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Three Essays on Financial Constraints and Foreign Direct Investment

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THREE ESSAYS ON FINANCIAL CONSTRAINTS AND FOREIGN DIRECT INVESTMENT

by

Todd Sarnstrom II

A dissertation submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
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THREE ESSAYS ON FINANCIAL CONSTRAINTS AND FOREIGN DIRECT INVESTMENT

Todd Sarnstrom II, Ph.D.
Western Michigan University, 2016

This three-essay dissertation makes contributions to the literature on foreign direct investment (FDI) and its relationship with collateral and the exchange rate. FDI refers to an investment made by a firm to establish or acquire a long-lasting interest in another firm operating outside its home country. Often, FDI involves substantial fixed costs that require the investing firm to seek external financing. Collateral has been identified as an important factor in the external financing of FDI. Firms lacking collateral are constrained in their ability obtain external financing. Exchange rates have also been identified as a factor in FDI. Exchange rate movements may create differences in relative wealth between firms headquartered in different countries.

The first essay studies how the value of collateral pledged to externally financed FDI varies with how productive firms are. I develop a theoretical model illustrating that more productive firms are able to pledge a smaller amount of collateral relative to less productive firms. Additionally, firms with a productivity level below a set threshold level need to pledge collateral of greater value than the amount borrowed. Firms facing this situation may opt to instead forego the FDI project. I empirically examine the relationship between pledged collateral and productivity using firm-level data on Japanese FDI into the U.S. between 1980 and 2000. My results support an inverse relationship between productivity and pledged collateral implied by the theoretical model. My results are the strongest for 1991–2000, the period that followed the
burst of Japan’s asset bubble and subsequent collapse of its banking system, which limited the access Japanese firms had to external financing.

The second essay studies the impact a financial shock has on the amount of controlling interest (ownership equity) the investing firm has in the foreign affiliate. In particular, I show how land price shocks in Japan shaped the ownership equity of Japanese foreign affiliates by analyzing impulse response functions for Japanese foreign direct investment into 12 OECD countries from 1975 to 2000. A positive shock to land value increased ownership equity in foreign affiliates belonging to the same 2-digit standard industrial classification as their Japanese parent by approximately 4–8 percentage points.

The third essay studies the impact exchange rate movements have on foreign direct investment flows. I use a relatively new empirical technique known as global vector autoregression (GVAR) to model the interactions between the real exchange rate and U.S. outward FDI. My results indicate evidence of a statistical relationship between U.S. FDI outflow and exchange rate movements. However, the actual size of the effect on U.S. FDI outflow is very small; amounting to much less than 1% of overall FDI received by host countries in the study for recent years. I conclude that exchange rates did not have an economically meaningful impact on U.S. FDI outflows during this period.
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Todd Sarnstrom II
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CHAPTER I
INTRODUCTION

This three-essay dissertation makes contributions to the literature on foreign direct investment (FDI) and its relationship with collateral and the exchange rate. FDI refers to an investment made by a firm in order to establish or acquire a long-lasting interest in another firm operating outside its home country. The OECD’s (2015) FDI financial flows indicator shows that world-wide outward FDI was approximately 48 percent lower in 2009 compared to its peak in 2007, and has subsequently struggled to return to its previous levels. This observation has generated a renewed interest in financial barriers to FDI.

Collateral has been identified as an important factor to externally financing FDI. Often, FDI involves substantial fixed costs that require the investing firm to seek external financing, such as a bank loan, to move forward with the FDI project. Firms pledge collateral in the form of tangible assets, such as land, to secure external financing. Pledged collateral is forfeited to the lender in the case of default, giving firms incentive to follow through with repayment. Firms lacking in available collateral are constrained in their ability to obtain external financing.

The first essay offers a different perspective on the relationship between collateral and FDI. Previous literature focuses on the value of collateral available to the firm, asserting that firms with more available collateral are less constrained in their ability to externally finance their FDI projects.¹ Instead, the first essay studies how the value of pledged collateral varies with a firm’s productivity level. I develop a theoretical model illustrating that more productive firms are able to pledge a smaller amount of collateral relative to less productive firms for FDI projects.

¹ See, for example, Buch et al. (2014), Gan (2007), and Raff et al. (2015).
requiring the same amount of external financing. Intuitively, more productive firms are safer investments in the eyes of lenders as their FDI projects are more likely to succeed relative to less productive firms. This grants more productive firms the ability to pledge less collateral relative to their less productive counterparts. Additionally, firms with a productivity level below a set threshold level need to pledge collateral of greater value than the amount borrowed. This may not be a feasible option for firms facing this situation and cause them to instead forego the FDI project.

I empirically examine the relationship between pledged collateral and productivity using firm–level data on Japanese FDI into the U.S. between 1980 and 2000. My results support an inverse relationship between productivity and pledged collateral implied by my theoretical model. My results are the strongest for 1991–2000, the period that followed the burst of Japan’s asset bubble and subsequent collapse of its banking system, which limited the access Japanese firms had to external financing. My results suggest that the productivity level of a firm is important in determining the amount of collateral pledged to secure external financing during a time of financial crisis. A plausible explanation is that in the eyes of lenders more productive firms are more likely to be successful with their FDI projects, reducing the likelihood of default. This allows more productive firms to secure external financing with less collateral relative to less productive firms.

The second essay studies the impact a shock to available collateral has on the amount of ownership equity parent firms place in their foreign affiliates. Ownership equity refers to the amount of controlling interest the investing firm has in the foreign affiliate. Japanese multinational firms were subjected to large financial shocks during the 1980s and 1990s. Land prices surged during the late 1980s, resulting in a large land price bubble which subsequently
collapsed during the early 1990s. Land prices lost approximately half their value during the 1990s, sending Japan into financial crisis. Domestically–held land is also a traditional form of collateral in Japan’s culture of corporate finance. While previous literature, such as Raff et al. (2015), has studied how collateral affects the amount of outgoing FDI, I instead focus on how collateral affects the amount of ownership equity parent firms place in their foreign affiliates. Intuitively, a positive shock to land prices such as the one experienced by Japan during the late 1980s increases the amount of collateral available to firms, thereby increasing their borrowing capacity. A multinational firm may opt to establish a wholly owned foreign affiliate, as opposed to sharing ownership with a partner, as a result of increased borrowing capacity. In other words, increased borrowing capacity may make an investment partner unnecessary by increasing the feasibility of financing a wholly owned foreign affiliate.

I show how land price shocks in Japan shaped the ownership equity of Japanese foreign affiliates by analyzing impulse response functions for Japanese foreign direct investment into 12 OECD countries from 1975 to 2000. A positive shock to land value increased ownership equity in foreign affiliates belonging to the same 2-digit standard industrial classification as their Japanese parent by approximately 4–8 percentage points. Ownership equity in foreign affiliates outside the 2-digit standard industrial classification of their Japanese parent does not appear to be affected by a positive land value shock. This may be due to the fact that non–core affiliates are likely to require assets and knowledge that the parent may not possess but can easily obtain through shared ownership of the foreign affiliate.

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2 See Gan (2007).
Exchange rates have also been identified as a factor in FDI.\(^3\) Exchange rate movements may create differences in relative wealth between firms headquartered in different countries. Firms are more capable of internally financing their FDI projects as the home country’s currency appreciates due to an increase in their relative wealth. However, there is also evidence that exchange rates are not an important factor to FDI\(^4\) or behave in a uniform manner.\(^5\) Perhaps an intuitive counterargument against the importance of exchange rates in FDI follows from the long time horizon associated with FDI. It is reasonable to say that it takes considerable time to plan and establish a foreign affiliate. It is also reasonable to say that once a multinational firm establishes a foreign affiliate in another country, they are in it for the long haul. Multinational firms should expect that the exchange rate between home and host country will fluctuate over the lifetime of the foreign affiliate. Therefore, the exchange rate should not be a critical factor to multinational firms engaging in FDI.

The third essay studies the impact exchange rate movements have on foreign direct investment flows using a relatively new empirical technique known as global vector autoregression (GVAR) to model the interactions between the real exchange rate and U.S. outward FDI. There are several attractive properties to this approach. First, the dynamics of the model can be studied via impulse response functions. This not only allows me to see which direction U.S. FDI moves in response to a change in the real exchange rate, but also the magnitude of the response in subsequent periods. Second, the model is global in nature. This allows me to consider many different host countries and economic regions for U.S. FDI around the world within a single model. Third, the model allows for interactions and feedback between

\(^3\) See, for example, Froot and Stein (1991), Klein and Rosengren (1994), and Blonigen (1997).
\(^5\) See Egger et al. (2010).
the countries and economic regions of the model. This allows me to examine whether or not changes in the real exchange rate in one country or economic region spread to others around the world through U.S. outward FDI.

My results indicate evidence of a statistical relationship between U.S. FDI outflow and a strengthening of the U.S. dollar. However, my results also indicate that an appreciation of the U.S. dollar relative one country or economic region does not appear to affect U.S. FDI outflow to other parts of the world. Finally, and perhaps most importantly, the actual size of the effect on U.S. FDI outflow is very small; amounting to much less than 1% of overall FDI received by host countries and economic regions in the model for recent years. I conclude that not only did an appreciation of the U.S. dollar have no economically meaningful impact on U.S. FDI outflows during this period, but also that exchange rate movements do not appear to spread through U.S. outbound FDI to other parts of the world as well.
CHAPTER II

PLEDGED COLLATERAL AND FOREIGN DIRECT INVESTMENT: THEORY AND EVIDENCE FROM JAPANESE INVESTMENT INTO THE U.S.

