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Essays on Multinational Firms, Financial Frictions, and Income in Developing Countries

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Essays on Multinational Firms, Financial Frictions, and Income in Developing Countries

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by

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ABSTRACT OF THE DISSERTATION

Essays on Multinational Firms, Financial Frictions,
and Income in Developing Countries

by

Yunfan Gu
Doctor of Philosophy in Economics
University of California, Los Angeles, 2018
Professor Lee Ohanian, Chair

The dissertation contributes to our understanding of how multinational firms and financial frictions affect income in developing countries. From a policy perspective, I find that as developing countries open up to multinational firms, financial reforms become increasingly beneficial to national income in the countries. I also find that the joint ventures of foreign multinational firms with state-owned firms, an industrial policy in China, prevent technology spillovers and suppress industrial output. The dissertation consists of three chapters.

Chapter 1: Financial frictions, Multinational Firms, and Income in Developing Countries: Theoretical Analysis

Financial frictions create resource misallocation across heterogeneous production units and reduce national income (GNP) in developing countries. Multinational firms, however, can largely circumvent local financial frictions by borrowing from international sources. In this chapter, I theoretically study whether the presence of multinational firms in developing countries alleviates the adverse impact of financial frictions on national income. I show that in a developing economy that is open to multinational firms, if domestic firms produce a sufficiently large (small) share of output, financial frictions will cause a larger (smaller) decline in national income than in an otherwise identical developing economy that is closed to multinational firms. Such

result calls for the quantitative analysis in the next chapter.

Chapter 2: Financial frictions, Multinational Firms, and Income in Developing Countries: Quantitative Analysis

In this chapter, I quantitatively study how the presence of multinational firms in developing countries change the adverse impact of financial frictions on national income. Using a calibrated structural model, I find that when a developing economy is open to multinational firms, a modest financial reform that reduces financial frictions in the developing economy will increase national income by 19%, as opposed to only 11% when the economy is closed to multinational firms. Such result indicates that financial frictions become increasingly costly and financial reforms become increasingly beneficial to national income in developing countries as they open up to multinational production.

Chapter 3, Joint Ventures and Technology Spillovers in China

Chinese government actively promotes joint ventures of foreign multinational firms with state-owned firms. In this chapter, I study the effects of the joint ventures in promoting technology spillovers. Using firm-level data in China, I find that higher joint venture presence in a sector leads to higher productivity of firms in the upstream of that sector, but lower productivity of firms in the downstream of that sector. A quantitative analysis suggests that the later force will dominate, and joint ventures will on aggregate prevent technology spillovers and cause a significant decline in total industrial output in China.

The dissertation of Yunfan Gu is approved.

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To my parents, my wife, and my son.

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CHAPTER 1

Financial Frictions, Multinational Firms, and Income in Developing Countries: Theoretical Analysis

1.1 Introduction

Financial frictions are prevalent in developing countries, and they severely distort resource allocation across heterogeneous production units (Buera, Kaboski, and Shin 2015). Recent structural analyses indicate that such resource misallocation caused by financial frictions will lead to significant declines in national income (GNP) in developing countries (Buera, Kaboski, and Shin 2011 & 2015, Midrigan and Xu 2014). These authors study the impact of financial frictions in closed-economy models and do not explicitly model the presence of multinational firms. Multinational firms have expanded quickly into the developing countries in the past three decades and now contribute a significant share of output in the developing countries. For example, the share of manufacturing output produced by multinational firms' affiliates is estimated to range from 20% to 40% in China and other developing countries in Southeast Asia (CNBS 2005, Ramstetter 2009). Moreover, multinational firms' affiliates frequently borrow from their parents and international capital markets, so they can largely circumvent the financial frictions in the developing countries (Desai, Foley, and Hines 2004).

The goal of this chapter is to answer the following question from a theoretical perspective: Does the presence of multinational firms in developing countries alleviate

the adverse impact of financial frictions on national income?

In this chapter, I develop two illustrative models to answer this question. In the first model, multinational production takes the form of greenfield investment, so multinational firms build their own new affiliates in the developing economy. In the second model, multinational production takes the form of foreign merger and acquisition (M&A), so multinational firms buy existing firms as their affiliates in the developing economy. In both models, multinational firms engage in monopolistic competition with domestic firms, so there is some degree of complementarity between the goods produced by domestic and multinational firms. Financial frictions will constrain the capital rentals of domestic firms but not multinational firms.

There are two key results from this chapter. First of all, the models illustrate three channels through which financial frictions can reduce national income when multinational firms are present. First, financial frictions create resource misallocation among domestic firms that produce goods that are complementary to the goods produced by multinational firms. As a result, financial frictions will cause a decline in total output (GDP). Second, since financial frictions constrain the capital rentals of domestic firms but not multinational firms, financial frictions will constrain domestic firms in the competition with multinational firms and reduce domestic firms' market share, which leads to a decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). Third, when multinational production takes the form of foreign M&A, financial frictions will reduce domestic firm's outside option in the M&A, which is the value of the firm if it is not sold to foreign firms. As a result, financial frictions will reduce the acquisition prices paid by foreign firms. The first and the second channels above are present when multinational production takes the form of either greenfield investment or foreign M&A, whereas the third channel is only present when multinational production takes the form of foreign M&A.

The second key result of this chapter is to show that when a developing economy opens up to multinational production, if domestic firms produce a sufficiently large (small) share of output in the economy, financial frictions will cause a larger (smaller)

decline in national income than in an otherwise identical developing economy that is closed to multinational production.

The intuition behind this second result is as follows: When the developing economy is closed to multinational production, financial frictions distort capital allocation among domestic firms and significantly reduce total output (GDP). However, since all the output in the economy is produced by domestic firms, financial frictions have little impact on domestic firms' market share. When the developing economy opens up to multinational production, if domestic firms produce a sufficiently large share of output, financial frictions will still cause a large decline in total output (GDP) by distorting capital allocation among domestic firms. In addition, financial frictions constrain domestic firms in the competition with multinational firms and reduce domestic firms' market share, which leads to a decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). The large decline in GDP combined with this additional decline in $\frac{GNP}{GDP}$ will lead to financial frictions causing a larger decline in national income after the economy opens up to multinational production. In the case when multinational production takes the form of foreign M&A, financial frictions will have an additional channel in reducing national income by reducing the acquisition prices paid by foreign firms. This additional channel only reinforce the result that financial frictions will cause a larger decline in national income after a developing economy opens up to multinational production.

If, instead, domestic firms produce too small a share of output when the economy is open to multinational production, since financial frictions do not constrain the capital rentals of multinational firms, financial frictions will create only very limited amount of resource misallocation in the developing economy. This will lead to financial frictions causing a smaller decline in national income after a developing economy opens up to multinational production. Such result highlights the importance of the quantitative analysis in the next chapter.

Related Literature

This chapter is closely related to the literature on finance and development. Buera, Kaboski, and Shin (2011, 2015) and Midrigan and Xu (2014) find that financial frictions significantly reduce national income in the developing countries. These authors study financial frictions in closed-economy models. Manovo (2013) and Leibovici (2016) study the adverse impact of financial frictions in models with international trade.[1] This chapter naturally extends the aforementioned papers to explicitly model multinational firms in the developing countries. This chapter contributes to the literature in two ways. First, this chapter illustrates the mechanisms through which financial frictions reduce national income in developing countries when multinational firms are present. Second, this chapter also finds that depending on the share of output produced by domestic firms, the presence of multinational firms could either alleviate or exacerbate the adverse impact of financial frictions on national income in developing countries.

This chapter is also closely related to the literature on multinational production and its welfare implications. Many scholars argue that opening up to multinational production could help bring capital and know-how into developing countries and improve national income in developing countries (Burstein and Monge-Naranjo 2009, Harrison and Rodríguez-Clare 2010). In this chapter, I show that there could be a side effect for the developing countries to open up to multinational production, in the sense that it could make the under-developed financial sector in the developing countries even more costly to national income in those countries. As will be more clear in the next chapter, this is not calling for the developing countries to close their borders to multinational firms, which means giving up the potential benefits brought by multinational production. Instead, this dissertation argues for the increased importance of financial reforms in developing countries as they open up to multinational production.

This chapter is also related to the literature on resource misallocation. Many

[1]The authors find that financial frictions significantly distort international trade. See Foley and Manova (2015) for a survey.

scholars find that resource misallocation across heterogeneous firms cause significant declines in income in developing countries (Banerjee and Duflo 2005, Hsieh and Klenow 2009, Hopenhayn 2014). In this chapter, I model financial frictions as capital rental wedges, which reduce national income by distorting resource allocation across domestic firms. Therefore, even though the focus of this chapter is on financial frictions, the results in this chapter should carry over to distortions that create resource misallocation among domestic firms but not multinational firms.

1.2 Model I

In this section and the next, I present two models and show the key results. In Model I, multinational production takes the form of greenfield investment. In Model II, multinational production takes the form of foreign M&A.

Consider a developing economy with both domestic and foreign entrepreneurs. There are two units of domestic entrepreneurs.[2] Each domestic entrepreneur owns a domestic firm. He can rent capital k and hire labor l to produce one distinct variety of intermediate good. The domestic entrepreneurs all have the same productivity z and Cobb-Douglas production function

$$y = zk^{\alpha}l^{1-\alpha}.$$

Financial frictions in the developing economy are modeled as a capital rental wedge for the domestic firms. In particular, one unit of the domestic firms in the economy face capital rental rate R. However, the other unit of domestic firms face a higher capital rental rate

$$R^* = R(1 + \tau_K).$$

[2]The choice of two units of entrepreneurs is without loss of generality. As will be clear soon, one unit of domestic entrepreneurs will be more financially constrained than the other unit, creating resource misallocation among them.

Here, $\tau_K > 0$ is the capital rental wedge. The additional rental rate $R\tau_K$ paid by the domestic firms will be transferred in a lump-sum to the workers in the economy. The capital rental wedge could exist for many different reasons. For example, some firms may have better balance sheet conditions or have better connections with local government officials than other firms. The existence of this wedge will distort resource allocation across the firms, as firms that face a higher capital rental rate will face a higher unit cost of production.

If the economy is closed to multinational production, there will be no foreign firms, and the two units of domestic firms will be the only producers in the economy. If the economy is open to multinational production, there will be one additional unit of foreign entrepreneurs in the economy. Each foreign entrepreneur will start his own firm, and also rent capital and hire labor to produce one distinct variety of intermediate good. The foreign entrepreneurs have productivity $\tilde{z}$ and Cobb-Douglas production function

$$y = \tilde{z}k^{\alpha}l^{1-\alpha}.$$

Foreign entrepreneurs are not subject to the capital rental wedge and they face capital rental rate R. Since the foreign entrepreneurs are only present when the economy opens up to multinational production, I set $\tilde{z} = 0$ when the economy is closed to multinational production.

There are competitive final goods producers in the economy. The final goods producers take all the intermediate goods in the economy to produce a composite final good

$$Y = \Big(\int_{\Omega} y(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \Big)^{\frac{\sigma}{\sigma-1}}. \tag{1.1}$$

Here, $\omega \in \Omega$ represents one distinct variety of intermediate good. Ω is the set of all intermediates goods available in the economy. The price index of the final good is defined in the standard way

$$P = \Big(\int_{\Omega} p(\omega)^{1-\sigma} d\omega \Big)^{\frac{1}{1-\sigma}}.$$

Here, $p(\omega)$ is the price for good $\omega \in \Omega$.

All the entrepreneurs face the following profit maximization problem

$$\max_{\{p,y\}} py - cy$$
$$s.t.\ y = \frac{p^{-\sigma}}{P^{1-\sigma}} X.$$

Here, X is the total expenditure in the economy. p is the price the firm charges. c is the unit cost of production. For the unit of domestic firms that face rental rate R, the unit cost of production is $\frac{R^{\alpha} w^{1-\alpha}}{z(1-\alpha)^{1-\alpha}\alpha^{\alpha}}$. For the unit of domestic firms that face rental rate $R(1+\tau_K)$, the unit cost of production is higher, at $\frac{(R(1+\tau_K))^{\alpha} w^{1-\alpha}}{z(1-\alpha)^{1-\alpha}\alpha^{\alpha}}$. The unit cost of production for foreign firms is $\frac{R^{\alpha} w^{1-\alpha}}{\tilde{z}(1-\alpha)^{1-\alpha}\alpha^{\alpha}}$. Here, w is wage.

The firms always charge prices that are $\frac{\sigma}{\sigma-1}$ times their unit costs of production

$$p = \frac{\sigma}{\sigma - 1} c.$$

The modeling choice of monopolistic competition allows firms to make profits, so in an economy with multinational firms, part of the total output will be the profits of foreign firms, which do not count as national income.

Besides the entrepreneurs, there is one unit of domestic workers in the developing economy. The workers are endowed with capital $\bar{K}$ and labor $\bar{L}$. Domestic workers, domestic entrepreneurs and foreign entrepreneurs all consume the final composite good in (1.1).

The equilibrium of the model is defined as the prices and allocations such that consumers maximize utility and spend all their income buying the final good, producers maximize profits, and capital, labor, and goods markets clear.

The object of interest is national income (GNP), which is defined as the income of domestic workers and domestic entrepreneurs. National income can be written as

the multiple of two terms, GDP and $\frac{GNP}{GDP}$,

$$GNP = GDP \times \frac{GNP}{GDP}. \tag{1.2}$$

Lemma 1. *Define total output, or GDP, as the total output produced by both domestic and foreign firms in the economy. Define national income, or GNP, as the income paid to both domestic workers and domestic entrepreneurs. We have*

$$GDP = \Big[\frac{\big(\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \tilde{z}^{\sigma-1}\big)^{\alpha+\frac{1}{\sigma-1}}}{\big(\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)+1}} + z^{\sigma-1} + \tilde{z}^{\sigma-1}\big)^{\alpha}}\Big]\bar{K}^{\alpha}\bar{L}^{1-\alpha} \tag{1.3}$$

and

$$\frac{GNP}{GDP} = \frac{1}{\sigma}\big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \tilde{z}^{\sigma-1}}\big) + \frac{\sigma-1}{\sigma}. \tag{1.4}$$

We can show that as the domestic financial frictions become more severe (larger τ_K), total output (GDP) will be smaller. Intuitively, as capital rental wedge τ_K increases, financial frictions create more severe resource misallocation among domestic firms and hence cause total output (GDP) to decline.

Notice that for $\frac{GNP}{GDP}$, since firms always charge a price that is $\frac{\sigma}{\sigma-1}$ times their unit cost of production, the share of total output that is paid as factor payments is always $\frac{\sigma-1}{\sigma}$. This is captured by the second term on the right hand side of (1.4). The share of total output that is domestic firm profits is captured by the first term on the right-hand side of (1.4). The term $\frac{1}{\sigma}$ is the fraction of the total output in the economy that is firm profits. Domestic and foreign entrepreneurs will split the profits. The term $\big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}+\tilde{z}^{\sigma-1}}\big)$ is domestic firms' market share. We can show that as the domestic financial frictions become more severe (larger τ_K), domestic firms' market share will be smaller, so $\frac{GNP}{GDP}$ will also be smaller. Intuitively, as capital rental wedge τ_K increases, financial frictions impose more constraints on domestic firms in the competition with multinational firms and more severely reduce domestic firms' market share, causing the share of total output paid to domestic residents ($\frac{GNP}{GDP}$) to

decline. We hence have the following lemma.

Lemma 2. *GDP is decreasing in the capital rental wedge τ_K. When $\tilde{z} > 0$, $\frac{GNP}{GDP}$ is also decreasing in the capital rental wedge τ_K.*

Lemma 2 highlights that when a developing economy is open to multinational production in the form of greenfield investment, financial frictions will reduce national income through two channels. First, financial frictions create resource misallocation among domestic firms that produce goods that are complementary to the goods produced by multinational firms. As a result, financial frictions will cause a decline in total output (GDP). Second, since financial frictions mainly constrain the capital rentals for domestic firms rather than multinational firms, financial frictions will constrain domestic firms in the competition with multinational firms and reduce domestic firms' market share, which leads to a decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$).

Before presenting the main theoretical results, I will use two examples to establish the ideas. The parameters in the examples are as follows: elasticity of substitution $\sigma = 4$, capital rental wedge $\tau_K = 1$, productivity of domestic firms $z = 1$, and capital share in intermediate firms' production function $\alpha = 0.5$. Without loss of generality, I choose $\bar{K} = 1$ and $\bar{L} = 1$. The two examples differ only in the productivity of foreign firms $\tilde{z}$. In the first example, the productivity of foreign firms is $\tilde{z} = 1$. In the second example, the productivity of foreign firms is $\tilde{z} = 2$.

Example 1:

When $\tilde{z} = 1$, the productivity of foreign firms is the same as that of domestic firms. When the economy is open to multinational production, the multinational firms will produce 42% of the output in the developing economy. Table 1.1 shows the declines in national income caused by financial frictions in this example. When the economy is closed to multinational production, financial frictions cause a 5.84% decline in GNP. When the economy is open to multinational production, financial

Table 1.1: Declines in GNP caused by Financial Frictions, $\tilde{z} = 1$

	Without MF			With MF		
	GNP	GDP	$\frac{\text{GNP}}{\text{GDP}}$	GNP	GDP	$\frac{\text{GNP}}{\text{GDP}}$
$\tau_K = 0$	1.260	1.260	1	1.322	1.442	0.917
$\tau_K = 1$	1.186	1.186	1	1.236	1.383	0.894
Percentage Decline	-5.84%	-5.84%	0.00%	-6.49%	-4.10%	-2.50%

frictions cause a 6.49% decline in GNP. Such results indicate that in this example, financial frictions cause a larger decline in national income when the economy is open to multinational production.

To understand the intuition behind this result, Table 1.1 also shows the declines in GDP and $\frac{GNP}{GDP}$ caused by financial frictions. When the economy is closed to multinational production, financial frictions distort capital allocation among domestic firms and reduce total output (GDP) by 5.84%. However, since all outputs are produced by domestic firms, $\frac{GNP}{GDP}$ is always equal to 1. When the economy is open to multinational production, domestic firms still produce 58% of the output in the economy. Financial frictions distort capital allocation among domestic firms that produce goods that are complementary to goods produced by multinational firms and still cause a 4.10% decline in total output (GDP). In addition, since financial frictions only constrain the capital rentals of domestic firms but not multinational firms, financial frictions reduce the competitiveness of domestic firms relative to multinational firms and cause a decline in domestic firms' market share. This decline in domestic firms' market share leads to a 2.50% decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). The combination of the 4.10% decline in GDP and the additional 2.50% decline in $\frac{GNP}{GDP}$ leads to a larger 6.49% decline in GNP caused by financial frictions when the economy is open to multinational production.

Example 2:

When $\tilde{z} = 2$, the multinational firms are twice as productive as the domestic firms. When the economy is open to multinational production, the multinational

Table 1.2: Declines in GNP caused by Financial Frictions, $\tilde{z} = 2$

	Without MF			With MF		
	GNP	GDP	$\frac{\text{GNP}}{\text{GDP}}$	GNP	GDP	$\frac{\text{GNP}}{\text{GDP}}$
$\tau_K = 0$	1.26	1.26	1	1.724	2.154	0.800
$\tau_K = 1$	1.186	1.186	1	1.672	2.127	0.786
Percentage Decline	-5.84%	-5.84%	0.00%	-2.97%	-1.27%	-1.73%

firms will produce 86% of the output in the developing economy. Table 1.2 shows the declines in national income caused by financial frictions in this example. When the economy is closed to multinational production, financial frictions cause a 5.84% decline in GNP. When the economy is open to multinational production, however, financial frictions cause only a 2.97% decline in GNP. Such results indicate that in this example, financial frictions cause a smaller decline in national income when the economy is open to multinational production.

To understand the intuition behind this result, Table 1.2 also shows the declines in GDP and $\frac{GNP}{GDP}$ caused by financial frictions. When the economy is open to multinational production, because multinational firms are much more productive than domestic firms, multinational firms produce a very large share (86%) of the output in the developing economy. Since financial frictions do not constrain the capital rentals of multinational firms, financial frictions will only create very limited amount of resource misallocation in the economy and only cause a very small 1.27% decline in total output (GDP). As a result, despite an additional 1.73% decline in $\frac{GNP}{GDP}$ caused by financial frictions, financial frictions cause a smaller 2.96% decline in national income (GNP) when the economy is open to multinational production.

From these two examples, we see that on one hand, when multinational firms are not very productive and domestic firms produce a relatively large share of output ($\tilde{z} = 1$), financial frictions cause a larger decline in national income when the economy is open to multinational production. On the other hand, when multinational firms are productive and domestic firms produce a relatively small share of output ($\tilde{z} = 2$), financial frictions cause a smaller decline in national income when the economy is open

to multinational production. Such results hold under general parameter conditions. In fact, we have the following proposition.

Proposition 1. *Define the decline in national income caused by financial frictions, ΔGNP, as the decline in GNP when the capital rental wedge increases from 0 to $\tau_K > 0 : \Delta GNP = GNP|_{\tau_K=0} - GNP|_{\tau_K>0}$. When $\sigma > 2$ and $\tau_K < \bar{\tau}_K(\alpha, \sigma)$, there exists a lower bound for the productivity of multinational firms $\underline{z}(\alpha, \sigma, \tau_K, z)$ and an upper bound for the productivity of multinational firms $\bar{z}(\alpha, \sigma, \tau_K, z)$ such that,*

- *when $\tilde{z} < \underline{z}(\alpha, \sigma, \tau_K, z)$, $\Delta GNP_{\tilde{z}>0} > \Delta GNP_{\tilde{z}=0}$. This means compared with the economy that is closed to multinational production ($\tilde{z} = 0$), financial frictions cause a larger decline in national income when the economy is open to multinational production ($\tilde{z} > 0$).*
- *when $\tilde{z} > \bar{z}(\alpha, \sigma, \tau_K, z)$, $\Delta GNP_{\tilde{z}>0} < \Delta GNP_{\tilde{z}=0}$. This means compared with the economy that is closed to multinational production ($\tilde{z} = 0$), financial frictions cause a smaller decline in national income when the economy is open to multinational production ($\tilde{z} > 0$).*

The definition of $\bar{\tau}_K(\alpha, \sigma)$ and the proof of the proposition are in the appendix.[3]

When the economy is open to multinational production, the share of total output produced by domestic firms, s_D, is

$$s_D = \frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \tilde{z}^{\sigma-1}}.$$

The share of output produced by domestic firms is a decreasing function of the productivity of multinational firms, $\tilde{z}$. Therefore, we have the following corollary.

[3]Two things are worth noting here. First, in all the numerical cases I have tried, I always find that $\underline{z}(\alpha, \sigma, \tau_K, z) = \bar{z}(\alpha, \sigma, \tau_K, z)$. I hence conjecture that a single cutoff point $\underline{z}(\alpha, \sigma, \tau_K, z) = \bar{z}(\alpha, \sigma, \tau_K, z)$ exists, but I do not have formal proof for such a conjecture. Second, the results in the proposition hold when $\sigma > 2$ and τ_K is not too large ($\tau_K < \bar{\tau}_K(\alpha, \sigma)$). I discuss the cases with other parameter values in the appendix.

Corollary 1. *Define the decline in national income caused by financial frictions,* ΔGNP*, as the decline in GNP when the capital rental wedge increases from* 0 *to* $\tau_K > 0 : \Delta GNP = GNP|_{\tau_K=0} - GNP|_{\tau_K>0}$*. When* $\sigma > 2$ *and* $\tau_K < \bar{\tau}_K(\alpha, \sigma)$*, there exists a lower bound for the share of total output produced by domestic firms* $\underline{s}_D(\alpha, \sigma, \tau_K, z)$ *and an upper bound for the share of total output produced by domestic firms* $\bar{s}_D(\alpha, \sigma, \tau_K, z)$ *such that,*

- *when* $s_D > \bar{s}_D(\alpha, \sigma, \tau_K, z)$*,* $\Delta GNP_{\tilde{z}>0} > \Delta GNP_{\tilde{z}=0}$*. This means compared with the economy that is closed to multinational production* $(\tilde{z} = 0)$*, financial frictions cause a larger decline in national income when the economy is open to multinational production* $(\tilde{z} > 0)$*.*
- *when* $s_D < \underline{s}_D(\alpha, \sigma, \tau_K, z)$*,* $\Delta GNP_{\tilde{z}>0} < \Delta GNP_{\tilde{z}=0}$*. This means compared with the economy that is closed to multinational production* $(\tilde{z} = 0)$*, financial frictions cause a smaller decline in national income when the economy is open to multinational production* $(\tilde{z} > 0)$*.*

The corollary suggests that when the developing economy is open to multinational production, if the domestic firms produce a sufficiently large (small) share of output in the economy, financial frictions will cause a larger (smaller) decline in national income than in an otherwise identical developing economy that is closed to multinational production. This is exactly what we see in our two previous examples.

