experiments involve shutting down the "spillover" effects to the agriculture and services sectors while permitting all other factors (both related and unrelated to reforms) to evolve over time. The goal is to isolate the contribution of "spillover" channels to the actual structural transformation and growth experiences of Vietnam during this period.

7.1 Aggregate Impacts of Reforms

The purpose of these experiments is to quantify the impact of reducing distortions on sectoral and aggregate labor productivity growth. Observed productivity growth can result from various factors, such as the reduction of distortions within foreign firms, the reduction of distortions between foreign and domestic firms, and technological progress across different sectors. By conducting these counterfactual experiments, I aim to disentangle and assess the relative importance of each of these factors in driving productivity growth. Specifically, I will analyze three counterfactual scenarios to evaluate the effects of three key sources of distortions: correlated distortions within foreign firms, average distortions between foreign and domestic firms, and correlated distortions within domestic firms.

The counterfactual experiment is conducted in as follows. First, I hold certain parameters at their calibrated 2000 values: these include the technology parameters for agriculture A_a, services A_s, domestic manufacturing firms ψ, and foreign manufacturing firms ψ^*, as well as the dispersion parameters for the random components of productivity and distortions within domestic firms (σ_z, σ_ϵ) and foreign firms (σ_z^*, σ_ϵ^*). Next, I sequentially update three key distortion parameters to their 2015 calibrated values: (1) the distortions between foreign and domestic firms θ; (2) two parameters (θ, ρ^*), including the correlated distortions among foreign firms ρ^*; and (3) all three parameters (θ, ρ^*, ρ), including the correlated distortions among domestic firms ρ.

Table 5: Counterfactual Results: Aggregate Impacts of Reforms

Productivity Growth (%)	2015	Counterfactuals		
		(θ)	(θ, ρ^*)	(θ, ρ^*, ρ)
Direct effects				
Manufacturing	5.39	0.91	3.34	3.37
Contribution (%)	–	*17*	*62*	*63*
"Spillover" effects				
Agriculture	3.14	0.20	0.72	0.73
Contribution (%)	–	*6*	*23*	*24*
Services	1.36	0.29	1.06	1.07
Contribution (%)	–	*21*	*78*	*79*
Aggregate effects	4.37	0.49	1.75	1.77
Contribution (%)	–	*12*	*40*	*41*

Notes: The table presents the annualized productivity growth of each economy relative to the benchmark economy in 2000. The first column presents the actual growth rates from 2000 to 2015 in the benchmark economies. Three counterfactuals represent scenarios where: first, only θ is updated to its 2015 value; second, (θ, ρ^*) are updated to their 2015 values; and third, all three parameters (θ, ρ^*, ρ) are updated to their 2015 values, with all other parameters remaining as in the 2000 benchmark economy. The contributions are calculated as the percentage of the actual growth rate.

Table 5 presents the results of the counterfactual experiments along with the baseline economy. The outcomes include the direct effect of reforms in the manufacturing sector on manufacturing labor productivity, the indirect "spillover" effect on labor productivity in the agricultural and services sectors, and the aggregate impact on overall labor productivity.

The second column reports the annualized productivity growth rates at the sectoral levels of manufacturing, agriculture, and services, as well as at the aggregate level. From 2000 to 2015 in the baseline economy, labor productivity grew at annualized rates of 5.39% in manufacturing, 3.14% in agriculture, and 1.27% in services. The aggregate labor productivity growth rate was 4.37%.

The third column shows the effect of reducing distortions between foreign and domestic firms, represented by a decrease in θ from 0.55 to 0.20. This reflects a significant reduction in resource misallocation between these two groups. The impact is substantial: this reduction alone generates an annualized growth rate of 0.91 percentage points (pp) in manufacturing labor productivity, accounting for 17% of the total growth rate of 5.39%. The indirect "spillover" effect, while smaller, is still notable, contributing 0.20 pp to agricultural productivity growth and 0.29 pp to services productivity growth, which account for 6% and 21% of their respective total growth rates. The overall aggregate effect is 0.49 pp, representing 12% of the total growth rate of 4.37%. These findings suggest that reducing misallocation between foreign and domestic firms plays a significant role in driving productivity growth in Vietnam, both at the sectoral and aggregate levels.