Introduction

The recent global financial crisis created strong interest in the important relationship between finance and foreign direct investment (FDI). The OECD’s (2015) FDI financial flows indicator shows that world-wide outward FDI is approximately 48 percent lower in 2009 compared to its peak in 2007. World-wide FDI financial outflows have subsequently struggled to return to their previous levels. This observation generated a recent emphasis on financial barriers to foreign market service which previously had been largely over-looked (for a recent survey see Foley and Manova, 2014). Collateral, a demand-side barrier to external financing, has been identified as an important factor to externally financing foreign market service. Firms pledge collateral in the form of tangible assets, such as land, to secure external financing. Pledged collateral is forfeited to the lender in the case of default, giving firms incentive to follow through with repayment. Firms lacking in available collateral are constrained in their ability to pledge collateral and obtain external financing.

This paper offers a different perspective on the collateral needed to externally finance FDI. Previous literature focuses on the value of collateral available to the firm, asserting that firms with larger values of available collateral are less constrained in their ability to secure external financing. Instead, this paper considers how the value of pledged collateral varies with productivity, a common measure of firm–level heterogeneity. Do heterogeneous firms pledge similar amounts of collateral for the same borrowing need? I show using a simple theoretical model that the value of collateral pledged is proportional to the firm’s productivity level. For the same borrowing need, more productive firms pledge less collateral relative to less productive
firms. The claim is that more productive firms are safer investments in the eyes of lenders, granting them the ability to pledge less collateral. However, a threshold level of productivity must be met before borrowing is a feasible option. Firms with a productivity level below this threshold must pledge collateral of greater value than their borrowing need.

I empirically examine my model using firm-level data on Japanese FDI into the United States between 1980 and 2000. Japanese firms have a long held tradition of using bank lending secured by land as a primary source of external finance. Land values in Japan collapsed in the early 1990’s following the bursting of an asset bubble. The resulting financial crisis was, for all intents and purposes, limited to Japan itself. This allows for the unique opportunity to empirically study my theoretical model both prior to and following a collapse in collateral values.6

My data consists of 619 Japanese multinational firms totaling 2,432 investments into the U.S. during this time period. I build a measure of collateral pledged by Japanese firms using the ratio of their land holdings to long–term loans. My empirical analysis shows that more productive Japanese multinationals tend to pledge less collateral, particularly during the 1991–2000 time period. These results are robust to use of either market land values or book land values.

Chor and Manova (2012) and Manova (2013) illustrate how important available collateral is to financially constrained exporters. Firms lacking in collateral are more vulnerable to financial frictions, impeding their ability to export. Manonova et al. (2014) extends this idea specifically to Chinese exporters to show that foreign affiliates in China have better export

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6 Or, put more broadly, a period of both economic boom and bust.
performance relative to domestic firms. This is due to the ability of a foreign affiliates to tap into capital from their parent firm, offering them more assets to pledge as collateral.

Buch et al. (2014) illustrate the importance of collateral to multinational firms. The authors present a collateral–based external financing model of FDI. Firms constrained in their ability to pledge collateral scale back output, resulting in reduced profits. Data on German firms is used to support the notion that a lack of collateral impedes FDI, with the effect being relatively stronger for larger firms. Raff et al. (2015) study the impact of financial constraints on FDI using firm–level data on Japanese multinationals. The authors use Japan’s land price collapse during the early 1990’s as a natural experiment to study how the value of available collateral effects FDI. Raff et al. show that a one percent reduction in land values held by Japanese firms reduced the likelihood of FDI by approximately 0.3 percent over the period of 1980 – 1994.

The importance of collateral has also been identified in literature on corporate investment. Gan (2007) considers the fixed investment activities of Japanese firms. Following the collapse of Japan’s land price bubble in the early 1990’s, fixed investment rates decline by 0.8 of a percentage point for every 10 percentage point decline in the value of land held by firms. Similarly, Cheney et al. (2012) consider the effect of fluctuations in real estate prices on aggregate corporate investment of U.S. firms. The authors show that U.S. corporations invest six cents out of every additional dollar of available collateral.

This paper complements previous literature by examining a different facet of collateral, namely the value of collateral a firm chooses to pledge. Several contributions to the literature are made. First, firms that are relatively more productive make more efficient use of their available collateral. Second, relatively less productive firms may find external finance unattractive even if they are not lacking in available collateral as they may need to pledge more in collateral than

Theoretical Model

Consider a segmented, two–country world composed of a domestic market and a foreign market. There initially exists a continuum of firms located in, and producing solely for, the domestic market. Firms are heterogeneous and differ by their retained earnings and productivity level. Productivity is captured by the firm’s output–per–unit–labor coefficient, where a larger coefficient indicates greater productivity. Let \( \alpha \) denote a firm’s retained earnings and \( \beta \) its productivity. Subsequently, a firm decides to also service the foreign market by establishing an affiliate in the foreign market.

There is an associated sunk cost, denoted by \( F \), included with establishing a foreign affiliate that is associated with the investment’s minimum efficient scale. This captures things such as building a plant and hiring workers that must be paid before profits can be realized. Firms prefer to use their retained earnings if at all possible when paying \( F \). This follows from the pecking–order theory of corporate finance, popularized by Myers and Majluf (1984), that suggests firms first prefer to use internal sources of financing as external sources are relatively costlier due to informational asymmetries.

Firms with insufficient retained earnings seek external financing in the form of debt financing. Let \( \varphi = \max\{0, F - \alpha\} \) denote the amount the firm needs to borrow to cover the sunk cost of foreign market entry. Since the sunk cost of entry is associated with the investment’s minimum efficient scale, firms unable to obtain needed financing do not establish a foreign affiliate rather than scaling back the size of the investment.
Firms in need of external financing make a “take it or leave it” offer to a risk–neutral lender. The contract specifies the amount borrowed $\phi$, repayment amount $D$, and pledged collateral $\gamma$. The probability that a firm’s investment is successful for the life of the loan, $\lambda$, is private information to the firm. The lender only knows that $\lambda$ is uniformly distributed between 0 and 1. However, the lender can infer productivity from the firm’s balance sheet. The lender views a more productive firm as less likely to default on its loan.

To remain consistent with literature on foreign market service, consumers in both the domestic and foreign market exhibit a love of variety with demand given by a CES utility function for a continuum of goods indexed by variety $\omega$:

$$
U = \left[ \int_{\Omega_\omega} q(\omega) \frac{\sigma}{\sigma - 1} d\omega \right]^{\frac{\sigma}{\sigma - 1}}
$$

(1)

$\Omega_\omega$ is the set of available varieties and $\sigma$ is the elasticity of substitution. Any given pair of varieties are substitutes, therefore $\sigma > 1$. Dixit and Stiglitz (1977) have shown that the optimal consumption for a particular variety can be derived using the aggregate price index:

$$
P = \left[ \int_{\Omega_\omega} p(\omega)^{\frac{1}{1-\sigma}} d\omega \right]^{\frac{1}{1-\sigma}}
$$

(2)

Consumer demand for an individual variety is then given by:

$$
q = A p^{-\sigma}
$$

(3)

where $A$ can be thought of as the demand level, or market size, and is exogenous from the view of an individual firm.

Firms compete in a monopolistically competitive environment where each firm produces a distinct variety. For simplicity, I adopt unit wages. The firms cost of domestic production is

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7 This is most applicable to publicly traded firms.
simply output sold, q, scaled by its productivity level $\beta$. Greater productivity results in the ability to produce a unit of output at a lower cost. The cost function of a firm that produces domestically is then:

$$C_D = \frac{q}{\beta}$$ \hspace{1cm} (4)

Firms that establish a foreign affiliate also face the additional cost function:

$$C_{FDI} = \frac{q}{\beta} + F$$ \hspace{1cm} (5)

The cost of foreign affiliate production differs from the domestic case by the sunk entry cost of establishing a foreign affiliate. The firm’s domestic profit function is given by:

$$\pi_D = pq - \frac{q}{\beta}$$ \hspace{1cm} (6)

The firm maximizes its profit subject to domestic demand in equation (3). This yields the optimal price and output for domestic production:

$$p_D = \frac{\sigma}{(\sigma - 1)} \left( \frac{1}{\beta} \right)$$ \hspace{1cm} (7)

$$q_D = A[p_D]^{-\sigma}$$

Domestic pricing is determined by consumers’ elasticity of substitution, where more productive firms charge a lower price. Output for a particular variety is decreasing in price, meaning that more productive firms produce more since they charge a lower price. The firm’s additional expected profits for establishing a foreign affiliate are:

$$\pi_{FDI} = \lambda pq - \frac{q}{\beta} - F + \varphi - \lambda D - (1 - \lambda)\gamma$$ \hspace{1cm} (8)

subject to

$$q = Ap^{-\sigma}$$ \hspace{1cm} (8.1)

$$pq - \frac{q}{\beta} \geq D$$ \hspace{1cm} (8.2)

$$\lambda D + (1 - \lambda)\gamma - \varphi \geq 0$$ \hspace{1cm} (8.3)
The profit function reads as follows: $\lambda pq - \frac{q}{\beta} - F + \phi$ denotes the firm’s expected net revenue of FDI with sunk cost $F$ and external financing $\phi$. The last two terms state that the firm repays the lender D with probability $\lambda$, but defaults with probability $(1-\lambda)$ and forfeits pledged collateral $\gamma$. In addition to consumer demand (8.1), the firm must also consider liquidity constraint (8.2) and participation constraint (8.3). The firm can at most offer its revenue as repayment to the lender. The lender is only willing to lend if its net return surpasses its outside option, normalized to zero here for simplicity. For cases when the firm does not need to seek external financing, optimal price and quantity are given by:

$$p_{FDI} = \frac{\sigma}{(\sigma-1)} \left( \frac{1}{\lambda\beta} \right)$$

$$q_{FDI} = A[p_{FDI}]^\sigma$$

Equations (9) differ from those of the domestic case by markup factor $\lambda$, the probability of a successful investment. Given the same elasticity of substitution and productivity, foreign affiliates charge a higher price and produce less than in the domestic case. A proof of this is provided in Appendix A.1.