1.3 Model II

In Model I, multinational production takes the form of greenfield investment, and multinational firms build their own affiliates in the developing economy. In Model II, multinational production takes the form of foreign M&A, and multinational firms buy existing firms as their affiliates in the developing economy. I will show that the main results from Model I still hold in Model II.

The setup of the model is very similar to Model I. Consider a developing economy

with both domestic and foreign entrepreneurs. There are again two units of domestic entrepreneurs. Each domestic entrepreneur owns a domestic firm. He can rent capital k and hire labor l to produce one distinct variety of intermediate good. The domestic entrepreneurs all have the same productivity z and Cobb-Douglas production function

$$y = zk^{\alpha}l^{1-\alpha}.$$

Financial frictions in the developing economy are again modeled as a capital rental wedge for the domestic firms. In particular, one unit of the domestic firms in the economy face capital rental rate R, and the other unit of domestic firms face a higher capital rental rate

$$R^* = R(1 + \tau_K).$$

The existence of this capital rental wedge τ_K will distort resource allocation across the domestic firms, as firms that face a higher capital rental rate will face a higher unit cost of production.

If the economy is closed to multinational production, there will be no foreign firms, and the two units of domestic firms will be the only producers in the economy. If the economy is open to multinational production, foreign entrepreneurs will enter into the developing economy through M&A and buy domestic firms from domestic entrepreneurs. Without loss of generality, I assume that the foreign entrepreneurs will buy $0 < \eta < 1$ units of domestic firms, and they will only buy the more financially constrained firms that face capital rental rate $R(1+\tau_K)$. η is set to 0 if the economy is closed to multinational production. After the acquisition, the acquired firms will face no capital rental wedge, so they face the capital rental rate of R. The acquired firms will also have a higher productivity $\tilde{z} \geq z$. The acquired firms have Cobb-Douglas production function

$$y = \tilde{z}k^{\alpha}l^{1-\alpha}.$$

For simplicity, I also assume that for the η units of domestic entrepreneurs whose

firm are bought by foreign firms, they will start η units of new firms with productivity z, and the new firms they started are still financially constrained and face capital rental rate $R(1+\tau_K)$. This simplifying assumption will make it easier to compare this model to Model I.

There are competitive final goods producers in the economy. The final goods producers take all the intermediate goods in the economy to produce a composite final good

$$Y = \Big(\int_{\Omega} y(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \Big)^{\frac{\sigma}{\sigma-1}}. \tag{1.5}$$

Here, $\omega \in \Omega$ represents one distinct variety of intermediate good. Ω is the set of all intermediates goods available in the economy. The price index of the final good is defined in the standard way

$$P = \Big(\int_{\Omega} p(\omega)^{1-\sigma} d\omega \Big)^{\frac{1}{1-\sigma}}.$$

Here, $p(\omega)$ is the price for good $\omega \in \Omega$.

All the entrepreneurs in the economy face the following profit maximization problem

$$\begin{aligned} &\max_{\{p,y\}} py - cy \\ &s.t.\ y = \frac{p^{-\sigma}}{P^{1-\sigma}} X. \end{aligned}$$

Here, X is the total expenditure in the economy. p is the price the firm charges. c is the unit cost of production.

The firm always charges a price that is $\frac{\sigma}{\sigma-1}$ times their unit cost of production

$$p = \frac{\sigma}{\sigma-1} c.$$

There is one unit of domestic workers in the developing economy. The workers are endowed with capital $\bar{K}$ and labor $\bar{L}$. All individuals in the economy, including the

domestic workers, domestic entrepreneurs, and the foreign entrepreneurs who bought firms from domestic entrepreneurs all consume the final composite good in (1.5).

The equilibrium of the model is defined as the prices and allocations such that consumers maximize utility and spend all their income buying the final good, producers maximize profits, and capital, labor, and goods markets clear. Similar to Model I, we have the following lemma.

Lemma 3. *Define total output, or GDP, as the total output produced by both domestic and foreign firms in the economy. We have*

$$GDP = \Big[\frac{\big(\frac{\tilde{z}^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}\big)^{\alpha+\frac{1}{\sigma-1}}}{\big(\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)+1}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}\big)^{\alpha}}\Big]\bar{K}^{\alpha}\bar{L}^{1-\alpha}. \tag{1.6}$$

The expression in (1.6) is very similar to the expression in (1.3), with $\tilde{z}^{\sigma-1}$ in (1.3) replaced by $\eta\tilde{z}^{\sigma-1}$ in (1.6) as we now have η units of foreign firms instead of just one unit of foreign firms in Model I. We can show that as the capital rental wedge τ_K gets larger, total output will be smaller. Intuitively, as capital rental wedge τ_K increases, financial frictions create more severe resource misallocation among domestic firms and hence cause total output (GDP) to decline.

Lemma 4. *Total output, or GDP in the economy, as measured by (*1.6*), is a decreasing function of the capital rental wedge τ_K.*

We next study the acquisition prices paid by foreign entrepreneurs to domestic entrepreneurs. The acquisition price paid by the foreign entrepreneurs will be determined by bargaining between the domestic and foreign entrepreneurs. In particular, after a firm is acquired, and assuming all other η units of firms are also acquired, the profit of the acquired firm will be

$$P^A = \frac{1}{\sigma}\Big(\frac{\tilde{z}^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}\Big) \times GDP = \frac{1}{\sigma}s^A \times GDP. \tag{1.7}$$

Notice $\frac{1}{\sigma}$ is the share of total output that is firm profits. The term in the bracket in

(1.7), $s^A = \big(\frac{\tilde{z}^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}+\eta\tilde{z}^{\sigma-1}}\big)$, is the firm's market share after being acquired.

If the firm choose not to be acquired, assuming all other η units of firms are still acquired, the profit of the firm will be

$$P^{NA} = \frac{1}{\sigma}\Big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}\Big) \times GDP = \frac{1}{\sigma}s^{NA} \times GDP. \tag{1.8}$$

Notice the term in the bracket in (1.8), $s^{NA} = \big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}+\eta\tilde{z}^{\sigma-1}}\big)$, is the firm's market share if the firm choose not to be acquired.

The bargaining power of domestic entrepreneurs is $\beta \in [0,1]$, so the acquisition price paid by a foreign entrepreneur to a domestic entrepreneur is

$$P = \beta P^A + (1-\beta)P^{NA}. \tag{1.9}$$

Given (1.7) and (1.8), we can write the acquisition price in (1.9) as

$$P = \frac{1}{\sigma}(\beta s^A + (1-\beta)s^{NA}) \times GDP. \tag{1.10}$$

As Lemma 4 indicates, GDP is a decreasing function of τ_K. We can also show that s^{NA} is a decreasing function of τ_K. Intuitively, if the firm chooses not to be acquired, since the firm is constrained by the capital rental wedge τ_K, as τ_K becomes larger, the firm's market share s^{NA} will be smaller. However, s^A is an increasing function of τ_K. Intuitively, since the acquired firm is not constrained by the capital rental wedge τ_K, as τ_K gets larger, the acquired firm's market share will get larger as it takes more market share away from firms that are constrained by the capital rental rate τ_K. Hence we can show that if β is small enough, $(\beta s^A + (1-\beta)s^{NA})$ will be decreasing in τ_K. We hence have the following lemma.

Lemma 5. *When β is small enough such that $\beta < \bar{\beta}(\alpha, \sigma, \eta, z, \tilde{z})$, the acquisition price P is a decreasing function of the capital rental wedge τ_K.*

The definition of $\bar{\beta}(\alpha, \sigma, \eta, z, \tilde{z})$ is in the appendix. Intuitively, when β is small enough, the domestic entrepreneurs have low bargaining power so that the acquisition price much depends on the domestic firm's value if it is not acquired (the outside option of the target firm in the acquisition). As τ_K gets larger, total output in the economy gets smaller, which reduces the firm's value. At the same time, as τ_K gets larger, if the firm is not acquired, the firm's market share also gets smaller, further reducing the firm's value. As a result, when β is sufficiently small, a larger capital rental wedge τ_K will reduce the acquisition prices paid by the foreign entrepreneurs.

Next, we turn to our object of interest, the national income, or GNP, in the economy. National income includes the income of domestic workers and domestic entrepreneurs. The workers will simply earn the factor payments (payments to capital and labor). The domestic entrepreneurs will earn domestic firm profits and also the payments from foreign entrepreneurs in the foreign acquisitions. National income (GNP) can be written as the multiple of GDP and $\frac{GNP}{GDP}$

$$GNP = GDP \times \frac{GNP}{GDP}. \tag{1.11}$$

The expression of GDP is in (1.6). We also have the following lemma.

Lemma 6. *Define national income, or GNP, as the income of domestic entrepreneurs and workers. The share of total output that is paid to domestic residents, $\frac{GNP}{GDP}$, is*

$$\frac{GNP}{GDP} = \Big[\underbrace{\frac{1}{\sigma}\Big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}\Big)}_{\frac{\text{domestic firm profit}}{GDP}} + \underbrace{\frac{\sigma-1}{\sigma}}_{\frac{\text{factor payments}}{GDP}} \Big] \tag{1.12}$$

$$\underbrace{+\frac{1}{\sigma}\Big[\beta\Big(\frac{\eta\tilde{z}^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}\Big) + (1-\beta)\Big(\frac{\eta\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}\Big)\Big]}_{\frac{\text{income from foreign acquisition}}{GDP}}. \tag{1.13}$$

Notice the first term on the right-hand side of (1.12), $\frac{1}{\sigma}\big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}+\eta\tilde{z}^{\sigma-1}}\big)$, is the share of total output that is domestic firm profits. The second term on the right-hand side of (1.12), $\frac{\sigma-1}{\sigma}$, is factor payments' share of total output. The term in (1.13) is simply the term $\frac{1}{\sigma}(\beta s^A + (1-\beta)s^{NA})$ in (1.10), which represents the share of total output that is paid to domestic firm owners as foreign acquisition payments.

Combining (1.6), (1.11), (1.12) and (1.13), we can write national income as follows.

$$GNP = \Big[\underbrace{\frac{1}{\sigma}\big(\frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}}+z^{\sigma-1}+\eta\tilde{z}^{\sigma-1}}\big)}_{\frac{\text{domestic firm profit}}{\text{GDP}}} + \underbrace{\frac{\sigma-1}{\sigma}}_{\frac{\text{factor payments}}{\text{GDP}}}\Big] * GDP \tag{1.14}$$

$$\underbrace{+\frac{1}{\sigma}\big[\beta s^A + (1-\beta)s^{NA}\big] * GDP}_{\text{income from foreign acquisition}}. \tag{1.15}$$

The expressions in (1.14) and (1.15) highlight that financial frictions reduce national income through three channels when multinational firms are present. First, if we focus on the term in (1.14), financial frictions create resouce misallocation among domestic firms that produce goods that are complementary to the goods produced by multinational firms, causing a decline in total output (GDP). Second, if we again focus on the term in (1.14), financial frictions constrain domestic firms in the competition with multinational firms and reduce domestic firms' market share, which leads to a decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). Notice this first and second channels are also present in Model I, where multinational production takes the form of greenfield investment. Third, we focus on the term in (1.15), which is the payments from foreign acquisitions and is absent in Model I. As shown in Lemma 5, financial frictions could reduce the acquisition payments from foreign entrepreneurs, which leads to a further decline in national income. This third channel is only present when multinational production takes the form of foreign M&A rather than greenfield investment.

Given that the two channels through which financial frictions reduce national

income in Model I are still present in this model, it is not surprising that a similar result from Model I still holds in this model as well, as in the following proposition.

Proposition 2. *Define the decline in national income caused by financial frictions, ΔGNP, as the decline in GNP when the capital rental wedge increases from 0 to $\tau_K > 0 : \Delta GNP = GNP|_{\tau_K=0} - GNP|_{\tau_K>0}$. When $\sigma > 2$ and $\tau_K < \bar{\tau}_K(\alpha, \sigma)$, there is a lower bound for the number of multinational firms $\underline{\eta}(\alpha, \sigma, \tau_K, z, \tilde{z})$, an upper bound for the number of multinational firms $\bar{\eta}(\alpha, \sigma, \tau_K, z, \tilde{z})$, and an upper bound for the productivity of foreign firms $\bar{\tilde{z}}(\alpha, \sigma, \tau_K, z)$ such that,*

- *when $\eta < \underline{\eta}(\alpha, \sigma, \tau_K, z, \tilde{z})$, $\Delta GNP_{\eta>0} > \Delta GNP_{\eta=0}$. This means compared with the economy that is closed to multinational production ($\eta = 0$), financial frictions cause a larger decline in national income when the economy is open to multinational production ($\eta > 0$).*
- *when $\eta > \bar{\eta}(\alpha, \sigma, \tau_K, z, \tilde{z})$ and $\tilde{z} > \bar{\tilde{z}}(\alpha, \sigma, \tau_K, z)$, $\Delta GNP_{\eta>0} < \Delta GNP_{\eta=0}$. This means compared with the economy that is closed to multinational production ($\eta = 0$), financial frictions cause a smaller decline in national income when the economy is open to multinational production ($\eta > 0$).*

The proof of the proposition is in the appendix. The share of total output produced by domestic firms, s_D, is

$$s_D = \frac{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1}}{\frac{z^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z^{\sigma-1} + \eta\tilde{z}^{\sigma-1}}. \tag{1.16}$$

From (1.16), we see that the share of output produced by domestic firms, s_D, is a decreasing function of the number of foreign firms, η, and the productivity of foreign firms, $\tilde{z}$. Therefore, we have the following corollary.

Corollary 2. *Define the decline in national income caused by financial frictions, ΔGNP, as the decline in GNP when the capital rental wedge increases from 0 to $\tau_K > 0 : \Delta GNP = GNP|_{\tau_K=0} - GNP|_{\tau_K>0}$. When $\sigma > 2$ and $\tau_K < \bar{\tau}_K(\alpha, \sigma)$, there is*

a lower bound for the share of output produced by domestic firms $\underline{s}_D(\alpha, \sigma, \tau_K, z, \tilde{z})$*, and an upper bound for the share of output produced by domestic firms* $\bar{s}_D(\alpha, \sigma, \tau_K, z, \tilde{z})$ *such that,*

- *when* $s_D > \bar{s}_D(\alpha, \sigma, \tau_K, z, \tilde{z})$*,* $\Delta GNP_{\eta>0} > \Delta GNP_{\eta=0}$*. This means compared with the economy that is closed to multinational production* ($\eta = 0$)*, financial frictions cause a larger decline in national income when the economy is open to multinational production* ($\eta > 0$)*.*
- *when* $s_D < \underline{s}_D(\alpha, \sigma, \tau_K, z, \tilde{z})$*,* $\Delta GNP_{\eta>0} < \Delta GNP_{\eta=0}$*. This means compared with the economy that is closed to multinational production* ($\eta = 0$)*, financial frictions cause a smaller decline in national income when the economy is open to multinational production* ($\eta > 0$)*.*

Corollary 2 suggests that the key result in Model I still holds in this model: when the economy is open to multinational production, if the domestic firms produce a sufficiently large (small) share of output in the economy, financial frictions will cause a larger (smaller) decline in national income than in an otherwise identical economy that is closed to multinational production.

1.4 Conclusion

In Chapter 1, I theoretically illustrate the key mechanisms through which financial frictions reduce national income in a developing economy that is open to multinational production. I also show that theoretically, depending on the share of output produced by domestic firms, the presence of multinational firms could either alleviate or exacerbate the adverse impact of financial frictions on national income. Such result calls for the quantitative analysis in the next chapter.

1.5 Appendices

1.5.1 Definition of $\bar{\tau}_K(\alpha, \sigma)$

I provide the definition of $\bar{\tau}_K(\alpha, \sigma)$ in the Propositions: $\bar{\tau}_K(\alpha, \sigma)$ is the minimum positive solution of τ_K to the equation

$$\left(\frac{\tau_K \kappa (1+\tau_K)^{-\kappa-1}}{(1+\tau_K)^{-\kappa-1}+1} - \frac{1}{\sigma}\right) \frac{\left((1+\tau_K)^{-\kappa}+1\right)^{\alpha+\frac{1}{\sigma-1}-1}}{\left((1+\tau_K)^{-\kappa-1}+1\right)^{\alpha}} + \frac{1}{\sigma} 2^{\frac{1}{\sigma-1}-1} = 0. \tag{1.17}$$

Here, $\kappa = \alpha(\sigma - 1)$. If no positive solution exists for equation (1.17), $\bar{\tau}_K(\alpha, \sigma) = +\infty$.

1.5.2 Definition of $\bar{\beta}(\alpha, \sigma, \eta, z, \tilde{z})$

Notice we have shown that s^{NA} in (1.8) is a decreasing function of τ_K, and s^A in (1.9) is an increasing function of τ_K. From (1.10), we see that when $\beta = 0$, the acquisition price is $P = \frac{1}{\sigma} s^{NA} \times GDP$, which is a strictly decreasing function of τ_K. In other words, $\frac{\partial P}{\partial \tau_K}|_{\beta=0} < 0$. Given that $\frac{\partial P}{\partial \tau_K}$ is a continuous function of β, for β sufficiently small and close to 0, we must have $\frac{\partial P}{\partial \tau_K} < 0$. Hence to define $\bar{\beta}(\alpha, \sigma, \eta, z, \tilde{z})$, we will increase β continuously from 0, and we will define $\bar{\beta}(\alpha, \sigma, \eta, z, \tilde{z})$ as the upper limit of β that satisfies $\frac{\partial P}{\partial \tau_K} < 0$.

1.5.3 Proof of Propositions

I first prove Proposition 1 in a more general form. In particular, I assume that for the two units of domestic firms, the productivity of the firms that are subject to the capital wedge is z_1, and the productivity of the firms that are not subject to the capital wedge is z_2. In the Proposition, $z_1 = z_2 = z$. In the proof, I allow z_1 and z_2

to be different. In this case, national income is

$$GNP = \underbrace{\Big[\underbrace{\frac{1}{\sigma}\Big(\frac{\frac{z_1^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z_2^{\sigma-1}}{\frac{z_1^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z_2^{\sigma-1} + \tilde{z}^{\sigma-1}}\Big)}_{\frac{\text{domestic firm profit}}{\text{GDP}}} + \underbrace{\frac{\sigma-1}{\sigma}}_{\frac{\text{factor payments}}{\text{GDP}}} \Big]}_{\frac{GNP}{GDP}} \times \underbrace{\Big[\frac{\Big(\frac{z_1^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)}} + z_2^{\sigma-1} + \tilde{z}^{\sigma-1}\Big)^{\alpha+\frac{1}{\sigma-1}}}{\Big(\frac{z_1^{\sigma-1}}{(1+\tau_K)^{\alpha(\sigma-1)+1}} + z_2^{\sigma-1} + \tilde{z}^{\sigma-1}\Big)^{\alpha}}\Big] \bar{K}^{\alpha}\bar{L}^{1-\alpha}}_{GDP}. \tag{1.18}$$

Denote $z_1^{\sigma-1}$ as a, $z_2^{\sigma-1}$ as b, and $\tilde{z}^{\sigma-1}$ as c; (1.18) can be written as

$$GNP = \underbrace{\Big[\underbrace{\frac{1}{\sigma}\Big(\frac{\frac{a}{(1+\tau_K)^{\alpha(\sigma-1)}} + b}{\frac{a}{(1+\tau_K)^{\alpha(\sigma-1)}} + b + c}\Big)}_{\frac{\text{domestic firm profit}}{\text{GDP}}} + \underbrace{\frac{\sigma-1}{\sigma}}_{\frac{\text{factor payments}}{\text{GDP}}} \Big]}_{\frac{GNP}{GDP}} \times \underbrace{\Big[\frac{\Big(\frac{a}{(1+\tau_K)^{\alpha(\sigma-1)}} + b + c\Big)^{\alpha+\frac{1}{\sigma-1}}}{\Big(\frac{a}{(1+\tau_K)^{\alpha(\sigma-1)+1}} + b + c\Big)^{\alpha}}\Big] \bar{K}^{\alpha}\bar{L}^{1-\alpha}}_{GDP}.$$

The decline in GNP caused by financial frictions is the decline in GNP when the wedge increases from 0 to $\tau_K > 0$. It can be written as

$$\Delta GNP = GNP|_{\tau_K=0} - GNP|_{\tau_K>0}. \tag{1.19}$$

First, I show that the decline in GNP caused by financial frictions, measured by (1.19), is positive in the economy without multinational firms ($c = 0$). In other words, $\Delta GNP|_{c=0} > 0$. When there are no multinational firms in the economy,

$GNP = GDP$. Hence, it suffices to show that $\frac{\partial GDP}{\partial \tau_K} < 0$.

$$\frac{\partial GDP}{\partial \tau_K} = a\alpha(\kappa+1)\big(a(1+\tau_K)^{-\kappa}+b+c\big)^{\alpha+\frac{1}{\sigma-1}-1}\big(a(1+\tau_K)^{-\kappa-1}+b+c\big)^{-\alpha} \quad (1.20)$$

$$\times (1+\tau_K)^{-\kappa-1} * \big(-1+\frac{\frac{a}{(1+\tau_K)^{\kappa+1}}+\frac{b}{1+\tau_K}+\frac{c}{1+\tau_K}}{\frac{a}{(1+\tau_K)^{\kappa+1}}+b+c}\big) < 0 \quad (1.21)$$

Here, $\kappa = \alpha(\sigma-1) > 0$, and $\bar{K}$ and $\bar{L}$ are normalized to 1. Given $\tau_K > 0$, we see that $\frac{\partial GDP}{\partial \tau_K}$ is negative.

Second, I show that as c approaches $+\infty$, the decline in national income caused by financial frictions, ΔGNP, approaches 0. Plugging (1.18) into (1.19), we have

$$\begin{aligned}
\Delta GNP = {} & \frac{1}{\sigma}(a+b)(a+b+c)^{\frac{1}{\sigma-1}-1} \\
& - \frac{1}{\sigma}\big(\frac{a}{(1+\tau_K)^{\kappa}}+b\big)\big(\frac{a}{(1+\tau_K)^{\kappa}}+b+c\big)^{\frac{1}{\sigma-1}-1}\Big(\frac{\big(\frac{a}{(1+\tau_K)^{\kappa}}+b+c\big)}{\big(\frac{a}{(1+\tau_K)^{\kappa+1}}+b+c\big)}\Big)^{\alpha} \\
& + \frac{\sigma-1}{\sigma}(a+b+c)^{\frac{1}{\sigma-1}} \\
& - \frac{\sigma-1}{\sigma}\big(\frac{a}{(1+\tau_K)^{\kappa}}+b+c\big)^{\frac{1}{\sigma-1}}\Big(\frac{\big(\frac{a}{(1+\tau_K)^{\kappa}}+b+c\big)}{\big(\frac{a}{(1+\tau_K)^{\kappa+1}}+b+c\big)}\Big)^{\alpha}.
\end{aligned}$$

Given that $\sigma > 2$, $\frac{1}{\sigma-1} < 1$, we see that ΔGNP approaches zero as c approaches infinity.