The fourth column shows the total effects of reducing both between-group distortions (θ) and within-group correlated distortions for foreign firms (ρ^*). Specifically, ρ^* decreases from 0.93 to 0.84 during this period. The combination of these two reforms results in a significantly higher growth rate at both the sectoral and aggregate levels. The reduction in both θ and ρ^* generates an annualized growth rate of 3.34 percentage points (pp) in manufacturing labor productivity, which accounts for 62% of the total growth rate of 5.39%. The indirect "spillover" effect is also substantial, contributing 0.72 pp to agricultural productivity growth and 1.06 pp to services productivity growth, representing 23% and 78% of their respective total growth rates. The overall aggregate effect is 1.75 pp, accounting for 40% of the total growth rate of 4.37%. Compared to the effect of reducing between-group distortions alone, these two reforms result in a 3.64-fold increase in the effect on manufacturing productivity and a 3.33-fold increase in the effect on aggregate growth.

The fifth column shows the total effect of reducing both distortions towards foreign firms and correlated distortions within domestic firms. The additional impact from reducing correlated distortions within domestic firms is relatively small compared to the effects of reforms in the foreign sector. Specifically, incorporating this additional channel contributes only about 1% to both manufacturing and aggregate productivity growth. This result is consistent with the minor change in elasticity of distortions within domestic firms, which decreased from approximately 0.85 to 0.83 during the period.

In summary, the counterfactual results demonstrate that reforms aimed at reducing distortions impacting foreign firms have a significant effect, contributing roughly 62% to productivity growth in the manufacturing sector and 40% to overall aggregate productivity growth. A further decomposition of distortions affecting foreign firms into two types—level distortions between domestic and foreign firms, and correlated distortions within foreign firms—reveals that correlated distortions are quantitatively more important.

7.2 Aggregate Impacts of Reforms through the "Spillover" Effects

This subsection presents counterfactual experiments to further assess the aggregate impacts of reforms aimed at reducing distortions toward foreign firms on structural transformation and aggregate productivity growth, specifically through "spillover" effects.

Three counterfactual experiments are conducted, maintaining the parameters consistent with the 2000 economy, except for the distortion parameters for foreign firms: distortion level θ^* and distortion elasticity ρ^*, which are updated to 2015 values. The three experiments involve: (1) shutting down the "spillover" to agriculture (ϕ_a), (2) shutting down the "spillover" to services (ϕ_s), and (3) shutting down the "spillover" to both agriculture and services. The outcomes investigated include changes in sectoral employment shares and aggregate productivity growth relative to the 2000 economy. These counterfactual experiments are equivalent to the effects in the standard structural transformation models without "spillover" effects.

Table 6 presents the results of the counterfactual experiments, including scenarios with adjustments to distortions towards foreign firms (θ, ρ^*) and comparisons to the benchmark economy in 2015. The table reports changes relative to the benchmark economy in 2000 across four outcomes: the manufacturing employment share, the agricultural employment share, the services employment share, and aggregate productivity growth.

Table 6: Aggregate Impacts of the Reforms through the "Spillover" Effects

	2015	Reform	Counterfactuals		
		(θ, ρ^*)	$(\phi_a = 0)$	$(\phi_s = 0)$	$(\phi_a = 0, \phi_s = 0)$
Structural transformation					
Δ Man. emp. share (ΔL_m)	5.00	-0.05	-1.90	-0.71	-2.43
Δ Agr. emp. share (ΔL_a)	-25.00	-6.77	0.06	-6.81	0.03
Δ Ser. emp. share (ΔL_s)	20.00	6.82	1.84	7.52	2.41
Aggregate growth	4.37	1.75	0.92	1.32	0.54
Contribution (%)	–	–	*47*	*24*	*70*

Notes: The table presents the change in sectoral employment shares and the annualized growth rate of aggregate productivity for each economy relative to the 2000 benchmark economy. The second column shows the benchmark economy in 2015. The third column represents the scenario where parameters θ and ρ^* are updated to their 2015 values, while other parameters remain as in the 2000 benchmark economy. The counterfactuals illustrate the impacts of these reforms while shutting down the "spillover" channels to agriculture, services, and both sectors. The contributions of each channel are calculated as one minus the percentage of the actual growth rate.