Under competitive credit markets, the firm adjusts its repayment such that the lender breaks even in expected return. Therefore, firms adjust their repayment such that:

$$pq = \frac{\phi}{\lambda} - \frac{1-\lambda}{\gamma}$$

Equation (10) can be used to obtain the value of collateral the firm pledges to borrow $\phi$. Using the optimal price and output from (9), solving (10) for $\gamma$ yields the non-negative level of collateral pledged to obtain external financing for FDI.\(^8\)

---

\(^8\) A negative value for $\gamma^*$ indicates either that the firm has sufficient internal funds available, and does not need external financing, or that the firm has a sufficiently large productivity such that it can obtain unsecured external financing.
γ* = \max\left\{0, \frac{\varphi}{(1-\lambda)} - A \frac{\lambda}{(1-\lambda)} \left[\frac{\sigma}{(\sigma-1)} \left(\frac{1}{\lambda}\right)^{1-\sigma}\right]\right\} \tag{11}

Equation (11) leads to proposition 1:

**Proposition 1** Pledged collateral increases with borrowing need \(\frac{\partial \gamma^*}{\partial \varphi} > 0\), but decreases with productivity \(\frac{\partial \gamma^*}{\partial \beta} < 0\). When the amount borrowed is less than market size A, pledged collateral is increasing for low probabilities of success and decreasing for larger probabilities of success. Pledged collateral is unambiguously increasing in the probability of success for borrowing amounts that meet or exceed market size A.

**Proof** See appendix A.2.

Pledged collateral increases with the amount borrowed, which makes intuitive sense. More interesting, pledged collateral is decreasing in productivity. Consider two firms, who differ only in their productivity level, seeking to establish a foreign affiliate. The relatively more productive firm can secure the same amount of financing as the less productive firm with less pledged collateral. In other words, a more productive firm can make more efficient use of its available collateral. Finally, pledged collateral is initially increasing for low probabilities of success, but is decreasing for higher probabilities of success. This non–linearity exists for borrowing amounts less than the total market size. Pledged collateral is increasing in the probability of success when borrowing amounts meet or exceed total market size.

Intuitively, a firm wants to pledge as little collateral as necessary to secure external financing. However, when productivity is sufficiently low the value of pledged collateral is larger than the amount borrowed. To show this, consider equation (11) when \(\beta\) is zero. Since the exponent \((1-\sigma)\) is negative due to the fact that \(\sigma > 1\), equation (11) reduces to:

\[\gamma^* = \frac{\varphi}{(1-\lambda)} \tag{12}\]
When firm productivity is zero, pledged collateral is the amount borrowed, \( \varphi \), scaled by a factor of \( \frac{1}{(1-\lambda)} \) > 1.\(^9\) This illustrates that pledged collateral is greater than the amount borrowed for low levels of productivity, suggesting that there exists a productivity level where the firm collateralizes 100 percent of its loan. Let \( \beta^* \) represent the productivity level that satisfies:

\[
\gamma^* = \varphi
\]  

(13)

Solving equation (12) for productivity yields:

\[
\beta^* = \frac{\sigma \lambda}{(1-\sigma) (1-\lambda)} \left[ \frac{1}{\varphi} \right]^{1-\sigma}
\]  

(14)

where \( \beta^* \) represents the productivity cutoff that a firm must meet before the value of pledged collateral is equal to or less than the amount borrowed. Firms with a productivity level \( \beta \geq \beta^* \) obtain external financing by pledging a value of collateral equal to or less than the amount borrowed. Firms with a productivity level \( \beta < \beta^* \) can only obtain external financing by pledging collateral of greater value than the amount borrowed. This leads to proposition 2:

**Proposition 2** There exists a productivity level where pledged collateral is just equal to borrowing need. Firms with a productivity level that fall below this cutoff must pledge collateral of greater value than the amount borrowed.

Propositions 1 and 2 are graphically illustrated in Figure 2.1 below. The minimum level of collateral to be pledged falls as productivity increases. A productivity level less than \( \beta^* \) indicates a lack of borrowing capacity in the sense that the firm would have to pledge collateral of greater value than what is borrowed.

\(^9\) This is due to the fact that \( \lambda \) is bounded between 0 and 1, implying that \( (1-\lambda) < 1 \).
The shape of the pledged collateral line is dependent upon the elasticity of substitution. For instance, pledged collateral is linear in productivity when $\sigma = 2$. This is due to the fact that the exponent $(1 - \sigma)$ in equation (11) reduces to 1 in absolute value. Pledged collateral is convex in productivity when $\sigma < 2$ and concave in productivity when $\sigma > 2$. Figure 2.1 also illustrates that productivity cutoff $\beta^*$ increases with elasticity of substitution $\sigma$. It can be shown that $\beta^*$ is increasing in $\sigma$ for levels of borrowing that do not exceed approximately one third of total market size. This leads to proposition 3:

**Proposition 3:** For borrowing amounts $\varphi < \frac{A}{e}$ the productivity cutoff such that pledged collateral is equal to the amount borrowed is increasing in the elasticity of substitution $\left( \frac{\partial \beta^*}{\partial \sigma} > 0 \right)$.

**Proof** See appendix A.3.

Proposition 3 states that the more likely consumers are to substitute one variety for another, firms must achieve higher levels of productivity before pledged collateral is equal to or less than the amount borrowed. One possible explanation for this result may be due the more competitive environment associated with consumers exhibiting larger elasticities of substitution. Since more productive firms charge lower prices, consumers find varieties produced by these
firms more attractive. Less productive firms may find it harder to survive in this type of environment, resulting in a larger productivity cutoff.

Data

My analysis is based on Japanese FDI into the United States from 1980 to 2000. This time period captures the bursting of Japan’s bubble economy of the 1980s. Japanese land and stock prices plunged approximately 50 percent during the early 1990s (Caballero et al. 2008). Limiting the time period under consideration to these 20 years avoids confounding issues such as the bursting of the dot–com bubble during the early 2000s and the global financial crisis of 2007–2008. This allows the unique opportunity to study the relationship between pledged collateral and productivity during both a period of economic boom and bust unique to Japan.

Figure 2.2 – Japanese Investments into the U.S.

Figure 2.2 depicts both the number and average size of FDI projects flowing out of Japan into the U.S. during this period. A sharp rise in the number of FDI projects occurred during the 1980s, coinciding with the height of Japan’s bubble economy. The number of investments into the U.S. grows from around 100 per year to around 500 per year by the end of the 1980s. The
number of FDI projects flowing into the U.S. rapidly declined to previous levels during the early 1990s, coinciding with the collapse of Japan’s bubble economy.

Japan’s culture of corporate finance is characterized by close ties between firms and their main bank. Due to this, Japanese firms tend to make heavy use bank lending as their primary source of external finance. By tradition, banks in Japan only lend on a secured basis by using domestic land held by firms as collateral (Gan 2007). It comes as no surprise that the sharp rise in the number and average size of FDI projects flowing out of Japan coincides with the land price bubble of the latter half of the 1980s.

Data on Japanese FDI is sourced from Toyo Keizai Inc.’s Japanese Overseas Investment: A complete listing by firms and countries (JOI). The JOI captures the entire universe of Japanese FDI abroad. Among other things, the JOI lists the host country, month and year of establishment, the size of the investment, and the equity share of the investment. Investments where the primary Japanese investor holds at least 10 percent equity ownership are considered FDI. This is a standard OECD definition of FDI. Financial data is taken from the Pacific Basin Capital Markets (PACAP) database. The PACAP database provides detailed balance sheet information of all publically traded Japanese firms. Table 2.1 lists relevant financial information obtained from the PACAP database.

Pledged collateral is private contract information. However, a reasonable proxy can be made using the ratio of a firm’s market value of land holdings to the value of its long–term loans. As previously noted, Japan has a tradition of secured bank lending using land as collateral. Because of this, it is reasonable to interpret the ratio of a firm’s land holdings to its outstanding
long–term loans as a measure of how much collateral firms pledge relative to what they borrow.\textsuperscript{10} This ratio increases as the amount of collateral pledged relative to borrowing increases.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>Total capital stock</td>
</tr>
<tr>
<td>Cash</td>
<td>Cash on hand</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>Income from operations divided by total sales</td>
</tr>
<tr>
<td>Employment</td>
<td>Number of employees</td>
</tr>
<tr>
<td>Gross profit</td>
<td>Total revenue minus cost of goods sold</td>
</tr>
<tr>
<td>Industry</td>
<td>3–digit SIC code</td>
</tr>
<tr>
<td>Intermediate Inputs</td>
<td>Materials, semi–finished products, supplies, and machine equipment</td>
</tr>
<tr>
<td>Leverage</td>
<td>Total debt divided by total assets</td>
</tr>
<tr>
<td>Pledged collateral</td>
<td>Market value of land holdings divided by long–term loans</td>
</tr>
<tr>
<td>Retained earnings</td>
<td>Retained earnings on hand</td>
</tr>
<tr>
<td>Return on Assets</td>
<td>Net income divided by total assets</td>
</tr>
</tbody>
</table>

Japanese firms are only required to report the book value of their land holdings. Firm’s reported book values of land holdings are converted to market values following a method popularized by Hoshi and Kashyap (1990). Land values are recorded as the purchase price, suggesting a last in–first out (LIFO) method to calculate market values. However, a significant divergence between firm’s book value and current market value of land held in 1980 has occurred. Hayashi and Inoue (1991) suggest a method for overcoming this divergence where they divide the market value of land in the National Accounts data for 1969 by the book value in the Corporate Statistics Annual to obtain a conversion factor of 7.582446. Because my data starts in 1980, this conversion factor was increased to 8 to account for the larger divergence.\textsuperscript{11} The market value of firm’s landholdings is then allowed to fluctuate according to changes in Japanese land market values, creating fluctuations that are exogenous to the firm without concern about endogeneity due to the purchase or sale of land by firms.