Lastly, I show that under the condition that τ_K is not too large ($\tau_K < \bar{\tau}_K(\alpha,\sigma)$ in the Proposition), $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$. Taking the first-order derivative of (1.19) with respect to c, we have

$$\begin{aligned}
\frac{\partial \Delta GNP}{\partial c} = {} & -\frac{1}{\sigma}(a+b)(a+b+c)^{\frac{1}{\sigma-1}-2} + \big(\frac{1}{\sigma}\frac{a+b}{a+b+c}+\frac{\sigma-1}{\sigma}\big)\frac{1}{\sigma-1}(a+b+c)^{\frac{1}{\sigma-1}-1} \\
& + \frac{1}{\sigma}(a(1+\tau_K)^{-\kappa}+b)\frac{(a(1+\tau_K)^{-\kappa}+b+c)^{\alpha+\frac{1}{\sigma-1}-2}}{(a(1+\tau_K)^{-\kappa-1}+b+c)^{\alpha}} + \big(\frac{1}{\sigma}\frac{\frac{a}{(1+\tau_K)^{\kappa}}+b}{\frac{a}{(1+\tau_K)^{\kappa}}+b+c}+\frac{\sigma-1}{\sigma}\big) \\
& * \frac{(a(1+\tau_K)^{-\kappa}+b+c)^{\alpha+\frac{1}{\sigma-1}-1}}{(a(1+\tau_K)^{-\kappa-1}+b+c)^{\alpha}}\frac{1}{\sigma-1}\frac{(1-\tau_K\kappa)a(1+\tau_K)^{-\kappa-1}+b+c}{a(1+\tau_K)^{-\kappa-1}+b+c}.
\end{aligned}$$

Plug in $c = 0$, $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$ is equivalent to

$$\frac{1}{\sigma - 1} \frac{\tau_K \kappa a (1+\tau_K)^{-\kappa-1}}{a(1+\tau_K)^{-\kappa-1} + b} \frac{(a(1+\tau_K)^{-\kappa} + b)^{\alpha + \frac{1}{\sigma-1} - 1}}{(a(1+\tau_K)^{-\kappa-1} + b)^{\alpha}} \tag{1.22}$$

$$> (\frac{1}{\sigma - 1} - \frac{1}{\sigma})(\frac{(a(1+\tau_K)^{-\kappa} + b)^{\alpha + \frac{1}{\sigma-1} - 1}}{(a(1+\tau_K)^{-\kappa-1} + b)^{\alpha}} - (a+b)^{\frac{1}{\sigma-1} - 1}). \tag{1.23}$$

When $\tau_K = 0$, both the left-hand side of the inequality, (1.22), and the right-hand side of the inequality, (1.23), are equal to 0. We want to show that when τ_K is small enough, the left-hand side of the inequality, (1.22), increases at a faster rate than the right-hand side of the inequality, (1.23), so $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$ when τ_K is small enough. It suffices to show that for a small enough τ_K, the first-order derivative of the left-hand side (1.22) with respect to τ_K is larger than the first-order derivative of the right-hand side (1.23) with respect to τ_K. For $\tau_K = 0$, we have

$$\frac{\partial LHS}{\partial \tau_K}|_{\tau_K=0} = \frac{1}{\sigma - 1}(a+b)^{\frac{1}{\sigma-1} - 2} a\kappa,$$

$$\frac{\partial RHS}{\partial \tau_K}|_{\tau_K=0} = (\frac{1}{\sigma - 1} - \frac{1}{\sigma})(a+b)^{\frac{1}{\sigma-1} - 2} a\kappa.$$

which gives us

$$\frac{\partial LHS}{\partial \tau_K}|_{\tau_K=0} > \frac{\partial RHS}{\partial \tau_K}|_{\tau_K=0}.$$

This means that when $\tau_K > 0$ is small enough, we always have $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$. In fact, denote the smallest positive τ_K such that $\frac{\partial \Delta GNP}{\partial c}|_{c=0} = 0$ as $\bar{\tau}_K(\alpha, \sigma, a, b)$. In other words, $\bar{\tau}_K(\alpha, \sigma, a, b)$ is the smallest positive solution to the equation

$$\frac{1}{\sigma - 1} \frac{\tau_K \kappa a (1+\tau_K)^{-\kappa-1}}{a(1+\tau_K)^{-\kappa-1} + b} \frac{(a(1+\tau_K)^{-\kappa} + b)^{\alpha + \frac{1}{\sigma-1} - 1}}{(a(1+\tau_K)^{-\kappa-1} + b)^{\alpha}}$$

$$= (\frac{1}{\sigma - 1} - \frac{1}{\sigma})(\frac{(a(1+\tau_K)^{-\kappa} + b)^{\alpha + \frac{1}{\sigma-1} - 1}}{(a(1+\tau_K)^{-\kappa-1} + b)^{\alpha}} - (a+b)^{\frac{1}{\sigma-1} - 1}).$$

The above equation can be simplified as

$$\left(\frac{\tau_K \kappa a(1+\tau_K)^{-\kappa-1}}{a(1+\tau_K)^{-\kappa-1}+b} - \frac{1}{\sigma}\right)\frac{(a(1+\tau_K)^{-\kappa}+b)^{\alpha+\frac{1}{\sigma-1}-1}}{(a(1+\tau_K)^{-\kappa-1}+b)^{\alpha}} + \frac{1}{\sigma}(a+b)^{\frac{1}{\sigma-1}-1} = 0. \quad (1.24)$$

If no positive solution τ_K for equation (1.24) exists, then $\bar{\tau}_K(\alpha, \sigma, a, b) = +\infty$. Since $\frac{\partial \Delta GNP}{\partial c}|_{c=0}$ equals 0 when $\tau_K = 0$ and is positive for $\tau_K > 0$ that is small enough, we have for any $0 < \tau_K < \bar{\tau}_K(\alpha, \sigma, a, b)$, $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$.

In the Proposition of Section 1.2, we have $a = b = z^{\sigma-1}$, and (1.24) simplifies to

$$\left(\frac{\tau_K \kappa (1+\tau_K)^{-\kappa-1}}{(1+\tau_K)^{-\kappa-1}+1} - \frac{1}{\sigma}\right)\frac{((1+\tau_K)^{-\kappa}+1)^{\alpha+\frac{1}{\sigma-1}-1}}{((1+\tau_K)^{-\kappa-1}+1)^{\alpha}} + \frac{1}{\sigma}2^{\frac{1}{\sigma-1}-1} = 0.$$

This is exactly the condition in (1.17).

We have so far proved that $\Delta GNP|_{c=0} > 0$, ΔGNP approaches 0 as c approaches $+\infty$, and $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$ when $0 < \tau_K < \bar{\tau}_K(\alpha, \sigma, a, b)$. This means the decline in national income caused by financial frictions, ΔGNP, starts from a positive number when $c = 0$ (when the economy is closed to multinational production), initially increases as c increases, and eventually declines towards zero as c approaches $+\infty$. This means that there is $\underline{c}(\sigma, \tau_K, \alpha, a, b)$ such that when $c < \underline{c}(\sigma, \tau_K, \alpha, a, b)$, $\Delta GNP|_{0<c<\underline{c}} > \Delta GNP|_{c=0}$; and there is $\bar{c}(\sigma, \tau_K, \alpha, a, b)$ such that when $c > \bar{c}(\sigma, \tau_K, \alpha, a, b)$, $\Delta GNP|_{c>\bar{c}} > \Delta GNP|_{c=0}$. Recall that $c = \tilde{z}^{\sigma-1}$ and $a = b = z^{\sigma-1}$ in the Proposition. This proves Proposition 1.

We now proceed to prove Proposition 2. The proof of Proposition 2 is very similar to the proof of Proposition 1. Notice that in Model II, national income can be written as the summation of the two terms in (1.14) and (1.15). The term in (1.14) is the national income minus payments from foreign M&A. We first focus only on this term in (1.14). If we denote $\eta \tilde{z}^{\sigma-1}$ as c, all the same proof for Proposition 1 above will carry over, and we can show that when the developing economy is open to multinational production, as long as η is sufficiently small, financial frictions will cause a larger decline in the term of (1.14) than in an otherwise identical economy that is closed to

multinational production.

Now we study the second term in (1.15). This term is the payments from foreign acquisitions. Notice that when the economy is closed to multinational production, this term is always zero, so financial frictions will have no impact on this term. When the economy is open to multinational production, as shown in Lemma 5, financial frictions will cause a decline in national income in this term (when β is sufficiently small). This means when the developing economy is open to multinational production, financial frictions will cause an additional decline in national income by reducing the term in (1.15).

Therefore, combining the analysis in the two paragraphs above, we have shown that when the developing economy is open to multinational production, as long as η is small enough, financial frictions will cause a larger decline in national income than in an otherwise identical economy that is closed to multinational production.

Following the same methodology in the proof of Proposition 1, we can also show that as $\eta\tilde{z}^{\sigma-1}$ goes to infinity, $\Delta GNP_{\eta>0}$ approaches 0. This means as long as $\tilde{z}$ is sufficiently large, as η approaches 1, $\Delta GNP_{\eta>0}$ will be close enough to 0. This means when the developing economy is open to multinational production, as long as η and $\tilde{z}$ is large enough, financial frictions will cause a smaller decline in national income than in an otherwise identical economy that is closed to multinational production. This concludes the proof of Proposition 2.

1.5.4 Discussion of Other Parameter Values for Proposition 1

The results in the proposition hold when $\sigma > 2$ and τ_K is not too large ($\tau_K < \bar{\tau}_K(\alpha, \sigma)$). I now briefly discuss what happens under other parameter values.

When $\sigma < 2$ and τ_K is not too large ($0 < \tau_K < \bar{\tau}_K(\alpha, \sigma)$, or when $\frac{\partial \Delta GNP}{\partial c}|_{c=0} > 0$), we can follow the same method in the proof of Proposition 1 to show that ΔGNP approaches $+\infty$ as c approaches $+\infty$. This means that ΔGNP starts from a positive number when $c = 0$ (when the economy is closed to multinational production), ini-

tially increases as c increases, and eventually approaches $+\infty$ as c approaches $+\infty$. As a result, financial frictions will tend to always cause a larger decline in national income when the economy is open to multinational production.

Intuitively, when σ is too small ($\sigma < 2$), the goods produced by different firms are very complementary to each other. Financial frictions will tend to cause a larger decline in national income when they create resource misallocation among domestic firms that produce goods that are very complementary to the goods produced by multinational firms.

When $\sigma > 2$ and τ_K is too large (such that $\frac{\partial \Delta GNP}{\partial c}|_{c=0} < 0$), we can show that ΔGNP starts from a positive number when $c = 0$ (when the economy is closed to multinational production), initially decreases as c increases, and eventually approaches 0 as c approaches $+\infty$. As a result, financial frictions will tend to always cause a smaller decline in national income when the economy is open to multinational production.

Intuitively, when τ_K is too large, financial frictions are very severe among domestic firms. Financial frictions will tend to cause a smaller decline in national income when the economy opens up to financially unconstrained multinational firms.

When $\sigma < 2$ and τ_K is too large (such that $\frac{\partial \Delta GNP}{\partial c}|_{c=0} < 0$), we can show that ΔGNP starts from a positive number when $c = 0$ (when the economy is closed to multinational production), initially decreases as c increases, but eventually approaches $+\infty$ as c approaches $+\infty$. This means that when the productivity of foreign firms $\tilde{z}$ is small enough, financial frictions will cause a smaller decline in national income when the economy is open to multinational production. When the productivity of foreign firms $\tilde{z}$ is large enough, financial frictions will cause a larger decline in national income when the economy is open to multinational production. This is exactly the reverse of Proposition 1.

Intuitively, there is a horse race between the two forces: On the one hand, since σ is very small ($\sigma < 2$), the goods produced by different firms are very complementary

to each other. Financial frictions will tend to cause a larger decline in national income when they distort capital allocation among domestic firms that produce goods that are very complementary to the goods produced by multinational firms. On the other hand, since τ_K is very large, financial frictions are very severe among domestic firms. Financial frictions will tend to cause a smaller decline in national income when the economy opens up to multinational firms. When $\tilde{z}$ is large (small), the former (later) force dominates.

CHAPTER 2

Financial Frictions, Multinational Firms, and Income in Developing Countries: Quantitative Analysis

2.1 Introduction

Financial frictions create resource misallocation across heterogeneous production units and reduce national income (GNP) in developing countries. Multinational firms, however, can largely circumvent local financial frictions by borrowing from international sources. The goal of this chapter is to quantitatively answer the following question: how does the presence of multinational firms in developing countries change the adverse impact of financial frictions on national income. A quantitative analysis is necessary and important because in Chapter 1 of this dissertation, I find that theoretically, the presence of multinational firms in developing countries can either alleviate or exacerbate the adverse impact of financial frictions on national income.

To answer this question, I develop a quantitative model in which multinational production takes the form of greenfield investment. In the model, multinational firms engage in monopolistic competition with domestic firms in the developing economy, and firms face collateral constraints in their capital rentals. A financial reform in the developing economy will mainly relax the collateral constraints for domestic firms. Using the calibrated model, I find that when a developing economy is open to multinational production, a modest financial reform will improve national income by 19%, as opposed to only 11% in an otherwise identical developing economy that is closed to

multinational production. Such result indicate that financial frictions become increasingly costly and financial reforms become increasingly beneficial to national income in developing countries as they open up to multinational production. I then show that the quantitative result is robust if multinational production takes the form of both greenfield investment and foreign M&A. Intuitively, when the economy is open to multinational production, financial reforms will significantly improve national income through three channels. First, a better financial system ensures that domestic firms can more efficiently produce goods that are complementary to the goods produced by multinational firms and will consequently improve total output (GDP). Second, a better financial system also ensures that domestic firms can compete on a more level playing field with multinational firms and will consequently improve the domestic firms' market share and, hence, the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). Third, when multinational production takes the form of foreign M&A, a better financial system will improve domestic firm's outside option in foreign M&A, which is the value of the firm if it is not sold to foreign firms. As a result, a better financial system will increase the acquisition prices paid by foreign firms.

This chapter is divided into two parts. In the first part, I develop the quantitative model and perform the quantitative analysis. There are two countries in the quantitative model, the North and the South. The North represents developed countries and the South represents developing countries. In the calibration, I group all major developed countries around the world into a single country, the North. I choose a single country, China, as the South.

In the quantitative model, multinational production is modeled as a substitute for exports (Helpman, Melitz, and Yeaple 2004). Compared with exports, firms in the North that set up foreign affiliates to access the market in the South will face higher fixed costs but lower variable costs, as the affiliates in the South can hire cheap local labor and avoid trade costs. In the data, multinational firms' affiliates' sales are, on average, 17 times larger than those of domestic private firms in China. However, domestic firms still produce 76% of the manufacturing output in China. These

observations imply that in the calibrated model, only a small number of productive firms in the North will choose to set up foreign affiliates in the South.

In the quantitative model, financial frictions are modeled as collateral constraints on firms' capital rentals (Buera, Kaboski, and Shin 2011 & 2015). Entrepreneurs can overcome the collateral constraints by self-financing through forward-looking saving behavior. However, the fixed cost of operation makes self-financing difficult, as firms are only efficient above certain minimum scales. Financial frictions combined with fixed cost of operation can severely distort the allocation of capital across heterogeneous firms and firms' entry and exit decisions. In the calibration, the fixed cost of operation is disciplined by the observed plant size. I discipline the magnitude of financial frictions with two empirical observations: First, the developed countries have higher private credit to output ratios than China. This implies that in the calibrated model, entrepreneurs in the South are more financially constrained than entrepreneurs in the North. Second, the average output per unit of capital for multinational firms' affiliates in China is only 90% of that for domestic private firms. This implies that in the calibrated model, multinational firms' foreign affiliates are less financially constrained than domestic private firms in the South.

In the calibration, I also extend the quantitative model to explicitly model export platform sales and state-owned firms in China. The extensions allow better matching of the model with the data. I use the calibrated model for quantitative analysis.

Using the calibrated model, I will calculate the impact of a financial reform that alleviates financial frictions in the South, in economies with and without multinational firms. If the financial reform brings a larger increase in national income in the economy with (without) multinational firms, it implies that financial frictions cause a larger decline in national income in the economy with (without) multinational firms. Quantitatively, I find that when the economy is closed to multinational production, a modest financial reform increases national income in the South by 11%. When the economy is open to multinational production, the increase is much larger, about 19%.

I further decompose the increases in national income brought by the financial reform into increases in total output (GDP) and increases in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). Quantitatively, when the economy is closed to multinational production, the financial reform will increase GDP by 10% and $\frac{GNP}{GDP}$ by only 1%. When the economy is open to multinational production, the same financial reform will increase GDP by 11% and $\frac{GNP}{GDP}$ by 7%. Intuitively, when the economy is open to multinational production, since domestic firms still produce 76% of the output in the South, the financial reform will bring a slightly larger increase in GDP by allowing domestic firms to more efficiently produce goods that are complementary to the goods produced by multinational firms. At the same time, the financial reform will bring a much larger increase in $\frac{GNP}{GDP}$ by allowing domestic firms to compete on a more level playing field with multinational firms.

I also separately study the impact of the financial reform on domestic wages and firm profits in the South. I find that when the economy is open to multinational production, the financial reform will benefit domestic entrepreneurs disproportionately more than workers. Quantitatively, when the economy is closed to multinational production, the financial reform in the South will increase domestic wages by 9% and domestic firm profits by 10%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 11% but domestic firm profits by 23%. This much larger benefit of financial reform on domestic firm profits is consistent with our intuition: a better financial system will allow domestic firms to compete on a more level playing field with multinational firms, increasing domestic firms' market share and profits.

In the second part of this chapter, I argue that the quantitative result is robust if multinational production takes the form of both greenfield investment and foreign M&A. Recall in the theoretical analysis in Chapter 1, we show that when a developing economy is open to multinational production in the form of foreign M&A rather than greenfield investment, financial frictions could reduce national income through an additional channel, by reducing the acquisition prices paid by foreign firms. In the

second part of this chapter, I empirically verify this channel and show that financial frictions indeed cause declines in the acquisition prices paid by foreign firms. This additional channel only reinforce the result that financial frictions will cause a larger decline in national income after a developing economy opens up to multinational production. This means the quantitative result in the first part of this chapter, that financial frictions cause a larger decline in national income after a developing economy opens up to multinational production, still holds if multinational production takes the form of both greenfield investment and foreign M&A.

To empirically verify that financial frictions cause declines in the acquisition prices paid by foreign firms, I follow the method in Aguiar and Gopinath (2005) and study the foreign acquisitions in five countries that are hit hard by the East Asian financial crisis. I first replicate their results that firms with lower cash flow (as measured by lower EBITDA) and higher capital expenditure in the previous year are acquired at a lower price to book ratio in the crisis year of 1998. The effects are absent in non-crisis years. I further improve on their work to show the following results: First, in the crisis year of 1998, the negative effect of previous capital expenditure on acquisition price to book ratio becomes larger in sectors that rely more on external finance[1]. Second, in the crisis year of 1998, the positive effect of cash flow on acquisition price to book ratio becomes smaller in sectors that rely more on external finance. These empirical findings support the notion that financial frictions reduce the acquisition prices paid by foreign firms. To see this, notice in sectors that rely more on external finance, the same amount of free cash flow will be less useful in alleviating the firms' financial constraints and will hence have smaller effect in lifting the firms' acquisition prices. Similarly, in sectors that rely more on external finance, higher previous capital expenditure means the firms may have started capital investment projects that will rely more on external finance in the future, so increased financial constraints will cause larger declines in firms' acquisition prices.

[1]The measure of sector level dependence on external finance is from Rajan and Zingales (1998)

Related Literature

This chapter is closely related to the literature on finance and development. Buera, Kaboski, and Shin (2011, 2015) and Midrigan and Xu (2014) find that financial frictions significantly reduce national income in developing countries. These authors study financial frictions in closed-economy models. Manovo (2013) and Leibovici (2016) study the adverse impact of financial frictions in models with international trade. This chapter naturally extends the aforementioned papers to explicitly model multinational firms in developing countries. The main contribution of this chapter is that it shows quantitatively that compared with a developing economy that is closed to multinational production, financial frictions will cause a significantly larger decline in national income when the economy is open to multinational production. Such result calls for the increased importance of financial reforms in developing countries as they open up to multinational production. The empirical part of this chapter is based on Aguiar and Gopinath (2005). This chapter improves on their results by showing that the magnitudes of how cash flow and previous capital expenditure affect foreign acquisition prices during the East Asian financial crisis vary across sectors with different dependence on external finance. The finding supports the argument that lack of access to external finance cause declines in foreign acquisition prices during the East Asian financial crisis.

This chapter is also closely related to the literature on multinational production and its welfare implications. Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2017) find that after a developing economy opens up to multinational production, the increased competition from multinational firms could cause a significant decline in domestic firm profits.[2] I adopt a similar monopolistic competition framework (Melitz 2003) to model competition between domestic and multinational firms. I also explicitly model financial frictions. Several papers empirically identify that multinational

[2]Javorcik (2008) documents survey evidence showing that domestic firms in the Czech Republic and Latvia perceive FDI inflows into the same industry as bringing increased competition and loss of market share.

firms have better access to external finance than domestic firms in the host country (Desai, Foley, and Hines 2004, Desai, Foley, and Forbes 2008, Alfaro and Chen 2012, Manova, Wei, and Zhang 2015). For example, Desai, Foley, and Hines (2004) find that borrowing from international sources substitutes for approximately three-quarters of reduced external borrowing induced by capital market imperfections in the host country. The quantitative analysis in this chapter suggests that such better access to external finance is a significant advantage for the multinational firms when competing with domestic firms in developing countries. As a result, financial reforms in developing countries are very important in fostering competition and improving national income.

This chapter is also related to the literature on resource misallocation. Many scholars find that resource misallocation across heterogeneous firms cause significant declines in income in developing countries (Banerjee and Duflo 2005, Hsieh and Klenow 2009, Hopenhayn 2014). The general lesson from this chapter is that for distortions that create resource misallocation among domestic firms but not multinational firms, policies that remove these distortions become increasingly beneficial to national income in developing countries as they open up to multinational production.

2.2 Quantitative Model

I present the baseline quantitative model in this section. The quantitative model allows richer modeling characteristics and is more appropriate for quantitative analysis than the illustrative models in Chapter 1. In particular, the quantitative model is a dynamic model, so financially constrained entrepreneurs can overcome the financial constraints through forward looking saving behavior. The quantitative model is also a two-country model, and foreign firms have the option to export to the developing country as an alternative of setting up affiliates there. Even though the quantitative model has more ingredients than the illustrative models in Chapter 1, in the appendix, I verify numerically that the key theoretical results in Chapter 1 still hold

for the quantitative model in this chapter.

2.2.1 Consumers

There are two countries in the economy, North and South. The North represents the developed countries, and the South represents the developing countries. There is a measure N of infinitely-lived individuals in the North and a measure N^* of infinitely-lived individuals in the South. Throughout the rest of this chapter, variables with superscript star will indicate variables in the South. Consumer preference in the North is

$$U(c) = E\Big[\sum_{t=0}^{\infty} \beta^t \frac{1}{1-\rho} c_t^{1-\rho}\Big].$$

Here, c_t is consumption at time t. Consumer preference in the South is defined symmetrically

$$U^*(c^*) = E\Big[\sum_{t=0}^{\infty} \beta^t \frac{1}{1-\rho} c_t^{*1-\rho}\Big].$$

2.2.2 Producers

Individuals are heterogeneous in terms of entrepreneurial productivity. In each period, each individual will receive a productivity draw. With probability γ, the individual's productivity will remain unchanged from the last period. With probability $1-\gamma$, the individual will draw a new productivity from the following Pareto distribution

$$\mu(z) = 1 - \Big(\frac{z}{\bar{z}}\Big)^{-\theta}, \quad z \geq \bar{z} \quad \text{for individuals in North.}$$
$$\mu^*(z^*) = 1 - \Big(\frac{z^*}{\bar{z}^*}\Big)^{-\theta}, \quad z^* \geq \bar{z}^* \quad \text{for individuals in South.}$$

If the individual lives in the North, the lower bound for the productivity distribution is $\bar{z}$. If the individual lives in the South, the lower bound for the productivity distribution is $\bar{z}^*$. The difference between $\bar{z}$ and $\bar{z}^*$ represents the intrinsic productivity difference between the North and South. Empirically, $\bar{z} > \bar{z}^*$, so that entrepreneurs in the North are, on average, more productive than entrepreneurs in the South.

I will describe the individuals' problem in the North. Individuals in the South face symmetric problems. After receiving the productivity draw z, an individual will make an occupational choice. He will choose to either become a worker or an entrepreneur. If he chooses to become a worker, he will supply one unit of labor and receive a homogeneous wage w. If he chooses to become an entrepreneur, he will rent capital k and hire labor l to produce one distinct variety of intermediate good.

If an individual chooses to become an entrepreneur, he will face financial frictions in capital rental. The capital rental constraint is modeled as a collateral constraint of the following form[3]

$$Pk \leq \phi a.$$

Here, P is the price of the capital good. k is the amount of capital the entrepreneur rents. The constraint says that an entrepreneur's capital rental limit is determined by his wealth a and the financial development condition ϕ. Higher individual wealth a means the entrepreneur has more collateral. Better financial development (a larger ϕ) means that with each unit of collateral, the entrepreneur can rent more capital. I will specify the collateral constraints faced by different types of entrepreneurs in more detail later on.

All entrepreneurs will serve the domestic market. To serve the domestic market, an entrepreneur in the North will need to pay a fixed cost of domestic sales κ_H in units of domestic labor.

There are two ways for entrepreneurs to serve the foreign market: export or foreign direct investment (FDI). Firms that choose to conduct FDI are categorized as multinational firms, whereas firms that choose to export are not. If an entrepreneur chooses to export, he will need to pay a fixed cost of export κ_E in units of foreign labor. He also faces an iceberg trade cost when selling to the foreign market - in order to sell one unit of goods to the foreign market, $\tau > 1$ units of goods need to be

[3]Such a modeling technique of financial frictions is widely used in the literature; see Buera, Kaboski, and Shin 2015

shipped. If an entrepreneur chooses to conduct FDI to serve the foreign market, he will need to pay a fixed cost of FDI κ_D in units of foreign labor. The fixed cost of FDI is higher than the fixed cost of export, $\kappa_D > \kappa_E$. The foreign affiliate may not be as productive as the headquarters - the reason could be that the headquarters faces various frictions to transfer know-how to the foreign affiliate. However, the foreign affiliate will produce and sell locally and avoid the iceberg trade cost.[4]

There are competitive final goods producers in each country. The final goods producers in the North will take all the intermediate goods in the country to produce a final composite good in the North

$$Y = \Big(\int_{\Omega} y(\omega)^{\frac{\sigma-1}{\sigma}} \omega \Big)^{\frac{\sigma}{\sigma-1}}. \tag{2.1}$$

Here, Ω is the set of all intermediate goods in the North. The price index of the final good is defined in the standard way

$$P = \Big(\int_{\Omega} p(\omega)^{1-\sigma} d\omega \Big)^{\frac{1}{1-\sigma}}. \tag{2.2}$$

Here, $p(\omega)$ is the price for good $\omega \in \Omega$. The final good can be used for consumption in the country, and it can be used for investment and transform one for one into capital in that country. The final goods producers in the South are modeled in the same way. Note that due to trade frictions, the North and South have different intermediate goods, so the final composite goods in the two countries are also different.