Column 2 presents the baseline changes between 2000 and 2015, incorporating all reforms in manufacturing sector and other exogenous changes for benchmark comparison. Column 3 focuses on the impacts of reforms aimed at reducing distortions for foreign firms. Columns 4, 5, and 6 display the impacts of shutting down the "spillover" to agriculture, services, and both sectors, respectively.

The baseline reform results in a slight decrease of 0.05 percentage points in the manufacturing employment share, a large decrease of approximately 6.77 percentage points in the agricultural employment share, and a large increase of about 6.82 percentage points in the services employment share. The aggregate productivity growth is 1.75%. While the direction of structural transformation aligns with the broader economy, except for manufacturing, the magnitude is still smaller than the changes observed in the 2015 benchmark economy: agricultural employment decreased by 25 percentage points, manufacturing increased by 5 percentage points, and services increased by 20 percentage points. This suggests that factors beyond the reforms also played a significant role in driving structural transformation and aggregate growth.

However, when the "spillover" effects are removed, the patterns of structural transformation are remarkably different. Specifically, shutting down the "spillover" to both agriculture and services leads to a 2.43 percentage point decrease in manufacturing employment, a 0.03 percentage point increase in agricultural employment, and a 2.41 percentage point increase in services employment. In a standard model without the "spillover" channel, the employment share of manufacturing sector would substantially shrink without any significant labor reallocation away from agriculture, resulting in a markedly different structural transformation pattern compared to the benchmark economy. The reduction in the size of the reformed sector (manufacturing), combined with the absence of productivity spillovers to agriculture and services, results in an aggregate productivity growth rate of just 0.54%. This suggests that the "spillover" effects account for approximately 70% of the overall impact of the reforms on aggregate productivity growth. In other words, missing these "spillover" channels would result in only 30% of the potential gains in aggregate productivity, substantially underestimating the overall impact of manufacturing sector reforms.

Columns 4 and 5 examine the impacts of shutting down the "spillover" to agriculture and services separately. Removing the "spillover" to agriculture leads to an increase in agricultural employment share, a decrease in manufacturing, and a small increase in services, resulting in minimal aggregate productivity growth of 0.92%, reducing overall growth by approximately 47%. Shutting down the "spillover" to services has a smaller impact, leading to a less pronounced decrease in manufacturing employment and a smaller increase in services employment. The aggregate productivity growth is 1.32%, reducing growth by around 24%.

7.3 Impacts of "Spillover" Effects in Benchmark Economy

The purpose of this section is to quantify the impact of indirect "spillover" effects of manufacturing productivity on on the agricultural and service sectors on structural transformation and productivity growth. Specifically, I will implement three counterfactual scenarios to assess the impact of key "spillover" channels: (1) "spillover" from manufacturing to agriculture, (2) "spillover" from manufacturing to services, and (3) "spillover" from manufacturing to both agriculture and services.

The counterfactual experiments are designed as follows. For each scenario, all parameters are set to their 2015 values, except for the productivity growth components in agriculture and services that result from the "spillover" effects from manufacturing. The three counterfactual experiments are: (1) shutting down the productivity "spillover" effect from manufacturing to agriculture ϕ_a, (2) shutting down the productivity "spillover" from manufacturing to services ϕ_s, and (3) shutting down the productivity "spillover" from manufacturing to both agriculture ϕ_a and services ϕ_s.

Table 7 reports the results of the counterfactual experiments, along with the benchmark economy in 2015. The table reports changes relative to the benchmark economy in 2000 across four outcomes: the manufacturing employment share, the agricultural employment share, the services employment share, and aggregate productivity growth.

The second column reports the changes in sectoral employment share and aggregate labor productivity growth between 2000 and 2015. In the baseline economy, during the period 2000 to 2015, Vietnam has experienced substantial structural transformation from agriculture to manufacturing and services. Agricultural employment share remarkably declines by 25 percentage points from 70% to 45%. Employment reallocates towards manufacturing and services sector. while the services employment share increases by 20 percentage points from 20% to 40%. The manufacturing employment share increases by 5 percentage points from 10% to 15%.