\textsuperscript{10} Long–term loans are used as these are the most likely to be secured by collateral.

\textsuperscript{11} Results do not appear sensitive to this conversion factor.
The Japanese Urban Land Price Index, published by the Japanese Ministry of International Affairs and Communications in the *Japan Statistical Yearbook*, was used to calculate market land prices. Variations in land price across regions exists as well. To account for this the postal code of firms’ headquarters are used to identify their regional location. Metropolitan–level land prices are used for firms headquartered in major urban areas (such as Tokyo). Prefecture or national land prices are used for remaining firms not located in major urban areas.

A potential issue when estimating a production function to obtain total factor productivity (TFP) is correlation between unobserved productivity shocks and inputs. Levinsohn and Petrin (2003) suggest the use of intermediate inputs as a proxy for unobserved productivity shocks. The authors have subsequently introduced a STATA command that estimates a production function to obtain TFP using the above method. For more details, see Petrin, Poi, and Levinsohn (2004). Data available from the PACAP on firms’ gross profit, capital stock, employment, and intermediate inputs\(^\text{12}\) was used to estimate TFP in this fashion.

To focus on FDI, firms in the PACAP are matched to parent firms in the JOI based upon their Tokyo Stock Exchange ID. The resulting data corresponds to all FDI by publicly traded firms in Japan flowing to the U.S. from 1980 to 2000. This consists of 619 unique firms making a total of 2,432 investments. However, only 456 of these 619 firms have financial data available for the entire time period under consideration; resulting is 1,762 investments in total. There are 30 distinctly different industries at the 3–digit SIC level present in the data, with just over half of these in the manufacturing sector. Table 2.2 presents average values of relevant financial characteristics over five year intervals for firms that have a foreign affiliate.

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\(^{12}\) These are: materials, semi–finished products, supplies, and machine equipment.
Table 2.2 – Average Values for Publicly Traded Firms with a Foreign Affiliate

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>TFP</td>
<td>3.13</td>
<td>4.48</td>
<td>4.31</td>
<td>4.14</td>
</tr>
<tr>
<td>Retained earnings(^a)</td>
<td>35,986</td>
<td>103,229</td>
<td>109,624</td>
<td>129,137</td>
</tr>
<tr>
<td>Market value of land holdings(^a)</td>
<td>54,848</td>
<td>249,711</td>
<td>200,654</td>
<td>71,669</td>
</tr>
<tr>
<td>Long-term loans(^a)</td>
<td>30,152</td>
<td>83,640</td>
<td>58,082</td>
<td>51,826</td>
</tr>
<tr>
<td>Pledged collateral(^b)</td>
<td>41.93</td>
<td>237.34</td>
<td>151.21</td>
<td>84.98</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>0.061</td>
<td>0.053</td>
<td>0.036</td>
<td>0.007</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.701</td>
<td>0.634</td>
<td>0.594</td>
<td>0.569</td>
</tr>
<tr>
<td>Return on assets</td>
<td>0.026</td>
<td>0.022</td>
<td>0.011</td>
<td>0.005</td>
</tr>
</tbody>
</table>

\(^a\) - Millions of Yen. \(^b\) - defined as the ratio of the market value of land holdings to long-term loans

Firms appear to be relatively more productive and hold more in retained earnings in the latter half of the 1990s as compared to the former half of the 1980s. Not surprisingly, land prices are quite a bit higher in the late 1980s and early 1990s. This corresponds to the inflation and bursting of Japan’s land price bubble during this period. Firms also appear to have relatively larger long-term loans and pledge more in collateral during this period. Cash flows and return on assets appear lower in the 1990s as compared to the 1980s. Lastly, firms appear to be more leveraged in the 1980’s as compared to the 1990s.

Empirical Strategy and Results

The relationship between pledged collateral and productivity is of main interest. However, care must be taken because some industries may be more dependent on external finance or relatively more land intensive than others. Therefore, I calculate the industry–year average for firms’ pledged collateral. I then look at firms’ deviation from the industry–year average. Firms that fall below the industry–year average tend to pledge less in collateral while firms that fall above the industry–year average tend to pledge more in collateral. This method of looking at firms’ deviation from industry–year average is applied to all other variables used in my empirical analysis as well. My empirical model is then:
\[
\left( \text{PledgedCollateral}_{ijt} - \overline{\text{PledgedCollateral}}_{jt} \right) = \alpha_1 \left( \text{TFP}_{ijt-1} - \overline{\text{TFP}}_{jt-1} \right) \\
\quad + \alpha_2 \left( \text{RetainedEarnings}_{ijt-1} - \overline{\text{RetainedEarnings}}_{jt-1} \right) \\
\quad + \alpha_3 \left( \text{CashFlow}_{ijt-1} - \overline{\text{CashFlow}}_{jt-1} \right) \\
\quad + \alpha_4 \left( \text{ReturnAssets}_{ijt-1} - \overline{\text{ReturnAssets}}_{jt-1} \right) \\
\quad + \alpha_5 \left( \text{Leverage}_{ijt-1} - \overline{\text{Leverage}}_{jt-1} \right) \\
\quad + \alpha_6 \text{PrevInv}_{it-1} + \alpha_7 \text{Industry}_{it-1} + \varepsilon_{ijt}
\]

where an upper bar indicates the average. The left hand side of the above empirical model is the deviation of pledged collateral (PledgedCollateral) of firm i in industry j at time t from average pledged collateral by all firms in industry j at time t. Right hand side variables are lagged by one year to account for the time difference between when a firm makes the decision to invest and when it appears in the dataset.

TFP is the Levinsohn–Petrin measure of total factor productivity discussed in Section 3. RetainedEarnings, CashFlow, ReturnAssets, and Leverage represent retained earnings, cash flow, return on assets, and leverage respectively. These variables follow from Table 2.1. Firms with greater levels of retained earnings may not need to be rely on external finance as much. Cash flow and return on assets are indicators of how profitable the firm is. Intuitively, more profitable firms might be viewed as less likely to default, leading to less pledged collateral. Leverage is more ambiguous. Highly leveraged firms may need to pledge more collateral as they potentially run a higher risk of default. However, a larger leverage ratio may also be indicative of a firm that tends to heavily borrow; resulting in a strong relationship with their bank and the tendency to pledge less collateral.
PrevInv is a count, at the time of investment, of the number previously observed foreign affiliates established by the firm. This captures the firm’s track record when it comes to FDI. Firms with a history of successful FDI projects are more appealing in the eyes of the lender and may end up pledging less collateral because of this. Industry is a full set of industry–time dummies included to capture industry fixed effects. As mentioned above, these dummies capture 30 distinct industries present in the data at the 3-digit SIC level. Finally, ε is the robust error term.

<table>
<thead>
<tr>
<th>Table 2.3 – Pledged Collateral of Japanese FDI into U.S.</th>
</tr>
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<tbody>
<tr>
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<tr>
<td></td>
</tr>
<tr>
<td>TFP</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RetainedEarnings</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>CashFlow</td>
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<tr>
<td></td>
</tr>
<tr>
<td>ReturnAssets</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Leverage</td>
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<tr>
<td></td>
</tr>
<tr>
<td>PreviInv</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>R–squared</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors in parenthesis. * and ** denote statistical significance at the 5% and 1% level, respectively. Industry dummies included but not reported.

Results are reported in Table 2.3. Over the time period of 1980 to 2000 firms that are relatively more productive do appear to pledge less in collateral. The same is true for firms that have previously established foreign affiliates. Relatively more leveraged firms appear to pledge lesser amounts of collateral as well. A possible explanation for this may be what is commonly
referred to as the existence of “zombie firms” (see Caballero et al. 2008, for example) in Japan during this time period. A zombie firm is a highly inefficient, debt–laden, firm that is kept on life support by continual lending\textsuperscript{13} from its main bank. Pledged collateral may be a moot point in this type of relationship and may be a possible reason for the observed negative coefficient on leverage.

A structural break around 1990 is likely. This coincides with the bursting of Japan’s bubble economy and the large drop in outgoing FDI illustrated in Figure 2.2. A simple Chow test of the null hypothesis that $\alpha_1$ through $\alpha_6$ are equal in the periods 1980–1990 and 1991–2000 yields and F statistic of 6.54 and critical value $F_{6,1706} = 2.0986$. Thus the null hypothesis is rejected, indicating that we do indeed have a structural break in 1990.

The last two columns of Table 2.3 present results for these two sub–periods. The key factor to pledged collateral in the 1980–1990 appears to be the firm’s previous FDI history. Firms with more previously established foreign affiliates pledge less collateral. However, a different pattern emerges in the period following the burst of Japan’s bubble economy and subsequent “lost decade.” In this instance, productivity and retained earnings appear key to pledged collateral. Firms that are more productive and have more retained earnings are able pledge less collateral in an environment of tighter credit.

To put the relationship between pledged collateral and productivity into context, elasticities are computed. For the overall period of 1980 to 2000 a one percent increase in productivity above industry average leads to an approximate 0.05 percent reduction in pledged collateral below industry average. However, when attention is focused to post 1990 a one percent increase in productivity above industry average leads to an approximate 0.73 percent reduction in pledged collateral.