2.2.3 Consumers' Problem

I will describe the consumers' problem in the North. The consumers' problem in the South is symmetric. An individual in the North is characterized by his productivity

[4]the modeling of FDI resembles greenfield investment - firms pay fixed costs and set up new production units abroad. I do not consider Merger and Acquisition (M&A) in the model. Empirically, the majority of FDI from developed countries to developing countries indeed takes the form of greenfield investment. From 2003 to 2015, 87% of total FDI inflow into the developing countries was greenfield (UNCTAD 2016, annex table 09 & annex table 19).

z and his wealth a. I allow individuals in any country to invest in both the North and South, so individual wealth a is defined as the value of domestic capital k and foreign capital k^* owned by the individual: $a = Pk + P^*k^*$.[5]

An individual with productivity z and wealth a will make an occupational choice of either becoming a worker (W) or an entrepreneur (N).

$$v(z,a) = \max_{\{W,N\}} \{v^W(z,a), v^N(z,a)\}. \tag{2.3}$$

The value of choosing an occupation $o \in \{W, N\}$ is

$$v^o(z,a) = \max_{\{c,a'\}} \frac{c_t^{1-\rho}}{1-\rho} + \beta E_{(z,a)} v'(z',a') \tag{2.4}$$

$$s.t.\ Pc + a' \leq I_{\{o=W\}} w + I_{\{o=N\}} \pi(z,a) + (1+r)a. \tag{2.5}$$

Here, r is the nominal interest rate the individual receives from investing his wealth for one period. $I_{\{o=W\}}$ and $I_{\{o=N\}}$ are indicator functions. Different occupations will give the individual different levels of income: If the individual chooses to become a worker ($I_{\{o=W\}} = 1$), he earns wage w. If the individual chooses to become an entrepreneur ($I_{\{o=N\}} = 1$), he earns firm profit $\pi(z,a)$. Given the occupational choice, the individual will choose consumption c and saving a' to maximize his value function.

2.2.4 Producers' Problem

I will describe the producers' problem in the North. The producers' problem in the South is symmetric. For an entrepreneur in the North, every period, he sells to the home market and, in addition, chooses whether and how to sell to the foreign market. Let $\pi_H(z, a_H)$ denote the profit of selling to the home market, $\pi_E(z, a_E)$ denote the profit of selling to the foreign market as an exporter, and $\pi_D(z, a_D)$ denote the profit

[5]Such assumption of international mobility is consistent with the finding in Caselli and Feyrer (2007). The authors find that international credit frictions do not play a major role in preventing capital flows from rich to poor countries.

of selling to the foreign market as a FDI investor, inclusive of all costs. These profit functions are explicitly derived below. Here a_H, a_E and a_D are the amount of collateral the entrepreneur uses to finance production for domestic sales, export sales and FDI sales, respectively. The entrepreneur's total profit from both domestic and foreign sales is

$$\pi(z,a) = \max_{\{a_H,a_E,a_D\}} \{\pi_H(z,a_H) + \max\{\pi_E(z,a_E), \pi_D(z,a_D), 0\}\} \tag{2.6}$$

$$s.t.\ a_H + a_E + a_D \leq a, \tag{2.7}$$

$$a_H \geq 0,\ a_E \geq 0,\ a_D \geq 0. \tag{2.8}$$

The term $\max\{\pi_E(z,a_E), \pi_D(z,a_D), 0\}$ in (2.6) suggests that the firm will optimally choose whether or not to serve the foreign market and, if so, whether to export or conduct FDI to serve the foreign market. (2.7) states that all the collateral the entrepreneur uses to finance domestic sales (a_H), export sales (a_E), and FDI sales (a_D) cannot exceed his total wealth, a.

For an entrepreneur in the North, his profit from domestic sales is

$$\pi_H(z,a_H) = \max_{\{k_H,l_H,p_H,y_H\}} p_H y_H - w l_H - R k_H - w\kappa_H \tag{2.9}$$

$$s.t.\ y_H = z k_H^{\alpha} l_H^{1-\alpha}, \tag{2.10}$$

$$y_H = \frac{p_H^{-\sigma}}{P^{1-\sigma}} X, \tag{2.11}$$

$$\frac{P k_H}{\phi} \leq a_H. \tag{2.12}$$

Here, z is the productivity of the entrepreneur, and a_H is the amount of collateral the entrepreneur uses to finance production for domestic sales. κ_H is the fixed cost of domestic sales in units of domestic labor. w and R are wage and rental rate in the North. (2.10) is the firm's production function. k_H and l_H are capital and labor used in production for domestic sales. (2.11) is the demand faced by the firm. p_H is the price the firm charges in the domestic market, and X is the domestic absorption in the

North. (2.12) is the financial constraint. ϕ controls the level of financial development in the North. As ϕ grows larger, with the same amount of collateral a_H, the maximum amount of capital the firm can rent will be higher.

For an entrepreneur in the North who chooses to export, his profit from export sales is

$$\pi_E(z, a_E) = \max_{\{k_E, l_E, p_E, y_E\}} p_E y_E - w l_E - R k_E - w^* \kappa_E \tag{2.13}$$

$$s.t.\ y_E = \frac{z}{\tau} k_E^{\alpha} l_E^{1-\alpha}, \tag{2.14}$$

$$y_E = \frac{p_E^{-\sigma}}{P^{*1-\sigma}} X^*, \tag{2.15}$$

$$\frac{P k_E}{\phi} \leq a_E. \tag{2.16}$$

Here, z is the productivity of the entrepreneur, and a_E is the amount of collateral the entrepreneur uses to finance production for export sales. κ_E is the fixed cost of domestic sales in units of foreign labor. w^* is the wage in the South. (2.14) is the firm's production function. k_E and l_E are the capital and labor used in production for export sales. $\tau \geq 1$ is the iceberg trade cost faced by the firm when exporting to the foreign market. (2.15) is the demand faced by the firm. p_E is the price the firm charges in the foreign market, and X^* is the domestic absorption in the South. (2.16) is the financial constraint.

For an entrepreneur in the North who chooses to conduct FDI, his profit from FDI sales is

$$\pi_D(z, a_D) = \max_{\{k_D, l_D, p_D, y_D\}} p_D y_D - w^* l_D - R^* k_D - w^* \kappa_D \tag{2.17}$$

$$s.t.\ y_D = \xi z k_D^{\alpha} l_D^{1-\alpha}, \tag{2.18}$$

$$y_D = \frac{p_D^{-\sigma}}{P^{*1-\sigma}} X^*, \tag{2.19}$$

$$\frac{P^* k_D}{\tilde{\phi}} \leq a_D. \tag{2.20}$$

Here, z is the productivity of the entrepreneur, and a_D is the amount of collateral the entrepreneur uses to finance production for FDI sales. κ_D is the fixed cost of FDI in units of foreign labor. w^* and R^* are wage and rental rate in the South. (2.19) is the demand faced by the firm. p_D is the price charged by the foreign affiliate in the foreign market, and X^* is the domestic absorption in the South.

(2.18) is the production function of the foreign affiliate. k_D and l_D are the capital and labor used in production for FDI sales. Note that the productivity of the foreign affiliate is just a fraction ξ of the productivity of the headquarters, $0 \leq \xi \leq 1$. The reason for this could be that the headquarters faces various frictions in transferring know-how to the foreign affiliate.

(2.20) is the financial constraint faced by the firm. The parameter $\tilde{\phi}$ is defined as a convex combination of the financial development condition in the North (ϕ) and the financial development condition in the South (ϕ^*).

$$\tilde{\phi} = v_\phi \phi + (1 - v_\phi)\phi^*, \;\; 0 \leq v_\phi \leq 1. \tag{2.21}$$

Empirically, the financial development in the North is better than that in the South, so $\phi > \phi^*$. v_ϕ is a parameter between 0 and 1. When $v_\phi = 1$, $\tilde{\phi} = \phi$, so the affiliate faces the same borrowing constraint as the headquarters in the North. When $v_\phi = 0$, $\tilde{\phi} = \phi^*$, so the affiliate faces the same borrowing constraint as the domestic firms in the South.

Given such model setup, the multinational firms' affiliates in the South enjoy better access to external finance than the domestic firms in the South for two reasons: First, the affiliates can rent more capital with each unit of collateral the entrepreneurs post ($\tilde{\phi} \geq \phi^*$). Second, productive entrepreneurs in the North can rely on the better financial system in the North to quickly accumulate sufficient wealth and use it as collateral to finance the foreign affiliates.

I briefly discuss the trade-offs between export and FDI for an entrepreneur in the North. On the one hand, FDI requires a larger fixed cost than export ($\kappa_D > \kappa_E$).

Foreign affiliates are also more borrowing-constrained than the headquarters ($\tilde{\phi} \leq \phi$)[6]. On the other hand, FDI could feature lower variable costs - even though the foreign affiliate in the South is not as productive as the headquarters, the much cheaper labor in the South and the ability to avoid trade costs could make the variable production costs lower for the foreign affiliates. Such trade-offs imply that more-productive and financially less-constrained firms are more likely to conduct FDI. Intuitively, more-productive firms sell more goods and benefit more from the lower variable costs. Financially less-constrained firms can better reach the optimal scale of operation and take full advantage of the lower variable costs.[7]

For an entrepreneur in the South, however, since the observed wage in the North is much higher than that in the South, FDI could actually feature a higher variable cost compared with export. Given that FDI also features a higher fixed cost, the firms in the South will optimally choose export over FDI to serve the market in the North. This is consistent with the observation that developing countries mainly serve as targets rather than sources of FDI (Antràs and Yeaple 2014).

A country's total output, or GDP, is defined as the output produced by both domestic and foreign firms in the country. A country's national income, or GNP, is defined as the income of residents in the country, including the income from capital rentals, wages (workers) and firm profits (domestic entrepreneurs).

2.2.5 Stationary Competitive Equilibrium

I will study the stationary competitive equilibrium of the model. A stationary competitive equilibrium is defined as an invariant distribution of wealth and productivity $G(z, a)$; policy functions c, a', o, l_H, k_H, a_H, l_E, k_E, a_E, l_D, k_D, a_D, p_H, p_E, p_D,

[6]The constraint (2.7) can be written as $\frac{Pk_H}{\phi} + \frac{Pk_E}{\phi} + \frac{P^*k_D}{\tilde{\phi}} \leq a$. A financially-constrained entrepreneur in the North will need to allocate his wealth a to finance k_H, k_E and k_D. Since $\tilde{\phi} \leq \phi$, borrowing the same amount of capital in the foreign affiliate will take more collateral than borrowing in the headquarters.

[7]Multinational firms are among the most productive firms in the source country (Girma, Kneller, and Pisu 2005, Tomiura 2007, Antràs and Yeaple 2014).

y_H, y_E, and y_D; and prices w, R, P, and $r = R/P + 1 - \delta$ in the North; and the symmetric invariant distribution, policy functions and prices in the South, such that in both countries:

- Consumers maximize utility, as in (2.3) to (2.5).
- Producers maximize profit, as in (2.6) to (2.8).
- Aggregate output and price index defined as in (2.1) and (2.2).
- Labor, capital, and goods markets clear in the North and the South.

Even though the quantitative model has more ingredients than the illustrative models in Chapter 1, in the appendix, I show numerically that the key theoretical results in Chapter 1 still hold for this quantitative model.

2.3 Quantitative Analysis

In this section, I will extend the baseline quantitative model in Section 2.2 and calibrate the extended model. I will then use the calibrated model to conduct a quantitative analysis.

2.3.1 Model Extensions

I will extend the model in two ways to allow a better match of the model with the data. First, multinational firms' foreign affiliates export a significant share of their output to foreign markets. I will extend the model to take into account such export platform sales. Second, the state-owned firms in China enjoy generous subsidies from the government. I will extend the model to take into account these state-owned firms.

2.3.1.1 Export Platform Sales

Multinational firms' foreign affiliates export a significant share of their output to foreign markets. For the affiliates of U.S. multinational firms, 55% of the sales stay in the host country, and 45% are exported to other markets[8] (Antràs and Yeaple 2014). In China, 51% of the foreign affiliates' sales stay in China, while the other 49% are exported.

I model export platform sales in the following way. For multinational firms' affiliates in the South, in addition to serving the local market in the South, the affiliates can export back to the North, but only to a fraction s_L of consumers in the North. This means that for every multinational firm that chooses to conduct export platform sales, the headquarters will still serve a $1-s_L$ fraction of the consumers in the North, and the foreign affiliate will serve the other s_L fraction of consumers in the North. If $s_L = 0$, we are back to the case without export platform sales. If $s_L = 1$, the foreign affiliate can export back to the entire home market in the North. I assume firms face no additional fixed cost when conducting export platform sales. The foreign affiliates also face no iceberg trade cost when exporting back to the home market. In the appendix, I present a calibration of the model when affiliates face iceberg trade cost when selling back to the home market, and our results remain robust.

For different entrepreneurs in the North, the s_L fraction of consumers they can serve with the foreign affiliates will be random and independent of each other. This modeling assumption implies that for the final goods producers in the North, when they purchase intermediate goods from the firms that conduct export platform sales, they will obtain the goods produced by the headquarters from a random $1-s_L$ fraction of the firms and will obtain the goods produced by the foreign affiliates from the other s_L fraction of firms. As a result, all final goods producers will obtain intermediate goods of the same quality, so they will produce the same final composite good.

[8]Of the 45% of sales that are exported, 34% are exported to foreign markets other than the U.S., and only 11% of the sales are exported back to the U.S. (Antràs and Yeaple 2014)

Given the additional option of export platform sales, I describe the producers' problem in the North. Producers in the South face the symmetric problem. In the calibrated model, since the observed wage is much higher in the North than in the South, firms in the South will optimally choose not to conduct either FDI or export platform sales.

For an entrepreneur in the North who chooses to conduct export platform sales, the foreign affiliate's profit from exporting back to the home market is

$$\pi_L(z, a_L) = \max_{\{k_L, l_L, p_L, y_L\}} p_L y_L - w^* l_L - R^* k_L \tag{2.22}$$

$$s.t.\ y_L = \xi z k_L^{\alpha} l_L^{1-\alpha}, \tag{2.23}$$

$$y_L = \frac{p_L^{-\sigma}}{P^{1-\sigma}} s_L X, \tag{2.24}$$

$$\frac{P^* k_L}{\tilde{\phi}} \leq a_L. \tag{2.25}$$

Here, z is the productivity of the entrepreneur, and a_L is the collateral used to finance production for export platform sales. (2.23) is the production function. k_L and l_L are capital and labor used by the foreign affiliate to produce and export back to the North. (2.24) is the demand faced by the firm. p_L is the price the firm charges for export platform sales, and X is the domestic absorption in the North. The firm can only access a fraction s_L of the consumers in the North. (2.25) is the financial constraint. Recall that the foreign affiliate's access to external finance is controlled by the parameter $\tilde{\phi}$, as defined in (2.21).

When the entrepreneur chooses to conduct export platform sales, the headquarters will only serve a $1 - s_L$ fraction of consumers in the North. The profit of the

headquarters from domestic sales is

$$\pi_{H'}(z, a_{H'}) = \max_{\{k_{H'}, l_{H'}, p_{H'}, y_{H'}\}} p_{H'} y_{H'} - w l_{H'} - R k_{H'} - w\kappa_H \tag{2.26}$$

$$s.t.\ y_{H'} = z k_{H'}^{\alpha} l_{H'}^{1-\alpha}, \tag{2.27}$$

$$y_{H'} = \frac{p_{H'}^{-\sigma}}{P^{1-\sigma}}(1 - s_L)X, \tag{2.28}$$

$$\frac{P k_{H'}}{\phi} \leq a_{H'}. \tag{2.29}$$

Here, z is the productivity of the entrepreneur, and $a_{H'}$ is the collateral used to finance production for the headquarters' sales. (2.27) is the production function. $k_{H'}$ and $l_{H'}$ are capital and labor used by the headquarters. (2.28) is the demand faced by the headquarters. $p_{H'}$ is the price the headquarters charges, and X is the domestic absorption in the North. The headquarters will only serve a $1 - s_L$ fraction of the consumers in the North. (2.29) is the financial constraint.

Given this additional option of export platform sales, the entrepreneur will optimally choose to serve only the home market, to export, to conduct FDI, or to conduct FDI and export platform sales. The entrepreneur's profit is

$$\pi(z, a) = \max_{\{a_H, a_E, a_D, a_P, a_{H'}\}} \big\{\pi_H(z, a_H) + \max\{\pi_E(z, a_E), \pi_D(z, a_D), 0\},$$
$$\pi_{H'}(z, a_{H'}) + \pi_D(z, a_{D'}) + \pi_L(z, a_L)\big\} \tag{2.30}$$

$$s.t.\ a_H + a_E + a_D \leq a, \tag{2.31}$$

$$a_{H'} + a_{D'} + a_L \leq a, \tag{2.32}$$

$$a_H \geq 0,\ a_E \geq 0,\ a_D \geq 0,\ a_{H'} \geq 0,\ a_{D'} \geq 0,\ a_P \geq 0. \tag{2.33}$$

The first term in (2.30), $\pi_H(z, a_H) + \max\{\pi_E(z, a_E), \pi_D(z, a_D), 0\}$, is the same as in (2.6), and it represents the firm's profit without the option of export platform sales. The second term in (2.30), $\pi_{H'}(z, a_{H'}) + \pi_D(z, a_D) + \pi_L(z, a_P)$ is the firm's profit when the firm chooses to conduct FDI and export platform sales. (2.31) and (2.32) state that the total collateral the entrepreneur posts cannot exceed his total wealth a.

2.3.1.2 State-owned Firms

In China, state-owned firms produce approximately 18% of the total manufacturing output.[9] The state-owned firms enjoy generous subsidies from the government. I model state-owned firms in the following way: For a small f_{SOE} fraction of individuals in the South, if they choose to become entrepreneurs, the firms they operate will not be financially constrained. Instead, those firms will enjoy sales subsidies and capital rental subsidies.

For an entrepreneur in the South who runs a state-owned firm, his profit from domestic sales is

$$\pi^*_{H,S}(z^*) = \max_{\{k^*_{H,S}, l^*_{H,S}, p^*_{H,S}, y^*_{H,S}\}} (1+\iota^Y_S) p^*_{H,S} y^*_{H,S} - w^* l^*_{H,S} - R^*_S k^*_{H,S} - w^* \kappa^*_H \tag{2.34}$$

$$s.t.\ y^*_{H,S} = z^* {k^*_{H,S}}^{\alpha} {l^*_{H,S}}^{1-\alpha}, \tag{2.35}$$

$$y^*_{H,S} = \frac{{p^*_{H,S}}^{-\sigma}}{{P^*}^{1-\sigma}} X^*, \tag{2.36}$$

$$R^*_S = (1-\iota^K_S) R^*. \tag{2.37}$$

Here, $\iota^Y_S > 0$ in (2.34) is the sales subsidy to the state-owned firm. $\iota^K_S > 0$ in (2.37) is the capital rental subsidy to the state-owned firm. The state-owned firms are not financially constrained. Instead, their capital rental rate is lower than that of other domestic firms. (2.35) is the production function for domestic sales. $k^*_{H,S}$ and $l^*_{H,S}$ are the capital and labor used in production for domestic sales. (2.36) is the demand faced by the firm. $p^*_{H,S}$ is the price charged by the firm in the domestic market, and X^* is the domestic absorption in the South.

For an entrepreneur in the South who runs a state-owned firm and chooses to

[9] I rely on the data in the Chinese Industrial Survey (2005), among others, to obtain this number. I show the details in the appendix.

export, his profit from export sales is

$$\pi^*_{E,S}(z^*) = \max_{\{k^*_{H,S}, l^*_{H,S}, p^*_{H,S}, y^*_{H,S}\}} p^*_{E,S} y^*_{E,S} - w^* l^*_{E,S} - R^*_S k^*_{E,S} - w\kappa^*_E \tag{2.38}$$

$$s.t.\ y^*_{E,S} = \frac{z^*}{\tau^*} {k^*_{E,S}}^{\alpha} {l^*_{E,S}}^{1-\alpha}, \tag{2.39}$$

$$y^*_{E,S} = \frac{{p^*_{E,S}}^{-\sigma}}{P^{1-\sigma}} X, \tag{2.40}$$

$$R^*_S = (1 - \iota^K_S) R^*. \tag{2.41}$$

(2.41) suggests that the firm still enjoys capital rental subsidies when exporting to the foreign market. However, the sales subsidy ι^Y_S no longer applies for export sales - frictions such as international trade rules make the Chinese government less capable to directly subsidize the sales of state-owned firms in the foreign markets than in the domestic market.[10] (2.39) is the production function for export sales. $\tau^* > 1$ is the iceberg trade cost. $k_{E,S}$ and $l_{E,S}$ are capital and labor used in the production for export. (2.40) is the demand faced by the firm. $p^*_{E,S}$ is the price charged by the firm, and X is the domestic absorption in the North.

Similarly, if an entrepreneur who runs a state-owned firm chooses to conduct FDI or export platform sales, the foreign affiliate of the state-owned firm will also enjoy the capital rental subsidy ι^K_S but not the sales subsidy ι^Y_S. However, in the calibrated model, since the observed wage is much higher in the North than in the South, firms in the South will optimally choose not to conduct FDI or export platform sales.

The sales and capital rental subsidies will be financed by a proportional income tax on domestic residents in the South. The tax rate ι^* is such that the government

[10]Such a modeling of the capital rental and sales subsidies is motivated by two empirical observations. First, the sales per unit of capital for state-owned firms is much lower than that for private firms. Second, the state-owned firms' export intensity, measured by the exports as a fraction of sales, is much lower than that of private firms. The first observation is consistent with our assumption on capital rental subsidies to state-owned firms. The second observation is consistent with our assumption on domestic sales subsidies to state-owned firms.

budget balances

$$f_S \int \left(\iota_S^K R^* k_{H,S}^* + \iota_S^K R^* k_{E,S}^* + \iota_S^Y p_{H,S}^* y_{H,S}^*\right) dG_S^*(z^*, a^*) \tag{2.42}$$

$$= \iota^*(1 - f_S) \int \left(I_{\{o^*=W\}} w^* + I_{\{o^*=E\}} \pi^*(z^*, a^*)\right) dG^*(z^*, a^*) \tag{2.43}$$

$$+ \iota^* f_S \int \left(I_{\{o_S^*=W\}} w^* + I_{\{o_S^*=E\}} \pi_S^*(z^*, a^*)\right) dG_S^*(z^*, a^*). \tag{2.44}$$

The term in (2.42) is the total amount of subsidies spent by the government, assuming that the state-owned firms do not conduct FDI or export platform sales. The combination of the terms in (2.43) and (2.44) is the total tax revenue collected by the government. Recall that f_S is the fraction of individuals in the South who can run state-owned firms. $G^*(z^*, a^*)$ is the joint cumulative probability distribution of productivity and wealth for individuals in the South who are capable of running private firms in the South. $G_S^*(z^*, a^*)$ is the joint cumulative probability distribution of productivity and wealth for individuals in the South who are capable of running state-owned firms in the South. $\pi^*(z^*, a^*)$ is the profit of entrepreneurs in the South who run private firms. $\pi_S^*(z^*, a^*)$ is the profit of entrepreneurs in the South who run state-owned firms.

2.3.1.3 Stationary Competitive Equilibrium

Given these extensions, the stationary competitive equilibrium is defined in a very similar way as in Section (2.2.5). A stationary competitive equilibrium is defined as an invariant distribution of productivity and wealth $G(z, a)$; policy functions c, a', o, l_H, k_H, a_H, l_E, k_E, a_E, l_D, k_D, a_D, l_L, k_L, a_L, $l_{H'}$, $k_{H'}$, $a_{H'}$, $a_{D'}$, p_H, p_E, p_D, p_L, $p_{H'}$, $p_{D'}$, y_H, y_E, y_D, y_L, $y_{D'}$ and $y_{H'}$; and prices w, R, P, and $r = R/P + 1 - \delta$ in the North; the symmetric invariant distribution, policy functions and prices for individuals in the South who are capable of running private firms; and the symmetric invariant distribution, policy functions and prices for individuals in the South who are capable of running state-owned firms, such that in both countries:

- Consumers maximize utility, as in (2.3) to (2.5)..
- Producers maximize profit, as in (2.30) to (2.33).
- Aggregate output and price index defined as in (2.1) and (2.2).
- Government budget balance in the South, as in (2.42) to (2.44).
- Labor, capital, and goods markets clear in the North and the South.