The third column presents the effects of eliminating the "spillover" effects from manufac-

Table 7: Counterfactual Results: Impacts of "Spillover" Effects

	2015	Counterfactuals		
		($\phi_a = 0$)	($\phi_s = 0$)	($\phi_a = 0, \phi_s = 0$)
Structural transformation				
Δ Man. emp. share (ΔL_m)	5.00	3.11	3.42	1.48
Contribution (%)	–	*38*	*32*	*70*
Δ Agr. emp. share (ΔL_a)	−25.00	−17.03	−25.05	−17.09
Contribution (%)	–	*32*	*0*	*32*
Δ Ser. emp. share (ΔL_s)	20.00	13.93	21.64	15.61
Contribution (%)	–	*30*	*−8*	*22*
Aggregate growth	4.37	3.73	3.58	2.82
Contribution (%)	–	*14*	*18*	*35*

Notes: The table presents the change in sectoral employment shares and the annualized growth rate of aggregate productivity for each economy relative to the 2000 benchmark economy. The second column shows the benchmark economy in 2015. The counterfactuals illustrate the impacts of shutting down the "spillover" channels to agriculture, services, and both sectors. The contributions of each channel are calculated as one minus the percentage of the actual growth rate.

turing to agriculture. Shutting down the productivity "spillover" channel from manufacturing to agriculture ($\phi_a = 0$) leads to substantial differences in structural transformation and aggregate productivity growth compared to the baseline economy. With lower productivity growth in agriculture, the agricultural employment share decreases only by 17.03 percentage points, which is less than the 25.00 percentage points decline observed in the baseline economy. The manufacturing and services sectors experience smaller increases, growing by 3.11 percentage points and 13.93 percentage points, respectively. This implies that the "spillover" effect from manufacturing to agriculture accounts for 38% of the expansion in the manufacturing sector and 32% and 30% of the structural shift away from agriculture and toward services, respectively. On aggregate level, the labor productivity in this counterfactual experiment grows at annualized rate of 3.73%, lower than the baseline rate of 4.37%. This indicates an approximate 14% contribution of "spillover" channel from manufacturing to agriculture to the aggregate productivity growth.

The fourth column presents the effects of eliminating the "spillover" effects from manufacturing to services. Removing this channel results in significant changes in the expansion of the manufacturing sector but only modest changes in the employment shares of agriculture and services compared to the baseline economy. Specifically, the manufacturing employment share increases by 3.42 percentage points, while the employment shares in agriculture and services increase by 25.05 and 21.64 percentage points, respectively. This suggests that the "spillover" effect from manufacturing to services accounts for 32% of the expansion in the manufacturing sector, with negligible effects on the shift away from agriculture and a slight negative impact on the shift toward services. On the aggregate level, the growth rate decreases from 4.37% to 3.58%, indicating an approximate 18% contribution of the "spillover" channel from manufacturing to services to overall productivity growth. Although shutting down this "spillover" channel generates small differences in agriculture and services employment shares, the overall impact on aggregate productivity growth is substantial due to the large size of the services sector and the important role this "spillover" channel in driving productivity growth in services.

The fifth column presents the effects of eliminating both the "spillover" effects from manufacturing to agriculture and to services. The combined impact is significant for both structural transformation and aggregate productivity growth. With these "spillover" channels removed, the manufacturing employment share increases by 1.48 percentage points, while employment shares in agriculture and services increase by 17.09 and 15.61 percentage points, respectively. This indicates that the "spillover" effects from manufacturing to agriculture and services account for 70% of the expansion in the manufacturing sector, 32% of the shift away from agriculture, and 22% of the shift toward services. At the aggregate level, the productivity growth rate declines from 4.37% to 2.82%, reflecting an approximate 35% contribution of these "spillover" channels to overall productivity growth. This suggests that the "spillover" effects from manufacturing to both agriculture and services are crucial in driving structural transformation and aggregate productivity growth in Vietnam.