\textsuperscript{13} This is sometimes referred to “evergreen” lending.
pledged collateral below industry average. This can translate into a meaningful reduction in pledged collateral for large values of borrowing.

Robustness

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP</td>
<td>-0.013*</td>
<td>-0.013</td>
<td>-0.015*</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.012)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>RetainedEarns</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>(&lt; 0.001)</td>
<td>(&lt; 0.001)</td>
<td>(&lt; 0.001)</td>
</tr>
<tr>
<td>CashFlow</td>
<td>-71.219</td>
<td>-83.745</td>
<td>-101.246</td>
</tr>
<tr>
<td></td>
<td>(61.411)</td>
<td>(89.469)</td>
<td>(110.807)</td>
</tr>
<tr>
<td>ReturnAssets</td>
<td>250.480*</td>
<td>412.984</td>
<td>245.405*</td>
</tr>
<tr>
<td></td>
<td>(110.881)</td>
<td>(312.362)</td>
<td>(124.058)</td>
</tr>
<tr>
<td>Leverage</td>
<td>-29.685</td>
<td>7.900</td>
<td>-82.037*</td>
</tr>
<tr>
<td></td>
<td>(24.375)</td>
<td>(42.681)</td>
<td>(33.361)</td>
</tr>
<tr>
<td>PrevInv</td>
<td>-0.163*</td>
<td>-0.093</td>
<td>-0.191</td>
</tr>
<tr>
<td></td>
<td>(76.000)</td>
<td>(0.052)</td>
<td>(0.205)</td>
</tr>
<tr>
<td>N</td>
<td>1718</td>
<td>1144</td>
<td>574</td>
</tr>
<tr>
<td>R–squared</td>
<td>0.04</td>
<td>0.05</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors in parenthesis. * denotes statistical significance at the 5% level. Industry dummies included but not reported.

The robustness of the above results is examined in several ways. First, to see how sensitive the above results are to land values the empirical model was re–estimated using book values of land to calculate pledged collateral. Table 2.4 presents results using the book value of land holdings to calculate pledged collateral rather than the more relevant market value. Results, in terms of TFP, are consistent to those found in Section 4.
Second, the estimations of Section 4 were performed with the exclusion industry–time dummies. The first column of results in Table 2.5 shows that productivity continues to be an important factor to pledged collateral when industry fixed effects are excluded. Third, the possibility of diminishing returns in the number of previously established foreign affiliates is accounted for by including the squared term \( \text{PrevInv}^2 \). The second column of results in Table 2.5 does not show evidence of diminishing returns, and results continue to remain consistent with those of Section 4. While only results for the entire time period have been reported in Table 2.5 for the sake of brevity, results within the sub–periods remain consistent with Section 4 as well.
Conclusion

This paper presents a theoretical model illustrating that more productive firms pledge less collateral relative to less productive firms. This allows more productive firms to make more efficient use of their available collateral. However, firms with a productivity level below a threshold need to pledge collateral of greater value than the amount they seek to borrow. I submit that this may be unattractive to a firm, even if it has the necessary collateral available. This threshold increases as consumers become more likely to substitute one variety of a product for another, so long the amount borrowed is less than approximately one third of the total market size.

Empirically analyzing the relationship between productivity and pledged collateral presents a challenge as pledged collateral is private contract information. A reasonable proxy was found by using the ratio of land holdings to long-term loans. This method has merit due to Japan’s tradition of bank lending secured by land. Results support the proposed theoretical inverse relationship between productivity and pledged collateral and are strongest for the 1991–2000 time period in Japan. These results are robust to use of either market land values or book land values. They are also robust to the inclusion or exclusion of industry fixed effects. These results suggest that further analysis of this facet of collateral holds merit.
CHAPTER III
FOREIGN AFFILIATE OWNERSHIP EQUITY AND FINANCIAL FRICTIONS: EVIDENCE FROM JAPANESE MULTINATIONALS

Introduction

Foreign affiliate ownership structure is one of many decisions an investor makes when establishing a foreign affiliate. Factors specific to the firm or host country are usually emphasized as determinants of ownership equity. These factors include previous investment experience, knowledge of institutions unique to the host country, costs and benefits of sharing equity with partners, how risky the investor perceives the host country, and host country foreign ownership restrictions. This paper instead considers how financial shocks in the home country affect foreign affiliate ownership equity.

Japanese multinationals were subject to a large, exogenous financial shocks during the 1980s and 1990s. Land prices surged during the late 1980s, resulting in a large land price bubble which subsequently collapsed during the early 1990s. Stock and land prices lost approximately half their value during the 1990s, sending Japan into financial crisis. Domestically–held land is a traditional form of collateral in Japan’s culture of corporate finance (Gan, 2007). High land prices may ease the process of obtaining financing, while low land prices may create a barrier to obtaining financing. Intuitively, a positive shock to land prices increases the level of available collateral, thereby increasing borrowing capacity, and vice versa. A multinational firm may opt to establish a wholly owned foreign affiliate, as opposed to sharing ownership with a partner, as a result of increased borrowing capacity. In other words, increased borrowing capacity may make an investment partner unnecessary.

14 Conversely, a negative shock to land prices may result in establishing a foreign affiliate via shared ownership due to decreased borrowing capacity.
Previous work on the ownership equity structure of foreign affiliates focuses on transaction costs (e.g. Anderson and Gatignon, 1986; Gomes–Casseres, 1989; Hennart, 1988 & 1991). Firms in need of specific assets that involve large transaction costs when obtained on their own are more likely to share ownership of the foreign affiliate. For example, establishing a foreign affiliate outside the main business, or industry, of the parent may require assets the parent firm lacks, such as knowledge or technology. Forming a partnership with a firm in possession of the necessary assets avoids any transaction costs involved with obtaining the assets on their own. However, there are downsides. Issues with aligning incentives between partners and protecting proprietary knowledge may outweigh the benefits of shared ownership. Whole ownership is more likely when the firm contributes a high degree of specific assets, such as knowledge or technology (e.g. Padmanabhan and Cho, 1996; Delios and Beamish, 1999; Asiedu and Esfahani, 2001; Raff et al., 2009). Firms with more international experience are also more likely to have wholly owned foreign affiliates (Mutinelli and Piscitello, 1998). Whole ownership is also more likely for firms that are relatively more productive (Raff et al., 2012).

This paper adds to the literature by considering the impact a financial shock in the home country has on the ownership equity decision of multinational firms when establishing a foreign affiliate. In particular, I consider how a shock to land prices, a primary source of Japanese business collateral, shaped the ownership equity of Japanese foreign affiliates. The run up of Japan’s asset prices during the late 1980s coincides with a boom in outward Japanese FDI. The collapse in Japan’s assets prices during the 1990s also coincides with a significant drop in the amount of outward Japanese FDI as well. Previous literature shows that negative financial shocks, such as reduced access to financing or reduced collateral, decrease the overall amount of outward Japanese FDI (e.g. Klein et al., 2002 and Raff et al., 2015).
It is reasonable to believe that a financial shock, whether it be positive or negative, may also have a meaningful influence on the ownership equity of Japanese foreign affiliates.

Intuitively, there should be a positive relationship between the level of collateral available to a firm and ownership equity in their foreign affiliate at the time of establishment. A positive shock to collateral increases borrowing capacity, easing a firm’s ability to finance a wholly owned foreign affiliate. A negative shock to collateral decreases borrowing capacity, making a firm’s ability to finance a wholly owned foreign affiliate more difficult. This may result in the firm sharing ownership of the foreign affiliate with an investment partner.

I address this question by analyzing impulse response functions for Japanese FDI into 12 OECD host countries from 1975 to 2000. I find that, on average, Japanese multinationals increase ownership equity in core affiliates established subsequent to a positive shock to land value by approximately 4–8 percentage points. I find this to be statistically significant for foreign affiliates appearing in the data approximately a year following the shock to land value. A positive shock to land value does not appear to affect the ownership equity decision of Japanese multinationals establishing non–core foreign affiliates. This may be due to the fact that non–core affiliates are likely to require assets and knowledge that the parent does not possess and can only obtain by sharing ownership. In this case how far away the affiliate is from the core business of the parent is likely more important to ownership equity decisions than the level of available collateral.

Data

My analysis consists of a panel of Japanese FDI into 12 OECD host countries from 1975 to 2000.\textsuperscript{15} I consider 1975 as the initial period of data due to the fact that an appreciable amount

\textsuperscript{15} These countries are: Austria, Belgium, Canada, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
of FDI did not start flowing out of Japan until 1972.\footnote{The year 1972 is referred to as the \textit{gannen} (the very first year) of outward Japanese FDI (Komiya and Wakasugi, 1991).} Prior to the 1970s various federal regulations restricted the ability of Japanese firms to establish affiliates outside of Japan (Komiya and Wakasugi, 1991). These restrictions were relaxed over the period of 1969 to 1972.

An interesting feature of the time period I consider is that it captures the run up of Japan’s land price bubble of the 1980s and its subsequent burst during the 1990s. Ending the sample period in the year 2000 captures this unique period of Japan’s history. Land prices in Japan during this time period are shown in Figure 3.1. One can clearly see the run up of a land prices during the 1980s and its subsequent collapse during the early 1990s.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{Japan Urban Land Price Index\footnote{1980 is used as the base year}}
\end{figure}
This allows the opportunity to examine how available collateral influences ownership equity of Japanese foreign affiliates during a time where Japanese multinationals experienced both significant positive and negative shocks to the value of their collateral.