2.3.2 Calibration

I now discuss the calibration and identification of the model parameters. In the calibration, I will focus on the manufacturing sector only. One reason to focus on the manufacturing sector is that financial frictions have a much larger impact on manufacturing than service due to higher fixed costs in the manufacturing sector (Buera, Kaboski, and Shin 2011).

I consider countries in the World Input Output Database (WIOD 2005). There are 24 countries and regions in the WIOD whose GDP per capita in 2005 exceeds 50% of the U.S. level. I group these 24 countries and regions into a single country, the North. Table 2.1 is a list of countries and regions included in the North. I choose a single country, China, as the South.

Table 2.1: Countries Included in the North

Australia, Austria, Belgium, Canada, Switzerland, Cyprus, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Slovenia, Sweden, Taiwan, United States

Note that the countries in the North include all major developed countries in the world. These countries include all of China's major trading partners and FDI sources.[11]

[11]Export to the 24 countries in the North would be responsible for 90% of China's total exports to all 43 countries in WIOD. From the UNCTAD FDI statistics (UNCTAD 2014), if we exclude the

The parameters in Table 2.2 are read directly from the data or the literature. In the calibrated model, the choice of $\sigma = 4$ would imply a profit share of total output at 15%. The choice of $\gamma = 0.89$ would imply a firm death rate of approximately 10%. The choice of $\beta = 0.92$ would imply a real interest rate of approximately 4%.[12] I normalize the population in the North, N, to be 1. The population in the South, N^*, is computed by comparing the number of manufacturing workers in the North and the South. The iceberg trade cost is simply computed as tariffs plus maritime trade costs.[13] The computational details are in the appendix.

Table 2.2: Parameters From Data & Literature

Parameter Value	Source
$\sigma = 4$	Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2017)
$\rho = 1.5$	Buera, Kaboski, and Shin (2011)
$\delta = 0.1$	Buera, Kaboski, and Shin (2011)
$\gamma = 0.89$	Buera, Kaboski, and Shin (2011)
$\beta = 0.92$	Buera, Kaboski, and Shin (2011)
$N = 1$	Number of Manufacturing Workers
$N^* = 1.53$	Number of Manufacturing Workers
$\tau = 1.09$	Tariff Profile & Maritime Trade Cost Database
$\tau^* = 1.09$	Tariff Profile & Maritime Trade Cost Database

I will calibrate the other parameters by matching the model moments with the data moments. Table 2.3 shows the calibrated parameters and the moments being matched. The data moments come from various sources. In particular, a key data set is the Chinese Industrial Survey (2005). The Chinese Industrial Survey covers all state-owned firms and non-state firms with revenue above 5,000,000 yuan (approximately

FDI from Hong Kong, Macau and tax heavens such as the Cayman Islands and the British Virgin Islands, the majority (85%) of the remaining FDI will be from the 24 developed countries in the North.

[12]The discount rate $\beta = 0.92$ is read directly from Buera, Kaboski, and Shin (2011) and is on the low end of what the literature uses. To address the concern that this discount rate is too low, I redo the calibration with $\beta = 0.94$ in the appendix, and the key quantitative results remain unchanged.

[13]I read tariffs from WTO tariff profiles and maritime trade costs from the Maritime Trade Cost Database. The simple sum of tariffs and maritime trade costs may underestimate the iceberg trade cost. To address this concern, in the appendix, I redo the calibration with the iceberg trade cost more than doubled ($\tau = \tau^* = 1.2$), and the main results remain unchanged.

$600,000 in 2005). The survey contains information on firm sales, capital and labor, among others. The survey also contains information on paid-up capital owned by the state, foreigners and various other sources. Details on how I compute the data moments in Table 2.3 are presented in the appendix.

Note that all the model parameters will jointly determine all the model moments. In Table 2.3, however, I try to map the parameters to the most relevant data moments that help identify the parameters. I discuss the identification of these parameters below.

Table 2.3: Parameters from Calibration

Parameter	Moment	Data	Model
$\bar{z} = 1$	North Manufacturing Output	1	1
$\bar{z}^* = 0.33$	South Manufacturing Output	0.13	0.13
$\kappa_H = \kappa_H^* = 10$	Average Establishment Size in U.S.	43	44
$\phi = 5.5$	North Private Credit to Output	1.50	1.50
$\phi^* = 1.55$	South Private Credit to Output	1.10	1.13
$v_\phi = 0.73$	Sales to Capital Ratio, FPE Relative to DPE	0.89	0.90
$\xi = 0.36$	Sales of FPE Relative to DPE	17	16
$\kappa_D = 125$	MF Share of Output in the South	24%	24%
$\kappa_E = 16$	North Export / South Output	21%	20%
$\kappa_E^* = 30$	South Export / South Output	31%	31%
$s_L = 0.10$	Export Intensity of Foreign Affiliates	49%	49%
$f_S = 0.0006$	South SOE Output / South Output	18%	18%
$\iota_S^K = 0.09$	Sales to Capital Ratio, SOE Relative to DPE	0.49	0.49
$\iota_S^Y = 0.64$	Export Intensity, DPE Relative to SOE	1.38	1.38
$\theta = 9$	Top 20% Wealth Share North	85%	88%
$\alpha = 0.5$	Capital Share of Output in U.S.	0.35	0.35

The levels of foreign affiliate productivity, ξ, and fixed cost of FDI, κ_D, are disciplined by the following two data moments: First, multinational firms' affiliates' sales are, on average, 17 times larger than the sales of domestic private firms in China. Second, domestic firms still produce 76% of the manufacturing output in China. These observations imply that in the model, while multinational firms' affiliates are relatively productive, the fixed cost of FDI is also high, so that only a small number of firms in the North will set up foreign affiliates. Numerically, to match the data moment that multinational firms produce 24% of the manufacturing output, we need

a combination of either high ξ and high κ_D, or low ξ and low κ_D. The exact combination of ξ and κ_D is then pinned down by the data moment that the average sales of the affiliates of multinational is 17 times larger than that of domestic private firms in China.

The financial development conditions in the two countries, ϕ and ϕ^*, are calibrated to match the private credit to output ratio in the North and the South. Numerically, as ϕ (ϕ^*) gets larger, the private credit to output ratio in the North (South) gets larger. The parameter controlling affiliates' access to external finance, v_ϕ, is disciplined by the following data moment: The average output per unit of capital for multinational firms' affiliates in China is only 90% of that for domestic private firms. This data moment implies that in the model, multinational firms' foreign affiliates are on average less financially constrained than domestic private firms in the South. Numerically, as v_ϕ gets larger, affiliates of multinational firms are less financially constrained, but at the same time, more financially constrained firms will choose to conduct FDI instead of export, making the effect of v_ϕ on the data moment ambiguous.

The other parameters are identified as follows: I normalize the lower bound of productivity in the North, $\bar{z} = 1$. The lower bound of productivity in the South, $\bar{z}^*$, is calibrated to match the ratio of manufacturing output in the South to that in the North. Numerically, as $\bar{z}^*$ gets higher, the output in the South relative to that of the North gets larger. The fixed cost of domestic sales, κ_H, is calibrated to match the average number of employees for establishments in the U.S. Numerically, as κ_H gets larger, the average firm size gets larger. For simplicity, I assume $\kappa_H^* = \kappa_H$. The fixed costs of export κ_E and κ_E^* are calibrated to match the share of value-added exports in total output in the North and the South. Numerically, as κ_E (κ_E^*) gets larger, exports as a share of total output becomes smaller in the North (South). The fraction of consumers that foreign affiliates can serve by conducting export platform sales, s_L, is calibrated by matching the export intensity of foreign affiliates in the South. Numerically, as s_L gets larger, affiliates' export intensity becomes larger. The share of individuals who run state-owned firms in the South, f_S, is calibrated to match

the share of output produced by state-owned firms in China. Numerically, as f_S gets larger, the share of output produced by state-owned firms gets larger. The capital rental subsidy ι_S^K is calibrated to match the ratio of average sales per unit of capital for state-owned firms to that of domestic private firms in China. Numerically, as ι_S^K gets larger, the sales per unit of capital for state-owned firms gets smaller relative to that of domestic private firms. The domestic sales subsidy ι_S^Y is calibrated to match the ratio of export intensity of state-owned firms to that of domestic private firms in China. Numerically, as ι_S^Y gets larger, the export intensity of state-owned firms gets smaller relative to that of domestic private firms. The parameter controlling the shape of the productivity distribution, θ, is calibrated to match the top 20% share of wealth in the U.S. Numerically, as θ gets larger, the top wealth share gets smaller.[14] The capital share in the production function, α, is calibrated to match the capital share of output in the U.S. Numerically, a higher α indicates a higher capital share of output.

2.3.3 Quantitative Results

Using the calibrated model, I will calculate the impact of a financial reform that reduces financial frictions in South, in economies with and without multinational firms. The economy without multinational firms corresponds to an economy where the fixed cost of FDI, κ_D, is infinite. The financial reform will improve ϕ^*, the financial development condition in the South, from 1.55 to 2. To get an idea of the magnitude of the financial reform, the financial reform will improve the private credit to output ratio in the South from 1.1 to 1.3.[15] If the financial reform brings a larger increase in national income in the economy with (without) multinational firms, it implies

[14] A larger θ will imply less dispersion of productivity, less concentration of wealth and a smaller top wealth share. $\theta = 9$ will still generate top 1% and 10% wealth shares that are higher than in reality, but it will match the top 20% wealth share reasonably well. We use $\theta = 9$ here, as it is already on the high end of what the literature typically uses.

[15] In the appendix, I show that the key quantitative results are robust if we change the magnitude of the financial reform.

that financial frictions cause a larger decline in national income in the economy with (without) multinational firms.

Table 2.4 shows the increases in GNP in the South brought by the financial reform. When the economy is closed to multinational production, the financial reform will increase GNP by 11.3%. When the economy is open to multinational production, the same financial reform will increase GNP by 18.7%.[16] The results indicate that when the developing economy is open to multinational production, the financial reform brings a significantly larger increase in national income than in the otherwise identical economy that is closed to multinational production.

Table 2.4 also decomposes the increases in GNP brought by the financial reform into increases in GDP and increases in $\frac{GNP}{GDP}$. When the economy is closed to multinational production, the financial reform will increase GDP by 9.6% and $\frac{GNP}{GDP}$ by 1.4%. When the economy is open to multinational production, the same financial reform will increase GDP by 10.6% and $\frac{GNP}{GDP}$ by 7.4%. Intuitively, when the economy is open to multinational production, since domestic firms still produce 76% of the output in the South, the financial reform will bring a slightly larger increase in GDP by allowing domestic firms to more efficiently produce goods that are complementary to the goods produced by multinational firms. At the same time, the financial reform will bring a much larger increase in $\frac{GNP}{GDP}$ by allowing domestic firms to compete on a more level playing field with multinational firms.

Table 2.5 shows the increases in domestic wages and domestic firm profits in the South brought by the financial reform. When the economy is closed to multinational

[16]Readers might notice in Table 2.4, after the economy opens up to multinational production, there is a decline in national income in the South. This is due to two reasons: First, multinational production is modeled as a substitute for exports, so opening up to multinational production does not bring new varieties of intermediate goods, as opposed to our illustrative model. Second, multinational firms compete with multinational firms and can crowd out domestic firms. These two effects together mean that opening up to multinational production could lead to a decline in GNP and GDP. This is consistent with the finding in Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2017). I discuss this result in more detail one of the robustness checks. In particular, in the robustness check, I show that if opening up to multinational production brings significant amount of technology diffusion to entrepreneurs in the South, then opening up to multinational production will increase GNP and GDP in the South. Our main results are robust to different magnitudes of technology diffusion.

Table 2.4: Benefits of Financial Reform in Calibrated Model

		Without MF	With MF
Before Reform	GNP	453	395
	GDP	450	445
	GNP/GDP	1.01	0.89
After Reform	GNP	504	469
	GDP	493	492
	GNP/GDP	1.02	0.95
Percentage Change	GNP	11.3%	18.7%
	GDP	9.6%	10.6%
	GNP/GDP	1.4%	7.4%

Table 2.5: Benefits of Financial Reform on Domestic Wages and Firm Profits

		Without MF	With MF
Before Reform	wage	220	211
	profit	71	56
After Financial Reform	wage	240	234
	profit	78	69
Percentage Change	wage	9.1%	10.9%
	profit	9.9%	23.2%

production, the financial reform in the South will increase domestic wages by 9.1% and domestic firm profits by 9.9%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 10.9% but domestic firm profits by 23.2%. This much larger benefit of financial reform on domestic firm profits is consistent with our intuition: a better financial system will allow domestic firms to compete on a more level playing field with multinational firms, increasing domestic firms' market share and profits. The results indicate that when the developing economy is open to multinational production, the financial reform will benefit domestic entrepreneurs disproportionately more than workers

The quantitative results in Table 2.4 and 2.5 indicate that when the developing economy is open to multinational production, the financial reform will bring significantly larger increases in domestic firm profits and national income than in an otherwise identical economy that is closed to multinational production. The policy implication is that financial reforms become increasingly beneficial to national in-

come in developing countries as they open up to multinational production. When the economy is open to multinational production, financial reforms will improve national income through two channels. First, a better financial system ensures that domestic firms can more efficiently produce goods that are complementary to the goods produced by multinational firms and will consequently improve total output (GDP). Second, a better financial system also ensures that domestic firms can compete on a more level playing field with multinational firms and will consequently improve the domestic firms' market share and, hence, the share of total output paid to domestic residents ($\frac{GNP}{GDP}$).

2.4 Empirical Analysis

In the quantitative model, multinational production takes the form of greenfield investment. In this section, I empirically show that when multinational production takes the form of foreign M&A, financial frictions will reduce the acquisition prices paid by foreign firms. Recall in the theoretical analysis in Chapter 1, we show that when the developing economy is open to multinational production in the form of foreign M&A rather than greenfield investment, financial frictions could reduce national income through an additional channel by reducing the acquisition prices paid by foreign firms. This chapter verifies the existence of such channel empirically. The result suggests that as a developing economy opens up to foreign M&A rather than greenfield investment, financial frictions will cause an even larger decline in national income. This means the quantitative result in this chapter, that financial frictions cause a larger decline in national income as a developing economy opens up to multinational production, still holds if multinational production takes the form of both greenfield investment and foreign M&A.

The empirical strategy follows from Aguiar and Gopinath (2005). In particular, I follow Aguiar and Gopinath (2005) to use the East Asian financial crisis as a shock of sudden deterioration in external financial conditions, so firms face a sudden and

unexpected increase in financial frictions. I focus on five countries that are hit hardest by the East Asian financial crisis - Malaysia, Indonesia, Thailand, South Korea, and Philippines. I study all the merger and acquisitions in these countries with the acquisition target being a domestic firm in these five countries and the acquirer being a foreign firm owned by foreigners outside of these five countries. I use data from Securities Data Company (SDC) Plantinum M&A database. The data spans from 1986 to 2007, and I use 1998 as the crisis year when the shock to external financial condition occurs. For each M&A, we observe the acquisition price to book ratio and other balance sheet items for the target firm. Since we will need balance sheet items to perform our regression tests, the sample is weighted towards public-traded firms.

The first regression aims to replicate the results in Aguiar and Gopinath (2005)[17]. In particular, I run the following regression test I

$$p_{ijct} = \alpha_0 + \alpha X_{ijct} + \beta X_{ijct} * D_{98} + \gamma D_{jct} + \epsilon_{ijct}. \tag{2.45}$$

Here p_{ijct} is the log price to book ratio for firm i in industry j in country c and at year t. D_{jct} include time, industry (3-digit SIC level) and country fixed effects, and their interactions. X is a set of balance sheet variables, which includes the log of EBITDA (proxy for cash flow), firm capital expenditure in the previous year, firm sales, firm asset and firm liability. D_{98} is a dummy for the year 1998.

The results from this regression test are tabulated in Table 2.6. Each row in the table reports the coefficient for a dependent variable. The rows "Year 1998" indicate the interactions of the dependent variables with the 1998 dummy D_{98}. We see that firms with higher cash flow are more likely to be acquired at a higher price to book ratio in the crisis year of 1998. This effect is absent in non-crisis years. We also see that firms with lower capital expenditure in the previous year is likely to be acquired at a higher price to book ratio in the crisis year of 1998. This effect is also absent in the non-crisis years. These are exactly the results documented by Aguiar and

[17]Aguiar and Gopinath (2005) uses data from 1986 to 2001.

Gopinath (2005).

To read a bit more into Table 2.6, we see that when we simply regress the log price to book ratio on log capital expenditure in the previous year, higher capital expenditure in previous year alone does not predict a significantly lower acquisition price to book ratio in 1998. However, once we also control for log cash flow (EBITDA), coefficients for both cash flow and previous capital expenditure become significant. The explanation to this finding is that firms with higher capital expenditure in the previous year also tends to have better cash flow.

While financial frictions could be one reason that lower cash flow and higher previous capital expenditure leads to lower acquisition prices, from the results in Table 2.6, it is hard to conclude that financial frictions cause the lower acquisition prices. For example, one alternative explanation could be that the financial crisis hit consumer confidence and lead to a decline in aggregate demand, so compared with a non-crisis year, during the crisis year firms with abundant cash and less capital expenditure would be valued relatively more than the firms with less cash and more capital expenditure.

Next, I improve their results by showing that the effects of cash flow and previous capital expenditure on acquisition price to book ratio will vary for firms in different sectors with different dependence on external finance. I read the sector level external finance dependence from Rajan and Zingales (1998)[18]. I then perform the following two regression tests, regression II

$$p_{ijct} = \alpha_0 + \alpha X_{ijct} + \beta X_{ijct} * D_{98} + \theta_1 lnCapExp_{ijct} * ExtFinDep_j + \theta_2 lnCapExp_{ijct} * ExtFinDep_j * D_{98} + \gamma D_{jct} + \epsilon_{ijct}, \quad (2.46)$$

[18]The sector data for external finance is at the 3-digit ISIC level, which maps into the 2-digit SIC level.

and regression III

$$p_{ijct} = \alpha_0 + \alpha X_{ijct} + \beta X_{ijct} * D_{98} + \theta_1 lnEBITDA_{ijct} * ExtFinDep_j + \theta_2 lnEBITDA_{ijct} * ExtFinDep_j * D_{98} + \gamma D_{jct} + \epsilon_{ijct}. \quad (2.47)$$

The regression in (2.46) adds the interaction of previous capital expenditure and sector level external finance dependence as an independent variable. The regression in (2.47) adds the interaction of cash flow and external finance dependence as an independent variable. The results from the two regression tests are tabulated in Table 2.7 and Table 2.8, respectively.

From Table 2.7, we see that the negative effect of capital expenditure on acquisition price to book ratio in 1998 becomes larger in sectors that rely more on external finance. This is consistent with the notion that financial frictions during the East Asian financial crisis reduce the acquisition prices paid by foreign firms. To see this, notice in sectors that rely more on external finance, higher previous capital expenditure means the firms may have started capital investment projects that will rely more heavily on external finance in the future, so the increased financial frictions during the financial crisis will cause larger declines in firms' acquisition prices.

From Table 2.8, we see that the positive effect of cash flow on acquisition price to book ratio becomes smaller in sectors that rely more on external finance. This is again consistent with the notion that financial frictions during the East Asian financial crisis reduce the acquisition prices paid by foreign firms. To see this, notice that in sectors that rely more on external finance, the same amount of free cash flow will be less useful in alleviating the firms' financial constraints during the financial crisis and will hence have a smaller effect in lifting the firms' acquisition prices.

The findings in Table 2.7 and Table 2.8 hence confirm that during the East Asian financial crisis, financial frictions cause significant declines in the acquisition prices paid by foreign firms.

Table 2.6: Results from Regression I in (2.45)

	Dependent variable:				
	ln(Price to Book Ratio)				
	(1)	(2)	(3)	(4)	(5)
lnCapExp	−0.084	−0.108	−0.081	−0.039	−0.003
	(0.060)	(0.106)	(0.110)	(0.118)	(0.114)
Year 1998	−0.267	−2.962***	−2.543**	−1.893	−2.739**
	(0.241)	(0.961)	(1.010)	(1.269)	(1.301)
lnEBIDTA		0.069	0.240	0.207	0.345**
		(0.127)	(0.187)	(0.153)	(0.153)
Year 1998		3.320***	4.227***	5.453***	15.116***
		(1.031)	(1.279)	(1.893)	(5.727)
lnSales			−0.220		
			(0.182)		
Year 1998			−1.409		
			(1.173)		
lnAsset					−1.041***
					(0.320)
Year 1998					14.858*
					(7.738)
lnLiability				−0.207	0.532**
				(0.137)	(0.258)
Year 1998				−3.339	−26.610**
				(2.541)	(12.752)
Constant	−2.611	−0.104	0.978	−1.711	0.316
	(4.502)	(5.253)	(5.257)	(4.948)	(4.756)
Industry × year × country fixed effects	YES	YES	YES	YES	YES
Observations	511	440	440	431	431
R^2	0.839	0.879	0.882	0.869	0.883
Adjusted R^2	0.449	0.545	0.551	0.511	0.556
Residual Std. Error	0.930 (df = 149)	0.836 (df = 117)	0.831 (df = 115)	0.827 (df = 115)	0.789 (df = 113)
F Statistic	2.149*** (df = 361; 149)	2.632*** (df = 322; 117)	2.661*** (df = 324; 115)	2.426*** (df = 315; 115)	2.695*** (df = 317; 113)

Note: Firms in manufacturing sectors only. Fixed effect at 3-digit SIC level. *p<0.1; **p<0.05; ***p<0.01

Table 2.7: Results from Regression II in (2.46)

	Dependent variable:				
	ln(Price to Book Ratio)				
	(1)	(2)	(3)	(4)	(5)
lnCapExp	−0.149	−0.111	−0.047	−0.110	−0.071
	(0.109)	(0.114)	(0.114)	(0.103)	(0.123)
Year 1998	1.340	1.469	2.599	4.956**	1.123
	(2.083)	(2.474)	(2.199)	(2.400)	(2.216)
lnEBITDA	0.070	0.229			0.193
	(0.127)	(0.188)			(0.155)
Year 1998	3.904***	3.592***			3.394
	(1.051)	(1.330)			(2.277)
lnSales		−0.210		−0.018	
		(0.182)		(0.110)	
Year 1998		0.516		3.137**	
		(1.606)		(1.399)	
lnAsset			−0.224		
			(0.197)		
Year 1998			−3.949		
			(2.854)		
lnLiability			0.096		−0.189
			(0.165)		(0.138)
Year 1998			8.688***		0.884
			(2.730)		(3.623)
$EFDEP * lnCapExp$	0.079	0.073	0.076	0.105	0.061
	(0.174)	(0.175)	(0.151)	(0.152)	(0.175)
Year 1998	−76.326**	−80.932*	−107.738**	−120.703**	−78.229
	(32.951)	(45.716)	(43.830)	(48.176)	(47.370)
Constant	−7.223	−7.672	−0.500	−0.920	−0.673
	(6.124)	(7.285)	(4.636)	(4.706)	(5.018)
Industry × year × country fixed effects	YES	YES	YES	YES	YES
Observations	440	440	497	511	431
R^2	0.884	0.886	0.845	0.851	0.872
Adjusted R^2	0.554	0.552	0.455	0.469	0.510
Residual Std. Error	0.828 (df = 114)	0.830 (df = 112)	0.892 (df = 141)	0.913 (df = 143)	0.828 (df = 112)
F Statistic	2.680*** (df = 325; 114)	2.653*** (df = 327; 112)	2.166*** (df = 355; 141)	2.225*** (df = 367; 143)	2.408*** (df = 318; 112)

Note: Firms in manufacturing sectors only, fixed effect on 3-digit SIC level *p<0.1; **p<0.05; ***p<0.01

Table 2.8: Results from Regression III in (2.47)

	Dependent variable:				
	ln(Price to Book Ratio)				
	(1)	(2)	(3)	(4)	(5)
lnEBITDA	−0.174**	0.057	0.334**	0.180	0.219
	(0.075)	(0.130)	(0.160)	(0.156)	(0.188)
Year 1998	4.105*	8.525***	8.047***	8.132***	8.490***
	(2.145)	(2.448)	(2.574)	(2.463)	(2.696)
lnSales					−0.217
					(0.181)
Year 1998					0.523
					(1.597)
lnCapExp		−0.139	0.017	−0.062	−0.101
		(0.105)	(0.116)	(0.118)	(0.110)
Year 1998		−3.245***	−3.632**	−3.576**	−3.393***
		(0.954)	(1.491)	(1.625)	(1.114)
lnAsset			−0.471***		
			(0.165)		
Year 1998			0.830		
			(1.818)		
lnLiability				−0.195	
				(0.136)	
Year 1998				0.891	
				(3.603)	
EFDEP * lnEBITDA	0.185	0.073	0.067	0.080	0.082
	(0.128)	(0.130)	(0.127)	(0.130)	(0.131)
Year 1998	−58.698*	−76.860**	−74.827*	−78.835*	−81.542*
	(33.400)	(32.944)	(39.172)	(47.319)	(45.685)
Constant	−1.817	−3.926	−3.501	−0.673	−4.096
	(5.529)	(5.452)	(6.115)	(4.961)	(6.006)
Industry × year × country fixed effects	YES	YES	YES	YES	YES
Observations	513	440	440	431	440
R^2	0.864	0.884	0.892	0.873	0.886
Adjusted R^2	0.510	0.559	0.581	0.516	0.557
Residual Std. Error	0.852 (df = 142)	0.824 (df = 115)	0.802 (df = 113)	0.823 (df = 113)	0.826 (df = 113)
F Statistic	2.442*** (df = 370; 142)	2.715*** (df = 324; 115)	2.868*** (df = 326; 113)	2.443*** (df = 317; 113)	2.690*** (df = 326; 113)

Note: Firms in manufacturing sectors only, fixed effect on 3-digit SIC level *p<0.1; **p<0.05; ***p<0.01

2.5 Robustness

In this section, I show that the quantitative results in the first part of this chapter are robust after we take into account the technology diffusion brought by the multinational firms. I then show that the quantitative results are not driven by the protectionist policies implemented by the Chinese government. Lastly, I show that the results are robust to using national welfare instead of national income as the welfare measure. More robustness checks can also be found in the appendix.