To summarize, the labor productivity "spillover" from manufacturing to agriculture and services plays a crucial role in driving both structural transformation and aggregate growth in Vietnam. This channel accounts for 70% of the industrialization experience and 35% of aggregate productivity growth. Missing this channel would significantly understate the overall impact of reforms in the manufacturing sector. Without considering these "spillovers", while the direct impact on the manufacturing sector would remain unchanged, the size of the manufacturing sector would be smaller, and aggregate productivity growth would be substantially lower.

8 Conclusions

This paper examines the impacts of reforms towards FDI openness on structural transformation proess and aggregate productivity growth in the context of Vietnam. Emprically, I document evidence on the reduction in two measures of distortions: average distortions between foreign and domestic firms and the correlated distortions among foreign firms during the period 2000 to 2015. This is consistent with gradual series comprehensive reforms implemented by Vietnamese government over time during this period. Quantitaively, through the lens of a multi-sector general equilibrium model, I find that reduction in measured distortions towrads foreign firms have substantial aggregate impact account for 62% of manufacturing productivity growth and 40% of aggregate productivity growth. About 70% of the industrialization experience and 35% of aggregate productivity growth can be attributed to the new channel "spillover" effects from manufacturing to agriculture and services. These findings suggest that the "spillover" effects from manufacturing to other sectors are crucial in driving structural transformation and aggregate productivity growth in Vietnam.

The findings of this paper have important policy implications. While previous studies often measure openness to foreign firms by the quantity of FDI capital inflows or stock, this paper's findings suggest that "how" foreign firms are attracted is crucial. Economic growth is not driven by the mere quantity of foreign firms or capital inflows but by the enhancement of productivity through improved resource allocation and the entry of higher-quality foreign firms. These types of reforms, by reducing distortions, have an amplified aggregate impact through "spillover" effects on other sectors. The policy implications, as evidenced by the case of Vietnam, underscore the importance of focusing on reducing barriers for foreign firms, particularly policies that distort against high-productivity foreign firms, and fostering an economic environment conducive to attracting and retaining productive foreign firms.

My analysis has several important implications for future research. First, reducing distortions affecting foreign firms, which benefit from advanced technology and management practices, offers substantial potential gains. Among various forms of distortions, those correlated with productivity generate significantly larger aggregate losses by not only causing resource misallocation among incumbents but also reducing incentives for technological upgrading. In the case of foreign firms, such distortions impact the productivity distribution, leading to the entry of less productive firms. More work is needed to identify the specific policies driving these distortion patterns in less developed countries, which may require more detailed analysis within specific country contexts. Second, the "spillover" effects from manufacturing to other sectors are crucial for driving structural transformation and aggregate productivity growth in Vietnam; missing this channel would significantly underestimate the overall impact of manufacturing sector reforms. Future research should focus on understanding the specific channels of correlated distortions and "spillover" effects, and quantifying their impacts on structural transformation and aggregate productivity growth.

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A Data Details

I describe the details of the construction for the final dataset.

A.1 Firm-level Data

The final firm-level dataset covers the period from 2000 to 2015, with observations at the firm-year (i, t) level. The baseline model requires measures for firm-level output y_{it} and labor input ℓ_{it}. Output is calculated as the real value of a firm's reported operating revenues, deflated using the sectoral producer price index (PPI) provided by the General Statistics Office (GSO). Sector classification is at the 2-digit level according to the Vietnam Standard Industrial Classification (VSIC). Labor input is measured as the total number of employees in the firm.

Observations are excluded based on the following criteria:

- **Missing Data.** Firm-year observations with missing values for key variables, including output, labor input, and sectoral classification, are removed.

- **Data Trimming.** To reduce the influence of outliers, the top and bottom 1% of the distribution of measured productivity and distortions are trimmed, in accordance with standard practices in the literature.

A.2 Household-level Data

I utilize the Vietnam Household Living Standard Surveys (VHLSS) to construct the household-level dataset. The VHLSS is a nationally representative survey conducted biennially by the General Statistics Office (GSO). The survey provides detailed information on household demographics, income, and expenditure. Key variables of interest include the industry of individual employment, the value of agricultural output, household income, and locations. The real value of agricultural output is deflated using a common agricultural price deflator, while household income is deflated using the Consumer Price Index (CPI) provided by the GSO.