Japanese FDI activity is obtained from Toyo Keizai Inc.’s *Japanese Overseas Investment: A complete listing by firms and countries* (JOI). Relevant information taken from the JOI include the host country of the foreign affiliate, its year of establishment, and equity share of the Japanese investor. Care has been taken to also identify the Standard Industry Code (SIC) of the foreign affiliate. This allows me to identify foreign affiliates that belong to the same core business as their Japanese parent. Foreign affiliates are identified as core affiliates if they belong to the same 2-digit SIC as their Japanese parent. I also identify new investors as Japanese multinationals with no previously established foreign affiliates in Europe, the U.S., or Canada. Established investors are those with at least one previously established foreign affiliate.

Domestic land held by all publicly traded Japanese multinationals is obtained from the Pacific Basin Capital Markets (PACAP) database. However, Japanese firms need only report book value of their land. Hoshi and Kashyap (1990) proposed a last in–first out (LIFO) method to calculate market values due to the face that land values are recorded at the purchase price. But, as pointed out by Hayashi and Inoue (1991), the book value differs from the market value in the initial period of the data. Hayashi and Inoue suggest adjusting book value to market value in the initial period by use of a conversion factor. They divide the market value of land in the National Accounts data for 1969 by the book value in the Corporate Statistics Annual to obtain a conversion factor of approximately 7.6.

I use a conversion factor of 8 in order to account for a larger divergence between book and market value due to the fact that my initial period is 1975. Subsequently, the value of
landholdings is only allowed to fluctuate according to changes in the Japanese Urban Land Price Index found in the *Japan Statistical Yearbook*.\(^{18}\) To account for heterogeneity in regional land prices, firm headquarter postal codes are used to identify their regional location. Where possible, metropolitan–level land prices are used for firms headquartered in major urban areas (such as Tokyo). I use prefecture land prices for firms not located in major urban areas, with national land prices used for any remaining firms.

My data allows me to observe individual foreign affiliates established in a country–year and the Japanese parents who establish each foreign affiliate. I identify the amount of ownership equity the Japanese parent has in their foreign affiliate and the value of land the Japanese parent holds domestically. I also identify whether or not the foreign affiliate is outside the core business of the Japanese parent and whether or not the Japanese parent has a previously established foreign affiliate. Realistically, however, a Japanese multinational does not establish a foreign affiliate in a given country each year. For example, Honda Motors established a foreign affiliate in the UK during the years 1978, 1979, 1986, 1989, 1990, 1992, and 1998.

A non–trivial number of missing observations occur when the data is examined at the firm–level. To address this, I aggregate my data to country–year averages. This results in average ownership equity of foreign affiliates newly established by Japanese multinationals in a particular country for a given year. The same is true for land values. After aggregation, I am left with the average value of domestically–held for Japanese multinationals who newly establish a foreign affiliate in a particular country for a given year. Also, because I can identify whether a foreign affiliate is in the parent’s core business and whether the parent has established any prior

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\(^{18}\) This creates land value fluctuations exogenous to the firm and alleviates concern of endogeneity resulting from the firm purchasing or selling land to do FDI.
foreign affiliates, I am able to split my data into various groups based upon these characteristics prior to aggregation.

Care must be taken when considering what truly represents the contemporaneous relationship between ownership equity and land prices in my data. What is observed in the data is when the foreign affiliate first opened its doors for business. The reality is that the process of establishing a new foreign affiliate does not happen swiftly. This implies that the decision to establish a foreign affiliate that appears in the data for 1990, for example, was based on information available to the firm in a previous time period, such as 1989. To account for this, I lag my data on land held by Japanese multinationals by one year prior to aggregation. This better represents the value of land held by the firm when it made its decisions about establishing the foreign affiliate.

Plots of average the ownership equity for Japanese foreign affiliates in each country of the sample are shown Figure 3.2. Countries that tend to host relatively more new affiliates from Japanese multinationals each year, such as Germany, the Netherlands, the UK and the U.S., see a relatively larger level of average ownership equity of Japanese foreign affiliates. In these cases, ownership equity is consistently 80% or more. Countries that tend to host relatively fewer new affiliates from Japanese multinationals each year, such as Austria, Sweden, and Switzerland, see a relatively lower level of average ownership equity of Japanese foreign affiliates. There does not appear to be any clear, systematic pattern for any country in Figure 3.2 that might be considered indicative of an ownership equity restriction for Japanese FDI.

19 This could either be construction of a new plant or the negotiation process involved in acquiring an existing plant.

20 It is worth mentioning that restrictions on FDI inflows into OECD countries, in general, have declined greatly since 1980 (Golub, 2003).
Empirical Strategy

I use a panel vector autoregressive (PVAR) methodology. At the time the PVAR is estimated, all variables are treated as endogenous in a system of equations, namely land value and ownership equity. Short-run dynamics among the variables can then be subsequently identified via impulse response functions (IRFs). A PVAR fits well with my data structure. I am limited to, at most, 26 observations per country, making a separate estimation for each country difficult. Stacking my data and estimating a PVAR is my solution to this limitation.

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21 An advantage of this methodology is that the model does not require strong \textit{a priori} theory.

To fix ideas, consider the following first–order PVAR model with \( k \) variables and a panel fixed effect:

\[
Y_{it} = A_1 Y_{it-1} + \alpha_i + e_{it}, \quad i = 1, 2, \ldots, N; \quad t = 1, 2, \ldots, T
\]

where \( Y_{it} \) is a \((k \times 1)\) vector of endogenous variables. For the case at hand two variables are being considered \((k = 2)\) so that \( Y_{it} = (\text{LAND}_{it}, \text{OWNERSHIP}_{it}) \). \text{LAND}_{it} is a row vector composed of the average price of domestic land held by the Japanese parent for affiliates located in the 12 countries being considered over the time period 1975 – 2000. Much the same, \text{OWNERSHIP}_{it} is a row vector composed of the average ownership equity held by the Japanese parent for affiliates located in the 12 countries being considered over the time period 1975 – 2000. \( A_1 \) is a \((k \times k)\) matrix of parameters to be estimated. The panel fixed effect is denoted by \( \alpha_i \) and \( e_{it} \) denotes well-behaved idiosyncratic errors\(^{23}\), both having dimension \((1 \times k)\).

The above represents a system of dynamic panels. However, as is well known in dynamic panels, the standard fixed effects estimator produces inconsistent results requiring use of a generalized method of moment (GMM) or two–stage instrumental variable estimator (Nickell, 1981; Anderson and Hsiao, 1982; Holtz–Eakin et al., 1988; Arellano and Bond, 1991). I use the forward orthogonal deviation transformation proposed by Arellano and Bover (1995) to eliminate the fixed effect from the model by removing the mean of all available future observations. This transformation does not magnify gaps present in unbalanced panels, thereby minimizing data loss. The forward orthogonal deviation transformation also preserves orthogonality between transformed variables and the variables in level (i.e. untransformed). Lagged variables in level are then used as instruments and parameters can be estimated by

\(^{23}\) The idiosyncratic errors are assumed to have the following characteristics: \( E[e_{it}] = 0, E[e'_{it}e_{it}] = 0, \) and \( E[e'_{it}e_{is}] = 0 \) for all \( t > s \).
system GMM. I estimate my model using the PVAR STATA program developed by Abrigo and Love (2015), which is capable of performing a forward orthogonal deviation transformation and estimation via GMM.

A first order PVAR is chosen based upon model selection criteria proposed by Andrews and Lu (2001) for GMM models, which include counterparts to the commonly used Akaike, Bayesian, and Hannan-Quinn information criteria. This information is presented in Table 3.1. Tests were performed for a first, second, and third order PVAR. A first order PVAR is the preferred model based on the model section criteria, as it minimizes the AIC, BIC, and HQIC.

Table 3.1 – Model Order Selection for Dynamic Panel

<table>
<thead>
<tr>
<th>Lag</th>
<th>AIC</th>
<th>BIC</th>
<th>HQIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-20.39</td>
<td>-74.32</td>
<td>-42.18</td>
</tr>
<tr>
<td>2</td>
<td>-14.27</td>
<td>-54.71</td>
<td>-30.61</td>
</tr>
<tr>
<td>3</td>
<td>-8.90</td>
<td>-35.86</td>
<td>-19.79</td>
</tr>
</tbody>
</table>

Note: AIC, BIC, and HQIC are the Akaike, Bayesian, and Hannan-Quinn information criterion, respectively, proposed by Andrews and Lu (2001) for dynamic panels estimated via GMM.

Table 3.2 presents results of Fisher–type tests for unit roots in panel data (Choi, 2001). A Fisher–type test was chosen as it works well when panels are unbalanced. The null hypothesis that my panels contain a unit root are strongly rejected. Both variables are stationary in levels for each panel.

My estimations are verified to be stable, which ensures the model is invertible and has an infinite order vector moving average representation. Impulse response functions can then be interpreted in the typical fashion. A Cholesky decomposition is used to orthogonalize shocks to

\[24\] The Fisher–type test performs a standard univariate augmented Dickey–Fuller unit-root test on each panel’s series separately, then combine the p-values to obtain an overall test statistic as to whether or not the panel series contains a unit root.

\[25\] The modulus of each eigenvalue of the companion matrix is strictly less than one. See Hamilton (1994) or Lütkepohl (2005) for details.
the model in order to obtain impulse response functions. This places a recursive structure on the model such that variables that enter first in ordering contemporaneously effect those lower in the ordering, but not vice versa. The value of land enters first in the model and ownership equity enters second. This results in a structure where shocks to land value have a contemporaneous impact on ownership equity in the model, but shocks to ownership equity do not contemporaneously affect land value in the model. This is a reasonable structure to impose as overall land prices in Japan are relatively more exogenous than multinational firms.