2.5.1 Technology Diffusion

An interesting finding in Table 2.4 is that the GNP in the South will decline after the economy opens up to multinational production. This is due to two reasons: First, multinational production is modeled as a substitute for exports, so opening up to multinational production does not bring new varieties of intermediate goods, as opposed to our illustrative model. Second, multinational firms compete with multinational firms and can crowd out the market share of domestic firms. These two effects together mean that opening up to multinational production could lead to a decline in GNP and GDP. This is consistent with the finding in Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2017). In particular, the authors show that countries that mainly serve as targets for multinational production will lose from opening up to multinational production.

However, such a result neglects the possibility that multinational firms in the North can bring new technology and management know-how to the South. The technology spillovers could improve the productivity of domestic firms and, hence, improve national income.[19] I show that the quantitative results still hold after introducing technology diffusion in the model.

Technology diffusion is modeled in a simple way. I assume that the lower bound for individual productivity in the South, $\bar{z}^*$, will increase by three percentage points after the economy opens up to multinational production,

$$\bar{z}^* = \begin{cases} 0.30, & \text{when the economy is closed to multinational production,} \\ 0.33, & \text{when the economy is open to multinational production.} \end{cases}$$

Table 2.9 shows the increases in GNP brought by the financial reform. The financial reform improves the financial development condition in the South, ϕ^*, from 1.55 to 2. Given this technology diffusion, Table 2.9 suggests that the national income in

[19] See Harrison and Rodríguez-Clare (2010) for a survey that covers technology spillovers from multinational firms.

Table 2.9: Benefits of Financial Reform in the Model with Technology Diffusion

		Without MF	With MF
Before Reform	GNP	383	395
	GDP	377	445
	GNP/GDP	1.02	0.89
After Reform	GNP	427	469
	GDP	414	492
	GNP/GDP	1.03	0.95
Percentage Change	GNP	11.5%	18.7%
	GDP	9.8%	10.6%
	GNP/GDP	1.7%	7.3%

the South increases after the economy opens up to multinational production.

The results in Table 2.9 indicate that the financial reform still cause a significantly larger increase in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 11.5%. When the economy is open to multinational production, the same financial reform will increase GNP by 18.7%.

Table 2.10 shows the increases in domestic wages and domestic firm profits in the South brought by the financial reform. The results indicate that when the economy is open to multinational production, the financial reform will still benefit the entrepreneurs disproportionately more than the workers: When the economy is closed to multinational production, the financial reform will increase domestic wages by 9.2% and domestic firm profits by 11.9%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 10.9% but domestic firm profits by 23.2%.

The results in Table 2.9 and Table 2.10 are consistent with the results in Table 2.4 and Table 2.5, suggesting that the quantitative results are robust after taking into account technology diffusion brought by multinational firms.[20]

[20]Note that financial frictions could also prevent the domestic firms from adopting the best available technology. This is illustrated in Cole, Greenwood and Sanchez (2016). This additional channel suggests that faced with financial frictions, domestic firms may not be able to adopt the technology brought by the multinational firms. This channel only reinforces the result in this chapter, that fi-

Table 2.10: Benefits of Reform on Wages and Profits with Technology Diffusion

		Without MF	With MF
Before Reform	wage	184	211
	profit	59	56
After Financial Reform	wage	201	234
	profit	66	69
Percentage Change	wage	9.2%	10.9%
	profit	11.9%	23.2%

2.5.2 Protectionist Policies

The Chinese government has implemented various protectionist policies that restrict the entry of multinational firms. For example, the Chinese government requires multinational firms to transfer technology in return for market access, or even to form joint ventures with state-owned firms in certain sectors (Holmes, McGrattan, and Prescott 2015).

These protectionist policies can have two effects. First, they increase the entry costs for multinational firms. Second, multinational firms may not deploy the best available technology for fear of it being easily stolen by their local rivals (Holmes, McGrattan, and Prescott 2015). In the quantitative model, these two adverse effects naturally translate into a larger fixed cost of FDI κ_D and a lower level of foreign affiliate productivity ξ. While it is beyond the scope of this chapter to estimate the exact magnitude of these effects, I will show that the quantitative results are unlikely to be driven by changes brought by these protectionist policies.

In particular, I study the hypothetical condition that the Chinese government removes the protectionist policies. I assume that the removal of these protectionist policies will reduce fixed cost of FDI κ_D by 10% and increase the level of foreign affiliate productivity ξ by 10%. Given this new fixed cost of FDI and the level of foreign affiliate productivity, multinational firms will produce approximately 60% of the manufacturing output in the South. Therefore, the magnitude of reduction in the

nancial frictions become more costly to the developing countries after they open up to multinational production.

Table 2.11: Benefits of Financial Reform without PP

		Without MF	With MF
Before Reform	GNP	453	302
	GDP	450	430
	GNP/GDP	1.01	0.70
After Reform	GNP	504	390
	GDP	493	484
	GNP/GDP	1.02	0.80
Percentage Change	GNP	11.3%	29.1%
	GDP	9.6%	12.6%
	GNP/GDP	1.4%	14.6%

fixed cost of FDI and the increase in affiliate productivity brought by the removal of protectionist policies are reasonable or perhaps even exaggerated.

Under such a hypothetical condition, Table 2.11 shows the increases in GNP brought by the financial reform. The results indicate that the financial reform still cause a significantly larger increase in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 11.3%. When the economy is open to multinational production, the same financial reform will increase GNP by 29.2%.

Table 2.12 shows the increases in domestic wages and domestic firm profits brought by the financial reform. The results indicate that when the economy is open to multinational production, the financial reform will benefit the entrepreneurs disproportionately more than the workers: When the economy is closed to multinational production, a financial reform in the South will increase domestic wages by 9.1% and domestic firm profits by 9.9%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 13.8% but domestic firm profits by 44.1%.

The results in Table 2.11 and Table 2.12 are consistent with the results in Table 2.4 and Table 2.5, suggesting that the results are not driven by the protectionist policies in China.

Table 2.12: Benefits of Financial Reform On Wages and Profits without PP

		Without MF	With MF
Before Reform	wage	220	196
	profit	71	34
After Financial Reform	wage	240	223
	profit	78	49
Percentage Change	wage	9.1%	13.8%
	profit	9.9%	44.1%

Table 2.13: Benefits of Financial Reform on National Welfare

	Without MF	With MF
Welfare Before Reform	-310.68	-319.31
Welfare After Reform	-297.74	-302.67
Change in Welfare	12.94	16.63

2.5.3 Welfare

National welfare is defined as the sum of individual welfare in the South

$$Welfare^* = (1 - f_S) \int v^*(z^*, a^*) dG(z^*, a^*) + f_S \int v_S^*(z^*, a^*) dG_S(z^*, a^*).$$

Recall that f_S is the fraction of individuals in the South who are capable of running state-owned firms.

The decline in national welfare caused by financial frictions will be measured by the increase in national welfare brought by a modest financial reform. The financial reform improves ϕ^*, the financial development condition in the South, from 1.55 to 2. The results in Table 2.13 indicate that financial reforms bring a larger increase in national welfare when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase national welfare by 12.9. When the economy is open to multinational production, the same financial reform will increase national welfare by 16.6. Such results are consistent with what we obtain in Table 2.4 using national income as the welfare measure.

2.6 Conclusion

In this chapter, I show that when a developing economy is open to multinational production, financial frictions will cause a significantly larger decline in national income than in an otherwise identical developing economy that is closed to multinational production. The main policy implication is that financial reforms become increasingly beneficial to national income in developing countries as they open up to multinational production.

2.7 Appendices

2.7.1 Numerical Analysis

I verify numerically that the key results from the models in Chapter 1 still hold in the quantitative model in Section 2.2. In particular, I illustrate numerically that when the economy is open to multinational production, if domestic firms produce a sufficiently large (small) share of output in the developing economy, financial frictions will cause a larger (smaller) decline in national income than in an otherwise identical economy that is closed to multinational production. In unreported results, I verify numerically that the results from the illustrative model also hold in the extended quantitative model in Section 2.3.

The parameters used in the numerical analysis are shown in Table 2.14. The parameters are largely from our model calibration. Note that in Table 2.14, the average productivity of entrepreneurs is much higher in the North than in the South: $\bar{z} > \bar{z}^*$. Financial development is also much better in the North than in the South: $\phi > \phi^*$.

Table 2.14: Parameter Values for Numerical Analysis

$\bar{z} = 1$	$\bar{z}^* = 0.33$	$\phi = 5.5$
$\phi^* = 1.55$	$v_\phi = 0.73$	$\xi = 0.4$
$\kappa_E = 16$	$\kappa_D = 125$	$\kappa_E^* = 30$
$\kappa_H = 10$	$\kappa_H^* = 10$	$\theta = 9$
$\sigma = 4$	$\rho = 1.5$	$\beta = 0.92$
$\alpha = 0.5$	$N = 1$	$N^* = 1.5$
$\tau = 1.09$	$\tau^* = 1.09$	$\delta = 0.1$

In the numerical analysis, the decline in national income caused by financial frictions will be measured by the increase in national income brought by a modest financial reform. The financial reform will improve ϕ^*, the financial development condition in the South, from 1.55 to 2.[21] In cases where the financial reform brings larger increases in national income, financial frictions cause larger declines in national income.

[21]The exact magnitude of the reform will not qualitatively change our results.

I will focus on two parameters in the numerical analysis: the level of foreign affiliate productivity ξ and the fixed cost of FDI κ_D. In particular, I will study how changes in the two parameters affect the increases in national income brought by the financial reform. The two parameters directly control the share of output produced by multinational firms in the South. Intuitively, higher levels of foreign affiliate productivity ξ and lower fixed cost of FDI κ_D will lead to larger shares of output in the South being produced by multinational firms.

2.7.1.1 Foreign Affiliate Productivity

Table 2.15 shows the increases in GNP in the South brought by the financial reform at different levels of foreign affiliate productivity ξ. Different columns in Table 2.15 correspond to the cases with different ξ. The first row shows the share of output produced by domestic firms in the South before the financial reform. Rows 2 through 4 show the GNP, GDP and $\frac{GNP}{GDP}$ in the South before the financial reform. The next three rows show the GNP, GDP and $\frac{GNP}{GDP}$ in the South after the financial reform. The last three rows show the percentage changes in GNP, GDP and $\frac{GNP}{GDP}$ in the South brought by the financial reform.[22]

We first study the cases where ξ equals 0.36, 0.39, 0.42 and 0.45. In these four cases, domestic firms produce relatively large shares of output in the South, and financial frictions cause larger declines in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 8.7%. When the economy is open to multinational production, the same financial reform will increase GNP by 10.5%, 11.5%, 14.5% and 12.7%, respectively, in the four cases. We can also decompose the increases in GNP brought by the financial reform into increases in GDP and increases in $\frac{GNP}{GDP}$. When the economy is closed to multinational production, the financial reform leads to an 8.8% increase in GDP but little change in $\frac{GNP}{GDP}$. When the economy is open

[22]All results below remain unchanged if we use absolute changes brought by the financial reform instead of percentage changes.

to multinational production, the financial reform will bring not only large increases in GDP (9.1%, 9.0%, 8.7% and 7.2%, respectively) but also additional increases in $\frac{GNP}{GDP}$ (1.3%, 2.4%, 5.4% and 5.2%, respectively).

The intuition here is the same as in the first example of Chapter 1. Intuitively, when the economy is closed to multinational production, financial frictions distort capital allocation among domestic firms and significantly reduce total output (GDP). However, since all the output in the economy is produced by domestic firms, financial frictions have little impact on domestic firms' market share. When the economy is open to multinational production, since domestic firms still produce a relatively large share of output, financial frictions still cause a large decline in total output (GDP) by distorting capital allocation among domestic firms that produce goods that are complementary to goods produced by multinational firms. In addition, because financial frictions constrain domestic firms much more than multinational firms, the key additional force is that financial frictions reduce the competitiveness of domestic firms relative to multinational firms and cause a significant decline in domestic firms' market share. This additional decline in domestic firms' market share leads to a decline in the share of total output paid to domestic residents ($\frac{GNP}{GDP}$). The still large decline in GDP combined with this additional decline in $\frac{GNP}{GDP}$ suggests that financial frictions cause a larger decline in national income when the economy is open to multinational production.

We then study the case when $\xi = 0.48$. In this case, domestic firms produce a relatively small share of output in the South, and financial frictions cause a smaller decline in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 8.7%. When the economy is open to multinational production, the same financial reform will only increase GNP by 5.5%.

We can again decompose the increase in GNP brought by the financial reform into the increase in GDP and the increase in $\frac{GNP}{GDP}$. When the economy is open to multinational production, the financial reform will bring only a small 3.1% increase

Table 2.15: Benefits of Financial Reform, different ξ

		Without MF	$\xi = 0.36$	$\xi = 0.39$	$\xi = 0.42$	$\xi = 0.45$	$\xi = 0.48$
Before Reform	Domestic Share	100%	90%	78%	55%	34%	24%
	GNP	507	488	471	437	416	440
	GDP	475	475	478	484	501	552
	GNP/GDP	1.07	1.03	0.98	0.90	0.83	0.80
After Reform	GNP	551	539	525	501	469	464
	GDP	517	518	521	526	537	569
	GNP/GDP	1.07	1.04	1.01	0.95	0.87	0.81
Percentage Change	GNP	8.7%	10.5%	11.5%	14.6%	12.7%	5.5%
	GDP	8.7%	9.1%	9.0%	8.7%	7.2%	3.1%
	GNP/GDP	0.0%	1.3%	2.4%	5.4%	5.2%	2.1%

in GDP, which leads to a small 5.5% increase in GNP.

The intuition here is the same as in the second example of Chapter 1. Intuitively, when the economy is open to multinational production, if domestic firms produce too small a share of output, since financial frictions do not much constrain the capital rentals of multinational firms, financial frictions cause only a very small decline in total output (GDP). As a result, despite the additional decline in $\frac{GNP}{GDP}$, financial frictions cause a smaller decline in national income (GNP) when the economy is open to multinational production.

These numerical results are consistent with the theoretical results in the corollaries of Chapter 1: On the one hand, if domestic firms produce a sufficiently large share of output in the developing economy ($\xi = 0.36, 0.39, 0.42$ and 0.45), financial frictions cause a larger decline in national income when the economy is open to multinational production. On the other hand, if domestic firms produce a sufficiently small share of output in the developing economy ($\xi = 0.48$), financial frictions cause a smaller decline in national income when the economy is open to multinational production.

2.7.1.2 Fixed Cost of FDI κ_D

Table 2.16 shows the increases in GNP in the South brought by the financial reform at different levels of fixed cost of FDI κ_D.

We first study the cases where κ_D equals 125, 105, 85 and 65. In these four

Table 2.16: Benefits of Financial Reform, Different κ_D

		Without MF	$\kappa_D = 125$	$\kappa_D = 105$	$\kappa_D = 85$	$\kappa_D = 65$	$\kappa_D = 45$
Before Reform	Domestic Share	100%	72%	60%	46%	34%	27%
	GNP	507	459	443	417	413	444
	GDP	475	479	482	486	509	563
	GNP/GDP	1.07	0.96	0.92	0.86	0.81	0.79
After Reform	GNP	551	516	503	479	453	466
	GDP	517	521	526	525	536	581
	GNP/GDP	1.07	0.99	0.96	0.91	0.85	0.81
Percentage Change	GNP	8.7%	12.4%	13.5%	14.9%	9.7%	5.0%
	GDP	8.7%	8.8%	9.1%	8.0%	5.3%	3.2%
	GNP/GDP	0.0%	3.3%	4.2%	6.2%	4.3%	2.4%

cases, financial frictions cause larger declines in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 8.7%. When the economy is open to multinational production, the same financial reform will increase GNP by 12.4%, 13.5%, 14.9% and 9.7%, respectively, in these four cases.

We then study the case when $\kappa_D = 45$. In this case, financial frictions cause a smaller decline in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 8.7%. When the economy is open to multinational production, the same financial reform will only increase GNP by 5.0%.

The results in Table 2.16 are consistent with the results in Table 2.15, and they are again consistent with our theoretical results in Chapter 1.

2.7.2 Data

I group countries into North and South. There are 43 countries in the World Input Output Database (WIOD) in 2005. The North is composed of 24 countries and regions whose GDP per capita is above 50% of the U.S. level in 2005. The countries are listed in Table 2.1. The GDP per capita level is from Penn World Tables 9.0. I choose a single country, China, as the South.

To obtain the populations in the North and the South, N and N^*, I use the

number of manufacturing workers in the two countries. In particular, I use the total number of employed workers in all 24 countries from the Penn World Tables 9.0 (Feenstra, Inklaar, and Timmer 2015), and I multiply them by the manufacturing employment share in these countries.[23] The number of manufacturing workers in the North is estimated to be 56 million. The number of manufacturing workers in China is computed from the Chinese Industrial Survey (2005). The number of manufacturing workers in China is 83.7 million. The number of manufacturing workers in the South is thus 1.5 times the number of manufacturing workers in the North. I normalize the population in the North, N, to be 1. This means $N^* = 1.5$.

The average firm size for manufacturing establishments in the North is from the U.S. manufacturing census. In particular, in 2007, the average number of employees of U.S. manufacturing establishments was 40. In 2002, the average number of employees of U.S. manufacturing establishments was 47. I simply take the average of the two numbers, and the average number of employees for firms in the North is set as 43.

The output in the North and the South and the bilateral value-added exports are computed using data from the World Input Output Database in 2005, following the methods introduced in Timmer, Dietzenbacher, Stehrer, and de Vries (2015).

The iceberg trade cost is computed as tariff plus maritime trade costs. The tariff rates are read directly from the WTO tariff profiles, which are computed in trade-weighted terms. The tariff rate of shipping goods from North to South is 5%, and the tariff rate of shipping goods from South to North is 2%. The transportation cost is read from the OECD maritime trade cost database. The maritime trade cost database reports bilateral ad valorem transportation costs between any two countries at the 2-digit manufacturing sector level. I use the data to compute the trade-weighted ad

[23] Although I do not have data on the manufacturing employment share except for the U.S., I do have data on the industry employment share from the World Bank. The manufacturing employment shares for countries in the North are estimated using their industry employment shares and the manufacturing employment share in the U.S. In particular, I assume that manufacturing employment as a share of total industry employment are the same across the countries in the North, and I use the manufacturing share of total industry employment in the U.S. and the industry employment share in the other 23 countries in the North to back out the manufacturing employment share in all countries in the North.

valorem transportation cost. I use the European Union (15 countries) and the United States as a proxy for the North, since the maritime trade cost database only records detailed trade costs of China with these countries. I find that the transportation cost of shipping goods from North to South is 4%, and the transportation cost of shipping goods from South to North is 7%. Adding the transportation costs and tariff rates together, I obtain a 9% iceberg trade cost of shipping goods from North to South and a 9% iceberg trade cost of shipping goods from South to North.

I obtain the private credit to output ratio from the financial structure database (Beck, Demirguc-Kunt, and Levine 2000). I use the private credit to output ratio in 2005. In particular, I use the average private credit to output ratio weighted by the output of each country in the North to obtain the private credit to output ratio in the North. The private credit to output ratio is 1.51 in the North and 1.10 in the South.

In the model, I have three types of individuals running three types of firms in the South: domestic private firms, state-owned firms and foreign firms. The Chinese Industrial Survey (2005) covers all state-owned firms and above-scale non-state firms with revenue above 5,000,000 yuan (approximately $600,000 in 2005; I henceforth refer to all state-owned firms and above-scale non-state firms as above-scale firms). The survey contains information on firm sales, capital and labor, among others. The survey also provides information on the amount of paid-up capital owned by six different sources: state, collective, foreign, HMT (Hong Kong, Macau and Taiwan), individual, and legal person. I will need to map the six sources into the three types of firms in the model. The exact ownership structure of firms owned by legal person sources is unclear, while 23.8% of all the paid-up capital of above-scale firms is owned by legal person sources. There are also some complications in interpreting firms owned by HMT sources. In particular, due to certain regional subsidies to FDI, some domestic private firms have the incentive to report themselves as owned by HMT sources. Some foreign firms may also report themselves as owned by HMT sources. In total, 7.9% of all paid-up capital for above-scale firms is owned by HMT sources.

I categorize the paid-up capital owned by both individual and collective sources as privately owned. For each firm i, I denote the observed share of paid-up capital owned by private (P), state (S), foreigner (F), HMT and legal person sources as $s_{i,P}$, $s_{i,S}$, $s_{i,F}$, $s_{i,HMT}$ and $s_{i,Legal}$. To compute some of the data moments, I will map these five categories of observed paid-up capital shares into the share of paid-up capital owned by three types of firms in the model: private ($Share_{i,P}$), state ($Share_{i,S}$), and foreign ($Share_{i,F}$). In particular, for each firm i, I will impute the share of paid-up capital owned by the three sources in the following way:

$$Share_{i,S} = s_{i,S} + m_1 s_{i,Legal}. \tag{2.48}$$

$$Share_{i,F} = s_{i,F} + m_2 s_{i,HMT}. \tag{2.49}$$

$$Share_{i,P} = s_{i,P} + (1 - m_1) s_{i,HMT} + (1 - m_2) s_{i,Legal}. \tag{2.50}$$

Note again that $s_{i,P}$, $s_{i,S}$, $s_{i,F}$, $s_{i,HMT}$ and $s_{i,Legal}$ are observed shares of paid-up capital, and $Share_{i,P}$, $Share_{i,S}$ and $Share_{i,F}$ are imputed shares of paid-up capital held by the three types of individuals in the model. (2.48), (2.49), and (2.50) suggest that for each firm with paid-up capital owned by legal person sources, I assume that a share $m_1 \in (0, 1)$ of the paid-up capital owned by the legal person sources is state-owned and the rest is privately-owned. I also assume that for each firm with paid-up capital owned by HMT sources, a share $m_2 \in (0, 1)$ of the paid-up capital owned by HMT sources is foreign-owned and the rest is privately owned.

I compute m_1 in the following way:

$$m_1 = \frac{\sum_i Sales_i * s_{i,S}}{\sum_i Sales_i * (s_{i,S} + s_{i,P})} = 28\%. \tag{2.51}$$

Here, $Sales_i$ is the sales of firm i. (2.51) states that if we only consider the sales controlled by the private and state sources ($Sales_i * (s_{i,S} + s_{i,P})$), the private shares control 72% of such sales and the state shares control the other 28%. I simply assume that for each firm with paid-up capital owned by legal person sources, 28% of the

paid-up capital owned by legal person sources is state-owned, and the other 72% is privately owned.