A.3 Industrial Zones data

I manually collect data from different databases on industrial zones. The data comprise of comprehensive information on the locations, establishment years and area of Industrial Zones (IZs) in Vietnam. I then link this data to the firm-level dataset to identify firms located within locations with the IZs. The data on IZs are used to construct the treatment variable for the empirical analysis.

I construct the datasets for the staggered difference-in-differences analysis as follows. For outcomes in the manufacturing and services sectors, I aggregate firm-level data to create district-level datasets for output and employment. This data is then merged with information on industrial zones (IZs) to distinguish between treated and control districts. Labor productivity for both sectors is calculated by dividing real output by employment for each district-year. The final dataset is compiled at the district-year level, covering the period from 2000 to 2015.

For agricultural outcomes and average income, I aggregate individual-level data from the Vietnam Household Living Standard Surveys (VHLSS) to create province-level datasets for agricultural employment share, agricultural output, and average household income. Agricultural labor productivity is computed as the ratio of real output to employment for each province-year. This data is merged with IZs information to identify treated and control provinces. The final dataset is compiled at the province-year level, spanning from 2000 to 2015.

B Staggered Difference-in-Difference

Identification Strategy. In this analysis, I employ the establishment of Industrial Zones (IZs) by the central government at different locations over time as the basis for my identification strategy to evaluate their effects on the local economy. Leveraging this staggered roll-out, I adopt a Staggered Diff-in-Diff estimation approach, following the method outlined by Callaway and Sant'Anna (2021). The core idea is to designate provinces/districts in periods with no IZs as the control group.

I focus on a range of outcome variables to capture the diverse impacts of industrial zones (IZs). First, I consider the direct effects, such as the number of firms, employment, and labor productivity of manufacturing firms at the local level. Additionally, I examine indirect "spillover" effects on employment and labor productivity in agriculture and services. Finally, I assess the overall impact on average household income.

Estimation method. Following the Callaway and Sant'Anna (2021), I adopt their methods for staggered difference-in-difference estimation, aggregation, and inference. My analysis utilizes panel data, focusing on locations denoted as i in each year denoted as t, such as district-year or province-year as the unit of observation.

$Y_{i,t}$ represents the outcome variable for unit i at time t. $D_{i,t} = 1$ indicates that unit i is treated at time t, while it is 0 otherwise. $G_{i,g} = 1$ signifies that unit i is initially treated at time g, and 0 otherwise. I designate a comparison group, denoted as $C = 1$, which consists of units that have never been treated. Furthermore, my analysis accounts for staggered treatment adoption, where the presence of treatment at time t ($D_{i,t} = 1$) implies its continuation at time $t + 1$ ($D_{i,t+1} = 1$).

The parameter of interest is defined as the Average Treatment Effect on the Treated (ATT), given by

$$ATT(g, t) = \mathbb{E}\left[Y_t(g) - Y_t(0)|G_g = 1\right], \text{ for } t \geq g.$$

Under the Parallel Trend (PT) Conditional on Observables Assumptions, I have two key conditions. First, for each time period t and treatment starting period g, where $t \geq g$, I assume

$$\mathbb{E}\left[Y_t(0) - Y_{t-1}(0)|X, G_g = 1\right] = \mathbb{E}\left[Y_t(0) - Y_{t-1}(0)|X, C = 1\right].$$

Second, for each pair of time periods s and t, and treatment starting period g, where $t \geq g$ and $s \geq t$, I assume

$$\mathbb{E}\left[Y_t(0) - Y_{t-1}(0)|X, G_g = 1\right] = \mathbb{E}\left[Y_t(0) - Y_{t-1}(0)|X, D_s = 0, G_g = 0\right].$$

Next, I proceed with estimation and aggregation procedures. Estimation is conducted using two different comparison groups: "never-treated" and "not-yet-treated". For the "never-treated" group, the estimator is given by

$$ATT^{nev}_{unc}(g, t) = \mathbb{E}\left[Y_t - Y_{g-1}|G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1}|C = 1\right].$$

Similarly, for the "not-yet-treated" group, the estimator is

$$ATT^{ny}_{unc}(g, t) = \mathbb{E}\left[Y_t - Y_{g-1}|G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1}|D_t = 0, G_g = 0\right].$$

Aggregation involves computing dynamic treatment effects for groups of units exposed for exactly e periods, given by

$$\theta_D(e) = \sum_{g=2}^{T} \mathbf{1}\{g + e \leq T\} ATT(g, g + e) P(G - g|G + e \leq T, C \neq 1).$$

Lastly, inference is carried out using a doubly robust DiD estimator based on Inverse Probability Weighting (IPW) and Ordinary Least Squares (OLS).