Table 3.2 – Fisher-Type Panel Unit-Root Test Based on Augmented Dicky-Fuller Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse chi-squared</td>
<td>95.51</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse normal</td>
<td>-6.65</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse logit</td>
<td>-7.51</td>
<td>0.00</td>
</tr>
<tr>
<td>Modified inverse chi-squared</td>
<td>10.32</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Ownership Equity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse chi-squared</td>
<td>87.19</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse normal</td>
<td>-6.29</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse logit</td>
<td>-6.82</td>
<td>0.00</td>
</tr>
<tr>
<td>Modified inverse chi-squared</td>
<td>9.12</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: Cross sectional means removed. Augmented Dicky-Fuller tests performed with 1 lag, but results are robust to the use of 2 lags as well.

However, as discussed in Section 2, a contemporaneous shock in the model does not truly mean within the same year given the manner the data is structured. A lag occurs between the time a firm makes the decision to establish a foreign affiliate and when the affiliate appears in my data. Land prices are lagged one year to address this concern. This better represents the value
of land held by Japanese firms in my data when they made their decision to establish a foreign affiliate. The impulse response functions presented in the next section represent the ownership equity of foreign affiliates appearing in the data a year or more following a shock to land value.

Results

Figure 3.3 presents the dynamic response of ownership equity to a one standard deviation shock in land value, estimated using the full data sample. Japanese multinationals hold approximately 2 percentage points more ownership equity in their foreign affiliates appearing in the data a year following a positive shock to land value. The response of ownership equity is statistically insignificant for foreign affiliates appearing in the data beyond a year following the shock. This supports the intuition that larger amounts of available collateral increase a firm’s borrowing capacity, making it easier to establish wholly owned foreign affiliates.

This result merits a deeper look. Previous literature, discussed in the introduction, suggests that firms with more international experience hold a larger amount of ownership equity in their foreign affiliates. Firms also hold a larger amount of ownership equity in foreign affiliates inside their core business. To investigate further, I consider the experience level of the parent firm and whether the affiliate is established inside the parent’s core business.

Figure 3.4 presents the dynamic response of ownership equity to a one standard deviation shock in land value, separating inexperienced Japanese parents from experienced ones. I consider a parent to be inexperienced if it has no previously established affiliates in Europe, the U.S., or Canada. I consider a parent to be experienced if it has at least one previously established foreign affiliate in Europe, the U.S., or Canada. A positive shock to land value does not lead to a
statistically significant response in ownership equity for either experienced or inexperienced parents at any time horizon. Figure 3.4 provides no evidence that Japanese parents with international experience adjust ownership equity when establishing foreign affiliates following a positive shock to their source of collateral.

Figure 3.5 presents the dynamic response of ownership equity to a one standard deviation shock in land value, separating affiliates in the parent’s core business from those not in the parent’s core business. Affiliates whose 2-digit SIC matches that of their Japanese parent are

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26 Confidence bands are estimated using Gaussian approximation based on Monte Carlo draws from the estimated panel PVAR model. This procedure is repeated 1000 times. The 2.5\(^{th}\) and 97.5\(^{th}\) percentile of this distribution is used as the confidence interval for the impulse response. A larger or smaller amount of Monte Carlo repetitions does not affect results.
said to be in the parent’s core business. A positive shock to land value does not affect the ownership equity decision of Japanese multinationals establishing foreign affiliates outside their core business; the IRF is statistically insignificant at all time horizons. However, Japanese parents establishing foreign affiliates inside their core business do respond to a positive land value shock. A positive shock to land value results in an approximate 4 percentage point increase in ownership equity of core affiliates appearing in the data a year following the shock. This response becomes statistically insignificant for core affiliates appearing in the data beyond a year following the shock.

Figure 3.4 – Investor Experience
The above provides evidence that Japanese multinationals, on average, increase ownership equity by approximately 2–4 percentage points in foreign affiliates established subsequent a positive shock to their collateral source, particularly for foreign affiliates inside their core business. It is unlikely a firm lacks the necessary assets and knowledge required to establish a foreign affiliate inside their core business. It is more likely the need to share ownership of a core affiliate arises due to financial constraints. A positive shock to a firm’s collateral source is likely to increase its ability to borrow, making whole ownership of the affiliate more feasible.

Japanese multinationals establishing non–core foreign affiliates do not appear to respond to a positive land value shock. Unlike core affiliates, firms may indeed lack the necessary assets
and knowledge required to establish a foreign affiliate outside their core business. This may result in the need to share ownership with a partner in possession of the necessary assets and knowledge. For situations such as these, how far away the affiliate is from the core business of the parent is likely a bigger factor to the ownership equity decision as opposed to how much collateral it has available. This may be why my results do not show a statically significant response for the case of non–core affiliates.

Robustness Check

Raff et al. (2009) show that more productive Japanese multinationals exhibit a larger degree of ownership equity in their foreign affiliates. Results in the previous section do not account for this variable. To address this, I extend the model of the previous section to a three variable PVAR. I use Levinsohn and Petrin’s (2003) measure of productivity where total factor productivity of a firm is estimated with use of intermediate inputs as a proxy for unobserved productivity shocks. Land value and productivity are lagged by one year before aggregating firm–level data to country–year averages. This is done for the same reasons described in Section 2.

Table 3.3 – Model Order Selection for Dynamic Panel

<table>
<thead>
<tr>
<th>Lag</th>
<th>AIC</th>
<th>BIC</th>
<th>HQIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-34.93</td>
<td>-135.88</td>
<td>-75.93</td>
</tr>
<tr>
<td>2</td>
<td>-34.04</td>
<td>-109.75</td>
<td>-64.80</td>
</tr>
<tr>
<td>3</td>
<td>-25.14</td>
<td>-75.61</td>
<td>-45.64</td>
</tr>
</tbody>
</table>

Note: AIC, BIC, and HQIC are the Akaike, Bayesian, and Hannan–Quinn information criterion, respectively, proposed by Andrews and Lu (2001) for dynamic panels estimated via GMM.

27 These are taken from the PACAP database and include: materials, semi–finished products, supplies, and machine equipment.
A first order PVAR is again chosen based upon model selection criteria proposed by Andrews and Lu (2001) as shown in Table 3.3. A first order model is preferred to a second or third order model based on the section criteria as it minimizes the AIC, BIC, and HQIC. I check for unit roots in my panels by again using the Fisher–type tests (Choi, 2001) presented in Table 3.4. All three variables are stationary in levels for each panel. Estimation of my three variable PVAR is verified to be stable. I again use a Cholesky decomposition to orthogonalize shocks to the model in order to obtain impulse response functions.

Table 3.4 – Fisher-Type Panel Unit-Root Test Based on Augmented Dicky-Fuller Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse chi-squared</td>
<td>75.98</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse normal</td>
<td>-5.53</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse logit</td>
<td>-5.86</td>
<td>0.00</td>
</tr>
<tr>
<td>Modified inverse chi-squared</td>
<td>7.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Ownership Equity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse chi-squared</td>
<td>78.69</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse normal</td>
<td>-4.93</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse logit</td>
<td>-5.66</td>
<td>0.00</td>
</tr>
<tr>
<td>Modified inverse chi-squared</td>
<td>7.89</td>
<td>0.00</td>
</tr>
<tr>
<td>Productivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse chi-squared</td>
<td>66.98</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse normal</td>
<td>-4.72</td>
<td>0.00</td>
</tr>
<tr>
<td>Inverse logit</td>
<td>-5.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Modified inverse chi-squared</td>
<td>6.20</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: Cross sectional means removed. Augmented Dicky-Fuller tests performed with 1 lag, but results are robust to the use of 2 lags.
Land value enters first in the ordering, productivity enters second, and ownership equity enters last. This results in a recursive structure where shocks to land value have a contemporaneous impact on productivity and ownership equity, and shocks to productivity have a contemporaneous impact on ownership equity, but shocks to ownership equity do not have a contemporaneous impact on either productivity or land value. Land value enters above ownership equity for the same reason described in Section 3. Productivity enters above ownership equity due to the findings of Raff et al. (2009). I continue to place land value first in the ordering.

Figure 3.6 presents the dynamic response of ownership equity to a one standard deviation shock in land value and productivity, estimated using the full data sample.

![Figure 3.6 – Full Sample Accounting for Productivity](image-url)
A positive shock to land value results in an approximate 2 percentage point increase in ownership equity for foreign affiliates appearing in the data a year following the shock. The response of ownership equity is statistically insignificant for foreign affiliates appearing in the data beyond a year following the shock. A positive shock to productivity results in approximately 1 percentage point greater ownership equity for foreign affiliates appearing in the data a year following the shock. This peaks at a near 4 percentage point increase for foreign affiliates appearing in the data two years following the shock. The response of ownership equity is statistically insignificant for foreign affiliates appearing in the data beyond three years following the productivity shock. These results are consistent with Section 4 and also agree with those of Raff et al. (2009) as well.

Figure 3.7 presents the dynamic response of ownership equity to a one standard deviation shock in land value, separating core from non–core affiliates. Results for non–core affiliates continue to be statistically insignificant. Japanese multinationals increase ownership equity in core affiliates appearing in the data a year following the shock by approximately 8 percentage points. This response is statistically insignificant for foreign affiliates appearing in the data beyond a year following the shock.

These results are qualitatively consistent with Section 4. Japanese multinationals, on average, increase ownership equity in foreign affiliates established subsequent a positive shock to their collateral source. This observation is most applicable to core affiliates. This is likely due to the reasons discussed at the end of Section 4. Affiliates far away from the parent’s core
Figure 3.7 – Core Investment Accounting for Productivity

Business is likely to require specific assets and knowledge that the firm can only obtain by sharing ownership. In these cases, the amount of collateral available is not likely to be the important factor in determining ownership equity of the foreign affiliate.