I compute m_2 in the following way: Note that the average sales of above-scale firms with paid-up capital explicitly owned by HMT sources is defined as

$$AboveScaleAvgSales_{HMT} = \frac{\sum_i Sales_i * s_{i,HMT}}{\sum_i s_{i,HMT}}.$$

The average sales of above-scale firms with paid-up capital explicitly owned by foreign sources is defined as

$$AboveScaleAvgSales_F = \frac{\sum_i Sales_i * s_{i,F}}{\sum_i s_{i,F}}.$$

The average sales of above-scale firms with paid-up capital explicitly owned by private sources is defined as

$$AboveScaleAvgSales_P = \frac{\sum_i Sales_i * s_{i,P}}{\sum_i s_{i,P}}.$$

m_2 is such that the average sales of above-scale HMT firms matches the average sales of above-scale private and foreign firms:

$$AboveScaleAvgSales_{HMT} = m_2 AboveScaleAvgSales_F + (1-m_2) AboveScaleAvgSales_P.$$

This gives us $m_2 = 58\%$. Using m_1 and m_2, I can impute the share of paid-up capital owned by private ($Share_{i,P}$), state ($Share_{i,S}$), and foreign ($Share_{i,F}$) sources following (2.48), (2.49), and (2.50). I proceed to discuss how I compute the data moments. Note that whenever possible, I use the observed paid-up capital share rather than the imputed paid-up capital share to ensure greater accuracy. Most of the data moments computed from the imputed paid-up capital share are cross-validated with other sources. Due to the robustness of the quantitative results, small differences in the data moments are unlikely to change the key results in this paper.

First, I compute the share of total sales from the affiliates of multinational firms in China, $SalesShare_F$

$$SalesShare_F = \frac{\sum_i Sales_i * Share_{i,F}}{\sum_i Sales_i} = 26\%.$$

Foreign firms contribute 26% of the total sales of above-scale firms. In the 2004 census yearbook, sales by state-owned firms and above-scale non-state firms is 20.43 trillion yuan, and sales by below-scale non-state firms is 1.98 trillion yuan.[24] This means that above-scale firms contribute 91.2% of total sales in China in 2004. I will take this number and use it in 2005. Since foreign firms are, on average, much larger than domestic private firms, I further assume that all foreign firms are above-scale firms. Taking into account the sales of below-scale firms, affiliates of foreign firms contribute approximately 24% of the total sales in China.

Second, I compute the share of total firm sales from state-owned firms, $SalesShare_S$.

$$SalesShare_S = \frac{\sum_i Sales_i * Share_{i,S}}{\sum_i Sales_i} = 20\%.$$

State-owned firms contribute 20% of the total sales of above-scale firms. The Chinese Industrial Survey covers all state-owned firms in the economy, but only above-scale non-state firms. Taking into account sales of below-scale firms, state-owned firms contribute approximately 18% of total sales. This number is largely in line with the data in Table 14-1 in the Chinese Statistical Yearbook (2006).

Third, I compute the share of sales exported to foreign countries by foreign private firms, $ExpShare_F$

$$ExpShare_F = \frac{\sum_i Exp_i * s_{i,F}}{\sum_i Sales_i * s_{i,F}}.$$

Note that the $s_{i,F}$ is the observed share of paid-up capital owned by foreign sources. I obtain $ExpShare_F = 49\%$, suggesting that foreign private firms, on average, export 49% of their sales abroad, and 51% of their sales stay in China.

[24] I obtain these numbers indirectly from Brandt, Van Biesebroeck, and Zhang (2014)

Fourth, I compute the ratio of average sales of foreign firms to the average sales of domestic private firms. This is done in two steps. First, given the average sales of above-scale foreign firms, $AboveScaleAvgSales_F$, and the average sales of above-scale domestic private firms, $AboveScaleAvgSales_P$, I obtain the ratio of average sales of above-scale foreign firms relative to the average sales of above-scale domestic private firms:

$$AboveScaleSalesRatio = \frac{AboveScaleAvgSales_F}{AboveScaleAvgSales_P}.$$

This ratio is 3.68, suggesting that above-scale foreign firms are, on average, 3.68 times larger than above-scale domestic private firms.[25] Second, to obtain the relative size of foreign firms to domestic private firms, we also need to take into account the below-scale firms. I use information in the 2004 census yearbook. In particular, the census states records 279,040 above-scale firms and 1,098,789 below-scale firms in 2004. The number of above-scale firms in the 2004 census is thus similar to the number of above-scale firms in the 2005 Chinese Industrial Survey (271,835 firms). Hence, I use the number of below-scale firms in the 2004 census as the number of below-scale firms in 2005. The sales of above-scale firms in 2004 is 20.43 trillion yuan, while the sales of below-scale firms in 2004 is 1.98 trillion yuan. Given that the foreign firms are much larger than the private firms, and given that all state-owned firms are already included in the above-scale firm survey, I make the simplifying assumption that all below-scale firms are domestic private firms. We compute the share of above-scale firms that are domestic private firms as follows:

$$\frac{\sum_i Share_{i,P}}{\sum_i (Share_{i,P} + Share_{i,S} + Share_{i,F})} = 80.32\%.$$

Thus, it is estimated that 80.32% of the above-scale firms are domestic private firms. Given that we have already estimated that state-owned firms produce 20% of above-scale total sales and that foreign firms produce approximately 26% of above-scale total

[25]This number does not change much if we compute the relative size of foreign firms to domestic private firms in each 4-digit industry and then take the average.

sales, we have domestic private firms producing the remaining 54% of total above-scale sales. Therefore, 80.32% of the above-scale firms are domestic private firms, and they produce 54% of the above-scale sales. We can hence compute the average sales of the above-scale domestic private firms. Given that we also know the total sales of all domestic private firms (above-scale domestic private firm sales + below-scale firm sales) and the total number of domestic private firms (number of above-scale domestic private firms + number of below-scale firms), we hence obtain the average sales of all domestic private firms. We can then compute the ratio of average sales of above-scale domestic private firms to the average sales of all private firms. This ratio is estimated to be 5.11. As a result, we have that foreign firms are, on average, 3.68 times larger than above-scale domestic private firms, and above-scale domestic private firms are, on average, 5.11 times larger than all domestic private firms. We hence have that the ratio of the average sales of foreign firms to the average sales of domestic private firms is $3.68 * 5.11 = 18.8$; on average, a foreign firm is 18.8 times larger than a domestic private firm.

I also read directly from Table 14-1 of the Chinese Statistical Yearbook. In the year 2004, 51,255 foreign firms produced 4,275.1 billion yuan worth of industrial output, while 902,647 private firms produced 4,970.5 billion yuan worth of industrial output. This means that the ratio of average sales of foreign firms to the average sales of domestic private firms is 15.1.[26] I simply take the average of the number I estimated (18.8) and the number I computed from the Chinese Statistical Yearbook (15.1) so that the relative sales of foreign firms relative to domestic private firms is set as 17.

Fifth, I compute the ratio of the export intensity of domestic private firms to the export intensity of state-owned firms. Define the export intensity for domestic private

[26]The Chinese Statistical Yearbooks divide firms into many different categories, making it more difficult to compare the sizes of foreign firms against domestic private firms.

firms and state-owned firms as follows

$$ExpShare_P = \frac{\sum_i Exp_i * s_{i,P}}{\sum_i Sales_i * s_{i,P}}.$$

$$ExpShare_S = \frac{\sum_i Exp_i * s_{i,S}}{\sum_i Sales_i * s_{i,S}}.$$

Here, Exp_i is the export sales for firm i. We find that state-owned firms export 8% of total sales, while above-scale domestic private firms export 13.8% of total sales. I also need to take into account the below-scale firms. In the 2004 census yearbook, sales by above-scale non-state firms are 20.43 trillion yuan, and sales by below-scale firms are 1.98 trillion yuan. Above-scale domestic private firms produce 54% of the total above-scale sales and export 13.8% of those sales. I assume that all below-scale domestic private firms do not export. As before, I also assume that all below-scale firms are domestic private firms. We can hence compute the export intensity of all domestic private firms. We obtain that the export intensity of domestic private firms is 1.40 times the export intensity of state-owned firms.

Sixth, I compute the sales per unit of capital ($YKRatio$), or the average product of capital for domestic private firms, foreign firms and state-owned firms. The Chinese Industrial Survey provides the total value of fixed assets, which documents the total value of fixed assets at the purchase price. Since the capital is measured at the purchase price, this is not a perfect measure of capital stock but is a reasonable proxy that makes the comparison between firms feasible.[27] In particular, I compute the weighted average of sales per unit of capital (weighted by the amount of fixed assets) for domestic private firms, foreign firms and state-owned firms.

$$YKRatio_P = \frac{\sum_i YKRatio_i * Asset_i * s_{i,P}}{\sum_i Asset_i * s_{i,P}}.$$

[27]The Chinese Industrial Survey also provides two alternative measures of fixed assets: the net value of fixed assets and the original value of fixed assets. For our purpose, using the two alternative measures yields very similar numbers.

$$YKRatio_F = \frac{\sum_i YKRatio_i * Asset_i * s_{i,F}}{\sum_i Asset_i * s_{i,F}}.$$

$$YKRatio_S = \frac{\sum_i YKRatio_i * Asset_i * s_{i,S}}{\sum_i Asset_i * s_{i,S}}.$$

I find that the sales per unit of capital for domestic private firms, $YKRatio_P$, is only 89% of the sales per unit of capital for foreign firms, $YKRatio_F$, and only 49% of the sales per unit of capital for state-owned firms, $YKRatio_S$. The fact that the state-owned firms have, on average, the lowest sales per unit of capital is consistent with the capital subsidies towards the state-owned firms. The fact that the domestic private firms have, on average, the highest sales per unit of capital is consistent with the fact that the domestic private firms are, on average, the most financially constrained.

In all the computations above, if I replace total sales with value-added, the numbers above will change very little.

2.7.3 Additional Robustness Checks

I show that the key results in Table 2.4 and Table 2.5 do not depend on the magnitude of the financial reform. I also show that the key results are robust to alternative values of iceberg trade cost τ and τ^* and are robust to alternative values of discount factor β.

2.7.3.1 Magnitude of Financial Reform

In the quantitative analysis, the decline in national income caused by financial frictions is measured by the increase in national income brought by a financial reform. The financial reform increases ϕ^* from 1.55 to 2. Now, I show that the quantitative results are robust to different magnitudes of the financial reform. In particular, I show that the key results still hold if we use a larger financial reform in the South. In the larger financial reform, ϕ^* increases from 1.55 to 2.5.

Table 2.17 shows the increases in GNP brought by the financial reform. The results

Table 2.17: Benefits of Financial Reform: A Larger Reform

		Without MF	With MF
Before Reform	GNP	453	395
	GDP	450	445
	GNP/GDP	1.01	0.89
After Reform	GNP	562	543
	GDP	540	543
	GNP/GDP	1.04	1.00
Percentage Change	GNP	24.1%	37.5%
	GDP	20.0%	22.0%
	GNP/GDP	3.2%	12.9%

indicate that the financial reform brings a larger increase in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 24.1%. When the economy is open to multinational production, the same financial reform will increase GNP by 37.5%.

Table 2.18 shows the increases in domestic wages and domestic firm profits brought by the financial reform. The results indicate that when the economy is open to multinational production, the financial reform will benefit the entrepreneurs disproportionately more than the workers: When the economy is closed to multinational production, the financial reform in the South will increase domestic wages by 18.6% and domestic firm profits by 22.5%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 22.7% but domestic firm profits by 46.4%.

The results in Table 2.17 and Table 2.18 are consistent with the results in Table 2.4 and Table 2.5, suggesting that our quantitative results are robust to alternative magnitudes of the financial reform.

Table 2.18: Benefits of Financial Reform on Wages and Profits: A Larger Reform

		Without MF	With MF
Before Reform	wage	220	211
	profit	71	56
After Financial Reform	wage	261	259
	profit	87	82
Percentage Change	wage	18.6%	22.7%
	profit	22.5%	46.4%

2.7.3.2 Iceberg Trade Cost

In the calibration of Section 2.3, I read the iceberg trade costs simply from the WTO tariff profile and the maritime trade cost database. One may argue that the iceberg trade costs will include more than just tariff and maritime trade costs and that I may have underestimated the iceberg trade costs. In this robustness check, I set $\tau = \tau^* = 1.2$, which is much larger than the iceberg trade cost in the calibration of Section 2.3 ($\tau = \tau^* = 1.09$). I show that the key results still hold after this change of calibration.

To incorporate the higher iceberg trade cost, I slightly change the modeling assumptions. In particular, for each firm in the North, I assume that it will incur an iceberg trade cost τ when selling to a random fraction s_L of domestic consumers. If the firm eventually decides to conduct export platform sales, this s_L fraction of consumers will be what the foreign affiliates can serve via export platform sales. The foreign affiliates can still serve this s_L fraction of consumers in the North without any iceberg trade, and this fraction s_L of consumers will be completely random and independent across different firms in the North. I adopt this modification to ensure that the foreign affiliates always have cheaper variable costs compared with the headquarters in serving this fraction s_L of domestic consumers.

With this modification, if the headquarters serves the entire market in the North,

the profit from headquarters sales $\pi_H(z, a_H)$ is

$$\pi_H(z, a_H) = \max_{\{k,l,p,y\}} p_{H,1}y_{H,1} + p_{H,2}y_{H,2} - w(l_{H,1} + l_{H,2}) - R(k_{H,1} + k_{H,2}) - w\kappa_H \tag{2.52}$$

$$s.t.\ y_{H,1} = zk_{H,1}^{\alpha} l_{H,1}^{1-\alpha}, \tag{2.53}$$

$$y_{H,2} = \frac{z}{\tau} k_{H,2}^{\alpha} l_{H,2}^{1-\alpha}, \tag{2.54}$$

$$y_{H,1} = \frac{p_{H,1}^{-\sigma}}{P^{1-\sigma}}(1 - s_H)X, \tag{2.55}$$

$$y_{H,2} = \frac{p_{H,2}^{-\sigma}}{P^{1-\sigma}} s_H X, \tag{2.56}$$

$$\frac{P(k_{H,1} + k_{H,2})}{\phi} \leq a_H. \tag{2.57}$$

Here, $p_{H,1}$ is the price the firm charges the consumers it can serve with no iceberg trade cost. $k_{H,1}$ and $l_{H,1}$ are the capital and labor used to serve these consumers, respectively. $p_{H,2}$ is the price the firm charges the consumers it can serve with iceberg trade costs. $k_{H,2}$ and $l_{H,2}$ are the capital and labor used to serve these consumers, respectively. (2.53) is the production function when the firm faces no trade cost. (2.54) is the production function when the firm faces iceberg trade cost τ. (2.55) is the demand from the consumers the firm can serve with no iceberg trade cost. (2.56) is the demand from the consumers the firm can serve with iceberg trade costs. (2.57) is the financial constraint.

I redo the calibration with this model setup and $\tau = \tau^* = 1.2$. The calibrated parameters are shown in Table 2.19.

Table 2.20 shows the increases in national income brought by a financial reform. The financial reform improves the financial development condition in the South, ϕ^*, from 1.55 to 2. The results indicate that the financial reform still bring a larger increase in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 11.7%. When the economy is open to multinational production, the

Table 2.19: Parameters from Calibration: $\tau = \tau^* = 1.2$

Parameter	Moment	Data	Model
$\bar{z} = 1$	North Manufacturing Output	1	1
$\bar{z}^* = 0.34$	South Manufacturing Output	0.13	0.13
$\kappa_H = \kappa_H^* = 10$	Average Establishment Size (U.S.)	43	44
$\phi = 5.5$	North Private Credit to Output	1.50	1.50
$\phi^* = 1.55$	South Private Credit to Output	1.10	1.15
$\kappa_E = 10$	North Export / South Output	21%	19%
$\kappa_E^* = 18$	South Export / South Output	31%	30%
$\kappa_D = 152$	South Affiliate Output / Output	24%	24%
$\xi = 0.36$	Size of FPE / DPE	17	17
$v_\phi = 0.78$	Sales to Capital Ratio, FPE Relative to DPE	0.89	0.90
$s_H = 0.09$	Export Intensity of Foreign Affiliates	49%	50%
$f_S = 0.0005$	South SOE Output / South Output	18%	18%
$\iota_S^K = 0.07$	Sales to Capital Ratio, SOE Relative to DPE	0.49	0.49
$\iota_S^Y = 0.72$	Export Intensity, DPE Relative to SOE	1.38	1.39
$\theta = 9$	Top 20% Wealth Share North	85%	88%
$\alpha = 0.5$	Capital Share of Output North	0.35	0.35

same financial reform will increase GNP by 19.6%.

Table 2.21 shows the increases in domestic wages and domestic firm profits brought by the financial reform. The results indicate that when the economy is open to multinational production, the financial reform will benefit the entrepreneurs disproportionately more than the workers: When the economy is closed to multinational production, the financial reform in the South will increase domestic wages by 10.6% and domestic firm profits by 8.0%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 11.4% but domestic firm profits by 23.7%.

The results in Table 2.20 and Table 2.21 are consistent with the results in Table 2.4 and Table 2.5, suggesting that our quantitative results are robust to changes in the values of iceberg trade costs.

Table 2.20: Benefits of Financial Reform: $\tau = \tau^* = 1.2$

		Without MF	With MF
Before Reform	GNP	469	408
	GDP	469	462
	GNP/GDP	1.00	0.88
After Reform	GNP	524	488
	GDP	517	514
	GNP/GDP	1.01	0.95
Percentage Change	GNP	11.7%	19.6%
	GDP	10.2%	11.3%
	GNP/GDP	1.5%	7.5%

Table 2.21: Benefits of Financial Reform on Wages and Profits: $\tau = \tau^* = 1.2$

		Without MF	With MF
Before Reform	wage	226	219
	profit	75	59
After Financial Reform	wage	250	244
	profit	81	73
Percentage Change	wage	10.6%	11.4%
	profit	8.0%	23.7%

2.7.3.3 Discount Rate

In the calibration of Section 2.3, I choose the discount rate of $\beta = 0.92$, which is read directly from the paper by Buera, Kaboski, and Shin (2011). This discount rate is on the low end of what the literature typically uses. In this robustness check, I set the discount rate $\beta = 0.94$. I show that the key results still hold after this change of calibration. With $\beta = 0.94$, the calibrated parameters are shown in Table 2.22.

Table 2.23 shows the increases in GNP brought by a financial reform. The financial reform improves the financial development condition in the South, ϕ^*, from 1.45 to 2. The results indicate that the financial reform still bring a larger decline in national income when the economy is open to multinational production: When the economy is closed to multinational production, the financial reform will increase GNP by 11.7%. When the economy is open to multinational production, the same financial reform will increase GNP by 19.6%.

Table 2.22: Parameters from Calibration: $\beta = 0.94$

Parameter	Moment	Data	Model
$\bar{z} = 1$	North Manufacturing Output	1	1
$\bar{z}^* = 0.31$	South Manufacturing Output	0.13	0.14
$\kappa_H = \kappa_H^* = 10$	Average Establishment Size (U.S.)	43	41
$\phi = 3.6$	North Private Credit to Output	1.50	1.48
$\phi^* = 1.45$	South Private Credit to Output	1.10	1.16
$\kappa_E = 17$	North Export / South Output	21%	22%
$\kappa_E^* = 16$	South Export / South Output	31%	31%
$\kappa_D = 100$	South Affiliate Output / Output	24%	24%
$\xi = 0.34$	Size of FPE / DPE	17	17
$v_\phi = 0.82$	Sales to Capital Ratio, FPE Relative to DPE	0.89	0.90
$s_H = 0.11$	Export Intensity of Foreign Affiliates	49%	49%
$f_S = 0.0005$	South SOE Output / South Output	18%	18%
$\iota_S^K = 0.00$	Sales to Capital Ratio, SOE Relative to DPE	0.49	0.50
$\iota_S^Y = 0.80$	Export Intensity, DPE Relative to SOE	1.38	1.39
$\theta = 9$	Top 20% Wealth Share North	85%	88%
$\alpha = 0.5$	Capital Share of Output North	0.35	0.34

Table 2.24 shows the increases in domestic wages and domestic firm profits brought by the financial reform. The results indicate that when the economy is open to multinational production, the financial reform will benefit the entrepreneurs disproportionately more than the workers: When the economy is closed to multinational production, the financial reform in the South will increase domestic wages by 11.5% and domestic firm profits by 17.4%. When the economy is open to multinational production, the same financial reform will increase domestic wages by 16.0% but domestic firm profits by 38.2%.

The results in Table 2.23 and Table 2.24 are consistent with the results in Table 2.4 and Table 2.5, suggesting that our quantitative results are robust to alternative values of the discount rate β.

Table 2.23: Benefits of Financial Reform: $\beta = 0.94$

		Without MF	With MF
Before Reform	GNP	455	394
	GDP	443	441
	GNP/GDP	1.03	0.90
After Reform	GNP	530	508
	GDP	499	500
	GNP/GDP	1.06	1.02
Percentage Change	GNP	16.5%	28.9%
	GDP	12.6%	13.4%
	GNP/GDP	3.4%	13.4%

Table 2.24: Benefits of Financial Reform on Wages and Profits: $\beta = 0.94$

		Without MF	With MF
Before Reform	wage	217	206
	profit	69	55
After Financial Reform	wage	242	239
	profit	81	76
Percentage Change	wage	11.5%	16.0%
	profit	17.4%	38.2%

CHAPTER 3

Joint Ventures and Technology Spillovers in China

3.1 Introduction

Chinese government actively promotes joint ventures of foreign multinational firms with state-owned firms. An important motivation behind such policy is to promote technology spillovers from the foreign multinational firms (Holmes, McGratten, and Prescott 2015). However, evidence on the effects of such policy in promoting technology spillovers is scarce. In this chapter, I study the effects of the joint ventures in promoting technology spillovers in China.

A joint venture is defined as a firm with both significant foreign share and state-owned share. Using Chinese firm-level data, I construct measures of joint venture presence in each industrial sector, as well as joint venture presence in the upstream and in the downstream of each sector. Empirically, I find that from 2000 to 2007, increased joint venture presence in a sector leads to higher productivity of firms in the upstream of that sector, but lower productivity of firms in the downstream of that sector, and no significant changes in the productivity of firms in the same sector.

To understand the aggregate impact of joint ventures in promoting technology spillovers, I use a quantitative model that features a production network (Acemoglu, Akcigit, and Kerr 2016). Quantitatively, I find that joint ventures' negative impact on the productivity of firms in the downstream is the dominant force. In particular, a counter-factual analysis suggests that increasing the joint venture presence from zero to the level observed in 2005 will lead to decreases in output in all two-digit industrial sectors and cause a significant decline in total industrial output in China.

Related Literature

This chapter is closely related to the literature on the technology spillovers of multinational firms (Aitken and Harrison 1999, Javorcik 2004, Harrison and Rodríguez-Clare 2010). Lin, Liu, and Zhang (2009) and Du, Harrison, and Jefferson (2012) use similar regression techniques to study the effects of technology spillovers from multinational firms in China. This chapter contributes to the literature by evaluating the effect of a specific industrial policy - the joint ventures of foreign multinational firms with state-owned firms - in promoting technology spillovers in China.

The chapter is closely related to the literature on industrial policies (Chang 2003, Harrison and Rodríguez-Clare 2010, Aghion, et al 2015). Holmes, McGratten, and Prescott (2015) finds that *quid pro quo* policies, or policies that require multinational firms to transfer technology in return for market access, significantly improve industrial output in China. In their paper, they adopt a structural model with a representative firm and do not consider the technology spillovers in a production network. Joint venture is a very important component of the *quid pro quo* policies. This chapter complements their study by studying the effects of the joint ventures on technology spillovers. I find that, contrary to the findings in Holmes, McGratten, and Prescott (2015), due to joint ventures' negative impact on the productivity of firms in the downstream, joint ventures will on aggregate prevent technology spillovers and significantly reduce total industrial output in China.

The chapter is also related to the literature on production network. The quantitative model of production network in this chapter is based on the model in Acemoglu, Akcigit, and Kerr (2016). The chapter finds that increased joint venture presence in a sector leads to higher productivity of firms in the upstream of the sector but lower productivity of firms in the downstream of the sector. The reasons behind this finding are worth further study. At the end of this chapter, I offer some possible explanations.

3.2 Empirical Strategy

3.2.1 Data and Variables

We use firm-level data in the Chinese Industrial Survey from 2000 to 2007. The Chinese Industrial Survey covers all state-owned firms and private firms with revenue above 5,000,000 yuan (around $600,000). The survey contains information on firm output, value-added, capital, labor and intermediate inputs, among others. The survey also contains information on paid-up capital owned by state, foreigner and various other sources. I follow the methods from Brandt, Van Biesebroeck, and Zhang (2014) to link firms over time and construct real variables. This gives us an unbalanced panel from 2000 to 2007.