Balance Test. To have a control group that are more similar to treated units, I exclude districts that are farther than 20 km from the treated districts. Table 8 shows the balancing test comparing several important characteristics including distance to sea, area, population, initial wage in 2000 between control and treated group. There's no statistically significant differences between control and treated group on all of the four variables.

Table 8: Balance Test

	Has IZs		Difference	
	Yes	No	(1)	(2)
Distance to sea (log)	2.95	3.18	−0.21	−0.24
			(0.47)	(0.48)
Area (log)	5.40	5.58	−0.16	−0.10
			(0.11)	(0.17)
Population (log)	6.37	6.02	0.14	0.09
			(0.16)	(0.27)
Initial wage (log)	1.83	1.84	−0.03	−0.05
			(0.15)	(0.21)
N	336	65	401	401
Region FE			No	Yes

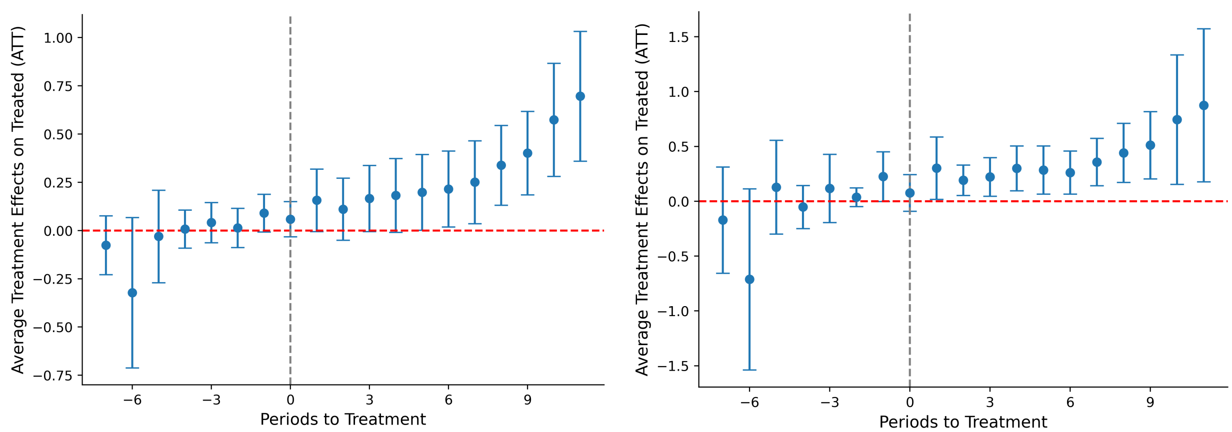
Notes: Comparisons of various characteristics between districts which have established IZs before 2017 and those which haven't. The sample is limited to districts that are within a 20 km radius of treated districts. Columns 1-2 report estimated differences from regressing each outcome on an indicator of having IZs. Columns 4 include region fixed effect. Error terms are clustered at the region level.

Direct Effect on Employment in Manufacturing Sector. Figure 9 shows the staggered diff-in-diff estimation of treatment effects of establishing the first industrial zone (IZ) at district level. After the establishment of the first IZ, there's statistically significant increases in the number and employment of all manufacturing firms. The effects is persistent and increases over time following the treated period. However, the increases in employment by domestic firms in manufacturing sector are not statistically significant. This indicates that most of increases on manufacturing employment following establishment of IZs are driven by foreign firms.

Figure 9: ATT on Number and Employment of Manufacturing Firms

(a) Number of Manufacturing Firms

(b) Manufacturing Employment



Notes: The dots represent the estimated average treatment effect on the treated (ATT) of establishing the first industrial zone (IZ) at the district level. The band represents the 95% confidence interval. The dash line represents zero treatment effect. The x-axis represents the years before and after the establishment of the first Industrial Zone.