The data covers 425 four-digit industries. For firm i in industry j in year t, we define the foreign share in the firm as the share of paid-up capital owned by foreigners

$$ForeignShare_{ijt} = \frac{ForeignPaidupCapital_{ijt}}{TotalPaidupCapital_{ijt}}.$$

Similarly, the state share in the firm is defined as the share of paid-up capital owned by the state

$$StateShare_{ijt} = \frac{StatePaidupCapital_{ijt}}{TotalPaidupCapital_{ijt}}.$$

We will define a firm as a state-owned firm (or state-owned enterprise, SOE) if the state share of paid-up capital exceeds 50%.

$$SOE_{ijt} = \begin{cases} 1, & StateShare_{ijt} > 0.5. \\ 0, & \text{otherwise.} \end{cases}$$

Notice our results in this paper will be unchanged if we define state-owned firms as firms with more than 10% of paid-up capital owned by state. If a firm is a state-owned firm and at the same time has paid-up capital owned by foreigners, we categorize such a firm as a joint venture. For firm i in industry j in year t, the joint venture share in

the firm is defined as

$$JVShare_{ijt} = ForeignShare_{ijt} * SOE_{ijt}.$$

The presence of multinational firms in industry j in year t, $HorizontalFDI_{jt}$, is defined as the average of firms' foreign shares in industry j weighted by firms' output.

$$HorizontalFDI_{jt} = \frac{\sum_{i \in j} ForeignShare_{ijt} * Y_{ijt}}{\sum_{i \in j} Y_{ijt}}.$$

Here Y_{ijt} is the real output of firm i in industry j in year t. Similarly, the presence of joint ventures in industry j in year t, $HorizontalJV_{jt}$, and the presence of state-owned firms in industry j in year t, $HorizontalState_{jt}$, are defined as

$$HorizontalJV_{jt} = \frac{\sum_{i \in j} JVShare_{ijt} * Y_{ijt}}{\sum_{i \in j} Y_{ijt}},$$

$$HorizontalState_{jt} = \frac{\sum_{i \in j} StateShare_{ijt} * Y_{ijt}}{\sum_{i \in j} Y_{ijt}}.$$

We also compute the presence of joint ventures in the upstream and downstream of industry j. To do so we use the approach in Javorcik (2004) and rely on the input-output tables. We use the 2002 input-output tables for China. We define the presence of multinational firms in the upstream of industry j as

$$UpstreamFDI_{jt} = \sum_{k \neq j} \sigma_{jk} \frac{\sum_{i \in k} ForeignShare_{ikt} * (Y_{ikt} - X_{ikt})}{\sum_{i \in k} (Y_{ikt} - X_{ikt})}.$$

Here X_{ikt} is the real export of firm i in industry k in year t. σ_{jk} is the share of total intermediate inputs used by industry j that is purchased from industry k. Similarly, the presence of joint ventures in the upstream of industry j in year t, $UpstreamJV_{jt}$, and the presence of state-owned firms in the upstream of industry j

in year t, $UpstreamState_{jt}$, are defined as

$$UpstreamJV_{jt} = \sum_{k \neq j} \sigma_{jk} \frac{\sum_{i \in k} JVShare_{ikt} * (Y_{ikt} - X_{ikt})}{\sum_{i \in k} (Y_{ikt} - X_{ikt})},$$

$$UpstreamState_{jt} = \sum_{k \neq j} \sigma_{jk} \frac{\sum_{i \in k} StateShare_{ikt} * (Y_{ikt} - X_{ikt})}{\sum_{i \in k} (Y_{ikt} - X_{ikt})}.$$

The presence of multinational firms in the downstream of industry j in year t is defined as

$$DownstreamFDI_{jt} = \sum_{k \neq j} \alpha_{jk} Horizontal_{kt}.$$

Here α_{jk} is the share of industry j's total output that is supplied to industry k as intermediate inputs. Similarly, the presence of joint ventures in the downstream of industry j in year t, $DownstreamJV_{jt}$, and the presence of state-owned firms in the downstream of industry j in year t, $DownstreamState_{jt}$, are defined as

$$DownstreamJV_{jt} = \sum_{k \neq j} \alpha_{jk} HorizontalJV_{kt},$$

$$DownstreamState_{jt} = \sum_{k \neq j} \alpha_{jk} HorizontalState_{kt}.$$

Notice to use the input-output tables, we map the 425 four-digit industries into 74 two-digit sectors in the input-output tables. As a result, our measures of joint venture presence in the upstream and downstream of industry j in each year t are defined at the two-digit sector level.

3.2.2 Regression I

The first regression test is as follows:

$$lnY_{ijt} = d_i + d_t + \alpha lnK_{ijt} + \beta lnL_{ijt} + \gamma lnM_{ijt} + \theta_1 HorizontalJV_{it} + \theta_2 UpstreamJV_{ijt} + \theta_3 DownstreamJV_{ijt} + \xi X_{ijt} + \epsilon_{ijt}. \tag{3.1}$$

Here d_i is firm fixed effect and d_t is year fixed effect. K_{ijt} is the real capital stock for firm i in industry j in year t. L_{ijt} is the labor for firm i in industry j in year t.[1] M_{ijt} is the real intermediate inputs for firm i in industry j in year t. X_{ijt} include a set of controls. The controls include the foreign share, state share and joint venture share in the firm ($ForeignShare_{ijt}$, $StateShare_{ijt}$, $JVShare_{ijt}$). The controls also include the presence of multinational firms and state-owned firms in the same industry ($HorizontalFDI_{jt}$, $HorizontalState_{jt}$), in the upstream of the industry ($UpstreamFDI_{jt}$, $UpstreamState_{jt}$) and in the downstream of the industry ($DownstreamFDI_{jt}$, $DownstreamState_{jt}$).

The parameters of interest are θ_1, θ_2 and θ_3. These parameters provides information on how changes in joint venture presence in the same sector (θ_1), in the upstream of the sector (θ_2) and in the downstream of the sector (θ_3) affect firm output and productivity.

3.2.3 Regression II

Simply regressing output (Y) on various inputs (K, L, M) may produce biased estimates for firm productivity (Olley and Pakes 1996). To address this concern, we estimate a Cobb-Douglas production function for each of the two-digit sectors

$$Y_{ijt} = A_{ijt} K^{\alpha_j} L^{\beta_j} M^{\gamma_j}.$$

[1]The empirical results remain unchanged if we use wage payment instead of labor here

The coefficients α_j, β_j and γ_j will be different for each of the two-digit sectors, and will be read from the share of total output paid to labor, capital and intermediate inputs in that sector. For each of the firm i in industry j in year t, we can then compute the productivity A_{ijt} as the residual

$$lnA_{ijt} = lnY_{ijt} - \alpha_j lnK_{ijt} - \beta_j lnL_{ijt} - \gamma_j lnM_{ijt}.$$

The second regression test is as follows:

$$lnA_{ijt} = d_i + d_t + \theta_1 HorizontalJV_{it} + \theta_2 UpstreamJV_{ijt} + \theta_3 DownstreamJV_{ijt} + \xi X_{ijt} + \epsilon_{ijt}. \quad (3.2)$$

Here d_i and d_t are firm and year fixed effects. X_{ijt} include the same set of controls as in the first regression test.

I also estimate the firm productivity, A_{ijt}, using the method documented in Levinsohn and Petrin (2003) and Petrin, Poi, and Levinsohn (2004), which is a variant of the method in Olley and Pakes (1996). As we will see later, the key results in this paper is also robust to using this alternative method to estimate firm productivity.

3.3 Empirical Results

Table 3.1 shows the results from Regression I. The results indicate the following: First, higher joint venture presence in a sector leads to higher productivity of firms in the same sector. This is reflected by the positive and significant coefficients for $HorizontalJV_{jt}$. Second, higher joint venture presence in the upstream of a sector leads to lower productivity of firms in the sector. This is reflected by the negative and significant coefficients for $UpstreamJV_{jt}$. Third, higher joint venture presence in the downstream of a sector leads to higher productivity of firms in the sector. This is reflected by the positive and significant coefficients for $DownstreamJV_{jt}$.

Table 3.2 shows the results from Regression II. The results suggest that higher joint venture presence in a sector does not significantly change productivity of firms in the same sector, since the coefficients for $HorizontalJV_{jt}$ are in most cases not significantly different from zero. Since we are using sector-level production functions in Regression II, we deem the results to be more accurate than the results we find in Table 3.1. We hence conclude that higher joint venture presence in a sector does not significantly change productivity of firms in the same sector.

Table 3.2 confirms our earlier finding on the effects of joint ventures on the productivity of firms in the upstream and downstream. In particular, we find that higher joint venture presence in the upstream of a sector leads to lower productivity of firms in the sector. This is reflected by the negative and significant coefficients for $UpstreamJV_{jt}$. We also find that higher joint venture presence in the downstream of a sector leads to higher productivity of firms in the sector. This is reflected by the positive and significant coefficients for $DownstreamJV_{jt}$.

I also compute firm productivity using the method in Petrin and Levinsohn (2003) and run regression II again. The results for this regression III are documented in Table 3.3. We see that the key results are robust to this alternative way of computing firm productivity.

Combining the results from Table 3.1 and Table 3.2, we conclude that higher joint venture presence in a sector will lead to higher productivity of firms in the upstream of that sector, but lower productivity of firms in the downstream of the sector, and no significant changes in the productivity of firms in the same sector.

As an aside, the coefficients for the control variables in Table 3.1 and Table 3.2 are largely consistent with what the literature has previously found. For example, the literature documents an ambiguous effect of technology spillovers from multinational firms to firms in the same sector (Javorcik 2008, Harrison and Rodríguez-Clare 2010). We find that the coefficients for $HorizontalFDI_{jt}$ are indeed of ambiguous signs in our various set-ups. The literature has typically found significant positive technology

spillovers from multinational firms to firms in the upstream and downstream sectors (Harrison and Rodríguez-Clare 2010). This is consistent with our significant and positive coefficients for $UpstreamFDI_{jt}$ and $DownstreamFDI_{jt}$.

3.4 Structural Analysis

In Section 3.3, we show that the presence of joint ventures in a sector will lead to higher productivity of firms in the upstream of the sector but lower productivity of firms in the downstream of the sector. This section aims to study the aggregate impact of such technology spillovers brought by the joint ventures. To do so we use a simple structural model that features a production network. The model is based on the model of production network in Acemoglu, Akcigit, and Kerr (2016).

3.4.1 Model

There are N sectors in the economy, $j = 1, 2, ..., N$. The production function of the representative firm in each sector j is

$$y_j = e^{z_j} l_j^{\alpha_j^l} \prod_{i=1}^{n} x_{ji}^{\alpha_{ji}}; \quad \alpha_j^l + \sum_{i=1}^{N} \alpha_{ji} = 1. \tag{3.3}$$

Here l_j is the labor hired in sector j. x_{ji} is the intermediate input from sector i that is used in the production of sector j. For simplicity, I consider a static model and abstract from capital and saving.

The productivity of the representative firm in sector j, z_j, will be affected by the presence of joint ventures in the same sector j ($HorizontalJV_j$), in the upstream of sector j ($UpstreamJV_j$) and in the downstream of sector j ($DownstreamJV_j$) in the following simple way:

$$z_j = \bar{z}_j + \theta_H HorizontalJV_j + \theta_D DownstreamJV_j + \theta_U UpstreamJV_j. \tag{3.4}$$

The representative household in the economy has preference

$$u(c_1, c_2, ..., c_N, l) = \gamma(l) \prod_{j=1}^{n} c_j^{\beta_j}; \quad \sum_{i=j}^{N} \beta_j = 1.$$

Here $\gamma(l)$ is a decreasing (differentiable) function capturing the disutility of labor.

Market clearing for all sector $j = 1, 2, ..., N$ indicates

$$y_j = c_j + \sum_{k=1}^{n} x_{kj}.$$

We have the following Proposition:

Proposition 3. *Let A denote the matrix of α_{ij}'s, $A = \begin{bmatrix} \alpha_{11} & \alpha_{12}... & & \\ \alpha_{21} & \alpha_{22}... & & \\ & & \ddots & \\ & & & \alpha_{nn} \end{bmatrix}$. The impact of a vector of productivity shocks $dz = (dz_1, dz_2, ..., dz_N)$ will lead to the following changes in output and consumption:*

$$dlny = dlnc = (I - A)^{-1} dz$$

The proof of the Proposition can be found in Acemoglu, Akcigit, and Kerr (2016). We will rely on this Proposition to measure how productivity changes (dz) brought by increased joint venture presence affect industrial output.

3.4.2 Quantitative Analysis

We read the matrix A and vector β directly from the 2002 input-output tables for China. We estimate θ_D, θ_U and θ_H in (3.4) using our regression results in Table 3.2.[2] In particular, we choose two sets of parameters from Table 3.2. In the first set,

[2]Such method of estimating θ_D, θ_U and θ_H is simple but does not take into account how changes in joint venture requirements can affect other variables, which in turn may affect firm productivity.

$\theta_D = 1.23$, $\theta_U = -15.7$, $\theta_H = 0$. In the second set, $\theta'_D = 1.77$, $\theta'_U = -13.3$, $\theta'_H = 0$.

We perform the following counter-factual analysis in the model: What will happen to industrial output when joint venture presence is increased from zero to the level observed in 2005?

We find the following quantitative results: First, after the increase in joint venture presence, under both set of parameters, all two-digit sectors in the economy will experience a decline in output, though the magnitude of the declines are different across sectors. Table 3.4 reports the declines in output in each of the two-digit sectors caused by the increased joint venture presence. Second, under the two sets of parameters, total industrial output is lowered by 2.2% and 3.0% respectively due to the increased joint venture presence.

Such results suggest that on aggregate, joint ventures' negative impact on the productivity of firms in the downstream is the dominant force. The joint ventures will on aggregate prevent technology spillovers and cause a significant decline in total industrial output in China.

3.5 Conclusion

In this chapter, I find that joint ventures prevent technology spillovers and reduce total industrial output in China. In particular, I find that higher joint venture presence in a sector leads to higher productivity of firms in the upstream of that sector, but lower productivity of firms in the downstream of that sector. The exact reasons behind such finding are left for future research. Here I offer some possible explanations: Joint ventures are perhaps more likely to source from local firms, impose local content requirements and share blueprints with local firms. As a result, joint ventures could help improve productivity of firms in the upstream. However, the multinational firms

For example, the removal of joint venture requirements may increase FDI and in turn improve productivity of firms. Capturing these complications will require a more complicated model. Here I abstract from these complications to get a first-pass quantitative answer.

may not bring their best technology to the joint ventures for fear of being stolen by local rivals. In addition, the joint ventures may be inefficient in producing goods that supply the downstream firms. Joint ventures may also enjoy monopoly power and reduce competition in its sector. As a result, joint ventures could hurt the productivity of firms in the downstream sectors.

Table 3.1: Results from Regression I in (3.1)

	(1) lnY_{ijt}	(2) lnY_{ijt}	(3) lnY_{ijt}	(4) lnY_{ijt}	(5) lnY_{ijt}	(6) lnY_{ijt}
lnK_{ijt}	0.053***	0.048***	0.048***	0.048***	0.048***	0.048***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnL_{ijt}	0.137***	0.131***	0.132***	0.131***	0.131***	0.131***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnM_{ijt}	0.718***	0.732***	0.732***	0.732***	0.732***	0.732***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$HorizontalJV_{jt}$	0.550***	0.596***	0.696***	0.707***	0.697***	0.651***
	(0.097)	(0.094)	(0.095)	(0.095)	(0.095)	(0.095)
$UpstreamJV_{jt}$	-15.694***	-15.417***	-16.158***	-15.224***	-15.254***	-15.315***
	(0.680)	(0.662)	(0.670)	(0.671)	(0.671)	(0.696)
$DownstreamJV_{jt}$	3.016***	2.836***	2.806***	3.727***	3.719***	2.572***
	(0.264)	(0.257)	(0.257)	(0.259)	(0.259)	(0.274)
$ForeignShare_{ijt}$		0.007**	0.007**	0.008**	0.007**	0.007**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$HorizontalFDI_{jt}$			0.027***	-0.041***	-0.041***	-0.033***
			(0.006)	(0.007)	(0.007)	(0.007)
$HorizontalState_{jt}$			-0.047***	-0.054***	-0.051***	-0.051***
			(0.006)	(0.006)	(0.006)	(0.006)
$UpstreamFDI_{jt}$				1.114***	1.115***	1.171***
				(0.030)	(0.030)	(0.030)
$DownstreamFDI$				0.246***	0.246***	0.227***
				(0.013)	(0.013)	(0.013)
$JVShare_{ijt}$					0.060**	0.060**
					(0.022)	(0.022)
$StateShare_{ijt}$					-0.016***	-0.015***
					(0.002)	(0.002)
$UpstreamState_{jt}$						0.058***
						(0.017)
$DownstreamState_{jt}$						0.256***
						(0.019)
Firm and Year Fixed Effects	YES	YES	YES	YES	YES	YES

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.2: Results from Regression II in (3.2)

	(1) lnA_{ijt}	(2) lnA_{ijt}	(3) lnA_{ijt}	(4) lnA_{ijt}	(5) lnA_{ijt}	(6) lnA_{ijt}
$HorizontalJV_{jt}$	-0.125	0.136	0.141	0.129	0.089	0.537***
	(0.100)	(0.098)	(0.098)	(0.098)	(0.098)	(0.120)
$UpstreamJV_{jt}$	-12.895***	-14.202***	-13.283***	-13.329***	-15.673***	-20.654***
	(0.703)	(0.692)	(0.694)	(0.693)	(0.719)	(1.063)
$DownstreamJV_{jt}$	0.637*	0.587*	1.767***	1.754***	1.232***	1.411***
	(0.273)	(0.266)	(0.268)	(0.268)	(0.284)	(0.344)
$ForeignShare_{ijt}$		0.004	0.004	0.004	0.004	0.008**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
$HorizontalFDI_{jt}$		0.002	-0.075***	-0.074***	-0.063***	-0.063***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$HorizontalState_{jt}$		-0.103***	-0.113***	-0.108***	-0.097***	-0.119***
		(0.006)	(0.006)	(0.006)	(0.006)	(0.008)
$UpstreamFDI_{jt}$			1.346***	1.348***	1.396***	1.520***
			(0.031)	(0.031)	(0.031)	(0.037)
$DownstreamFDI_{jt}$			0.242***	0.242***	0.234***	0.244***
			(0.014)	(0.014)	(0.014)	(0.017)
$JVShare_{ijt}$				0.061**	0.060**	0.048
				(0.022)	(0.022)	(0.026)
$StateShare_{ijt}$				-0.023***	-0.023***	-0.019***
				(0.002)	(0.002)	(0.003)
$UpstreamState_{jt}$					0.250***	0.220***
					(0.017)	(0.022)
$DownstreamState_{jt}$					0.149***	0.247***
					(0.020)	(0.025)
$lnA_{ij,t-1}$						-0.015***
						(0.001)
Firm and Year Fixed Effects	YES	YES	YES	YES	YES	YES

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.3: Results from Regression II in (3.2), Levinsohn and Petrin Method

	(1) lnA_{ijt}	(2) lnA_{ijt}	(3) lnA_{ijt}	(4) lnA_{ijt}	(5) lnA_{ijt}Y	(6) lnA_{ijt}
$HorizontalJV_{jt}$	0.527***	0.669***	0.680***	0.669***	0.629***	1.039***
	(0.099)	(0.098)	(0.098)	(0.098)	(0.098)	(0.118)
$UpstreamJV_{jt}$	-16.237***	-16.552***	-15.638***	-15.680***	-15.856***	-21.550***
	(0.697)	(0.689)	(0.690)	(0.690)	(0.716)	(1.050)
$DownstreamJV_{jt}$	3.357***	3.197***	4.092***	4.080***	3.094***	3.325***
	(0.271)	(0.265)	(0.267)	(0.267)	(0.282)	(0.340)
$ForeignShare_{ijt}$		0.008**	0.008***	0.007**	0.007**	0.011***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
$Horizontal_{jt}$		0.033***	-0.034***	-0.033***	-0.026***	-0.023**
		(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$HorizontalState_{jt}$		-0.051***	-0.058***	-0.055***	-0.054***	-0.068***
		(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
$UpstreamFDI_{jt}$			1.081***	1.083***	1.133***	1.154***
			(0.031)	(0.031)	(0.031)	(0.037)
$DownstreamFDI_{jt}$			0.239***	0.240***	0.223***	0.223***
			(0.014)	(0.014)	(0.014)	(0.016)
$JVShare_{ijt}$				0.057*	0.056*	0.050
				(0.022)	(0.022)	(0.026)
$StateShare_{ijt}$				-0.021***	-0.021***	-0.018***
				(0.002)	(0.002)	(0.003)
$UpstreamState_{jt}$					0.062***	-0.007
					(0.017)	(0.022)
$DownstreamState_{jt}$					0.222***	0.312***
					(0.020)	(0.025)
$lnA_{ij,t-1}$						0.016***
						(0.001)
Firm and Year Fixed Effects	YES	YES	YES	YES	YES	YES

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.4: Output Changes in Two Digit Sectors due to Joint Ventures

Two-digit Industry Name	First Set of θs	Second Set of θs
Grain grinding	-0.39%	-0.50%
Feed processing	-0.56%	-0.70%
Vegetable oil processing	-0.40%	-0.54%
Sugar	-0.42%	-0.74%
Slaughter and meat processing	-0.23%	-0.29%
Aquatic products processing	-0.23%	-0.31%
Other food processing and food	-0.91%	-1.22%
Alcohol and beverages	-0.90%	-1.16%
Other beverage	-1.49%	-1.91%
Tobacco products	-1.89%	-2.34%
Cotton, chemical fiber textile printing and dyeing	-2.18%	-2.72%
Wool, dyeing and finishing	-1.37%	-1.74%
Hemp, silk fine processing	-1.76%	-2.21%
Textile products	-1.99%	-2.57%
Knitwear and its products	-2.78%	-3.46%
Textile and garment, shoes, hats	-2.03%	-2.59%
Leather, fur, feather (velvet) and its products	-1.27%	-1.64%
Wood, bamboo, rattan, brown, grass products	-1.40%	-1.83%
Furniture	-1.91%	-2.46%
Paper and paper products	-2.01%	-2.58%
Printing and recording devices	-2.52%	-3.21%
Culutral products	-2.87%	-3.63%
Toy, sports and entertainment products	-3.22%	-4.05%
Oil and nuclear fuel processing	-0.33%	-0.49%
Coking	-0.43%	-0.64%
Basic chemical raw materials	-0.94%	-1.38%
Fertilizer	-1.93%	-2.45%
Pesticide	-1.83%	-2.37%
Coatings, paints, inks and similar products	-1.27%	-1.98%
Synthetic materials	-0.93%	-1.33%
Specialized chemical products	-1.33%	-1.86%
Daily chemical products	-1.66%	-2.17%
Pharmaceutical	-1.18%	-1.52%
Chemical fiber	-2.69%	-3.41%
Rubber products	-0.96%	-1.85%
Plastic products	-3.71%	-4.76%
Cement, lime and gypsum	-1.52%	-1.98%
Glass and glass products	-1.12%	-1.64%
Ceramic products	-1.08%	-1.42%
Refractory and fire-proof products	-1.10%	-1.52%

Two-digit Industry Name	First Set of θs	Second Set of θs
Ironmaking industry	-0.72%	-1.07%
Other non - metallic mineral products	-1.26%	-1.70%
Steelmaking industry	-1.18%	-1.89%
Steel rolling and processing industry	-1.24%	-1.93%
Ferroalloy smelting	-1.00%	-1.43%
Nonferrous metal smelting	-0.58%	-0.82%
Non - ferrous metal rolling processing	-2.38%	-3.03%
Metal products	-2.20%	-2.94%
Boiler and prime mover	-0.98%	-2.37%
Metal processing machinery	-2.63%	-3.56%
Other general equipment	-2.60%	-3.59%
Agriculture, forestry, animal husbandry and fishery machinery	-6.33%	-8.04%
Other special equipment	-2.92%	-3.83%
Railway transportation equipment	-3.15%	-4.10%
Automotive	-2.80%	-4.78%
Automobile parts and accessories	-1.26%	-4.51%
Ship and floating device	-4.79%	-6.10%
Other transportation equipment	-5.01%	-6.47%
Motor manufacturing	-2.73%	-3.81%
Household utensils	-2.49%	-3.35%
Other electrical machinery and equipment	-2.34%	-3.12%
Communications equipment	-2.89%	-3.70%
Electronic computer	-3.05%	-3.87%
Other electronic equipment	-3.07%	-3.91%
Electronic components	-2.58%	-3.34%
Household audio - visual equipment	-3.02%	-3.85%
Other communications, electronic equipment	-3.05%	-3.94%
Instrumentation	-2.45%	-3.30%
Culture, office machinery	-2.97%	-3.83%
Arts and crafts	-1.86%	-2.45%
Other industry	-2.01%	-2.62%
Electricity, heat production and supply	-0.61%	-0.87%
Gas production and supply	-0.42%	-0.58%
Water production and supply	-0.91%	-1.30%
Total Industrial Output	-2.23%	-2.97%

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