Conclusion

This paper considers a different dimension to ownership equity of foreign affiliates. I find that, on average, Japanese multinationals increase ownership equity in foreign affiliates established subsequent a positive shock to their primary source of collateral. This is particularly true when the foreign affiliate is established inside the core business of the parent. Japanese multinationals increase ownership equity in core affiliates established subsequent a positive shock to land value by approximately 4–8 percentage points. I find this to be statistically
significant for foreign affiliates appearing in the data approximately a year following the shock to land value.

A positive shock to land value does not appear to affect the ownership equity decision of Japanese multinationals establishing non–core foreign affiliates. This may be due to the fact that non–core affiliates are likely to require assets and knowledge that the parent does not possess and can only obtain by sharing ownership. In this case how far away the affiliate is from the core business of the parent is likely more important to ownership equity decisions than the level of available collateral.

My results provide evidence of a relationship between collateral and ownership equity of foreign affiliates. Further research is required in order to determine if similar results are observed for the foreign affiliates of firms headquartered in countries other than Japan. In addition, I only consider a demand side financial shock (collateral). Another avenue of future research is to extend this concept to a supply side financial shock, such as bank health, as the relative response of ownership equity to a financial shock may differ by the source or cause of the shock.
CHAPTER IV

DOES THE EXCHANGE RATE MATTER FOR FOREIGN DIRECT INVESTMENT?
EVIDENCE FROM A GLOBAL VECTOR AUTOREGRESSION

Introduction

The purpose of this paper is two-fold. First, a global macroeconomic empirical model is used to re-examine the importance of the exchange rate for FDI. Second, the empirical model will then shed light as to whether or not exchange rate movements are propagated around the world through FDI. Exchange rate movements are often cited as an important factor for foreign direct investment (FDI), in both the amount of investment and the allocation of investment around the world. The commonly proposed intuition behind why the exchange rate should be a factor in FDI is as follows.

Currently, there does not appear to be a strong consensus on the overall affect exchange rate movements have on FDI around the world. Popular studies conducted by Froot and Stein (1991), Klein and Rosengren (1994), and Blonigen (1997) suggest that FDI into the U.S. during the mid 1970s to the early 1990s can, in part, be explained by a depreciation of the U.S. dollar. Froot and Stein offer a popular theoretical argument for the importance of exchange rates in FDI based upon imperfect capital markets. Multinational firms can borrow on the international market in order to externally fund their FDI projects. However, lenders require compensation for the greater monitoring cost associated with keeping tabs on their overseas investment. When possible, firms would prefer to avoid this cost and fund their FDI project internally. Now consider a movement in the exchange rate. A depreciation of a country’s currency improves the internal wealth position of foreign firms relative to domestic firms. Foreign firms are subsequently able to purchase assets in the country experiencing a currency depreciation at a
lower cost relative to domestic firms. This results in more FDI flowing into the country experiencing a currency depreciation.

However, Stevens (1993) suggests that the results of Froot and Stein are empirically weak and there may not be a significant relationship between the exchange rates and FDI. Healy and Palepu (1993) also suggests there is no relationship between exchange rates and FDI. Evidence also exists showing that the relationship between exchange rates and FDI isn’t always negative. Egger, Egger, and Ryan (2009) provide evidence that a strengthening of the U.S. dollar reduced U.S. outbound FDI during the 1990s. Lui (2010) also provides evidence of a positive relationship between exchange rates and FDI into China from 18 source countries during the 1990s and early 2000s.

Perhaps an intuitive counter–argument against the importance of exchange rate in FDI is as follows. FDI projects have long time horizons. It’s reasonable to say that it takes considerable time to plan and establish a foreign affiliate. It’s also reasonable to say that once a multinational firm establishes a foreign affiliate in another country, they’re in it for the long haul. Multinational firms should expect that the exchange rate between home and host country will fluctuate over the lifetime of the foreign affiliate. Therefore, the exchange rate shouldn’t be a critical factor to multinational firms engaging in FDI.

This paper re–examines the relationship between exchange rates and U.S. outbound FDI to 8 regions around the world. A relatively new empirical technique, known as the global vector autogression, is used to model the interactions between the exchange rate and FDI from a world–wide macroeconomic aspect. There are several attractive properties of this approach. First, the dynamics of the model can be studied via impulse response functions. This not only allows users to see which direction U.S. FDI moves in response to a change in the exchange rate, but also
how long the response lasts and its magnitude. Second, the model is truly global in nature. This allows the user to consider many different host countries/regions for U.S. FDI around the world within a single model. Third, the model allows for interactions and feedback between the countries/regions of the model. This allows the user to examine whether or not changes in the exchange rate in one country propagate to other countries/regions around the world through U.S. FDI.

Results provide some evidence that a deprecation of a host country’s currency relative to the U.S. causes a reduction in U.S. FDI received by the host country. This appears to be limited region where the currency depreciation relative to the U.S. originates, suggesting that exchange rate movements do not propagate through U.S. outbound FDI. However, the size of the reduction in U.S. outbound FDI is very small. The actual effect over the course of a year is much smaller than 1% of overall FDI received by the host countries in recent years. One can only conclude that, in practical terms, exchange rates have no real economically meaningful impact on U.S. outbound FDI.

Empirical Approach

The global vector autoregression (GVAR) model provides a feasible way to model interactions in a global economy by providing a solution to the “curse of dimensionality” problem typically associated with a global macroeconomic model. It was initially developed by Pesaran, Shuermann, and Weiner (2004) in an effort to study losses suffered by major financial institutions around the world following the 1997 Asian financial crisis.

In simple terms, a GVAR model can be described as a two–step procedure. The first step entails estimating smaller country/region–specific models conditional on the rest of the world. These models are essentially augmented standard VAR models, denoted as VARX* models.
They showcase domestic variables augmented by weighted cross-section averages of weakly exogenous foreign variables. The weighing procedure of the foreign variables is what makes the model feasible to estimate. The second step of the GVAR procedure stacks the individual VARX* models and solves them simultaneously as a single, large global VAR model.

The attractive quality of a GVAR model is that it truly allows the user to study the transmission of shocks around the globe, making it useful to the area of international economics. One can study the dynamics of how an economic event occurring in a source country, such as an exchange rate movement, transmits to countries around the world. While conceptually simple, a GVAR model is computationally demanding and usually involves large data sets. Fortunately, an open source project known as the “GVAR Toolbox” has recently been developed by Smith and Galesi (2014). The GVAR Toolbox allows users a straightforward way to build and estimate a GVAR model via MATLAB.\(^\text{28}\)

The GVAR model is estimated using quarterly data over the period 1995Q1–2015Q4 and covers 23 countries in total.\(^\text{29}\) These countries comprised over 57% of world trade and over 65% of world FDI in 2014.\(^\text{30}\)

<table>
<thead>
<tr>
<th>U.S.</th>
<th>Euro Area</th>
<th>Southeast Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Austria</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>Japan</td>
<td>Belgium</td>
<td>Korea</td>
</tr>
<tr>
<td>U.K.</td>
<td>Finland</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Switzerland</td>
<td>France</td>
<td>Singapore</td>
</tr>
<tr>
<td></td>
<td>-Germany</td>
<td></td>
</tr>
<tr>
<td>Scandinavia</td>
<td>Ireland</td>
<td>Latin America</td>
</tr>
<tr>
<td>-Denmark</td>
<td>Italy</td>
<td>Brazil</td>
</tr>
<tr>
<td>-Norway</td>
<td>Netherlands</td>
<td>Mexico</td>
</tr>
<tr>
<td>-Sweden</td>
<td>Spain</td>
<td></td>
</tr>
</tbody>
</table>

\(^{28}\) The GVAR Toolbox and its documentation is available at https://sites.google.com/site/gvarmodelling/

\(^{29}\) FDI data at a quarterly frequency is not available from the U.S. Bureau of Economic Analysis prior to 1994.

\(^{30}\) These percentages were calculated using data available in the UNCTADstat, 2016 database.
Since a GVAR model can quickly become computationally demanding, the 23 countries being considered are grouped into the 9 different regions shown in bold in Table 4.1. The countries in the sample belonging to the Euro area are easily considered a collective region as they share a common currency beginning in 1999. Countries belonging to Scandinavia, Southeast Asia, and Latin America seemed natural to consider as collective regions as well.

Data

Five variables are included in the GVAR model and are summarized in Table 4.2. With the exception of FDI, all variables are expressed in terms of logarithms. The data for FDI represents a quarterly flow and in some cases is negative. This indicates disinvestment and precludes a log transformation. The log of real GDP ($y_t$) for all countries was obtained from the IMF’s International Financial Statistics (IFS) database. Data for Hong Kong, Malaysia, and Singapore was only available in a non–seasonally adjusted format. Data for these three countries were then seasonally adjusted using the R package `seasonal`, which employs the United States Census Bureau’s X–13ARIMA–SEATS software for seasonal adjustment.31

Nominal exchange rate data vis-à-vis the US dollar was also obtained from the IFS database for all countries. The nominal exchange rate for countries belonging to the euro area prior to 1999Q1 was converted to the euro using the following method. The 1999Q1 value of the euro exchange rate was used as the base value, which was then extrapolated backwards to 1995Q1 for each country using the quarterly percent change in its national currency exchange rate. The euro exchange rate is used as the exchange rate for all countries in the sample belonging to the euro area from 1999Q1 and onward. The consumer price index, also obtained

31 [https://www.census.gov/srd/www/x13as/]
from the IFS database, was then used to convert nominal exchange rates into real exchange rates and the logarithms subsequently taken ($e_{it}$).

Table 4.2 – Variables Used in GVAR Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_{it}$</td>
<td>Log of real GDP index of country i during period t. Seasonally adjusted.</td>
</tr>
<tr>
<td>$e_{it}$</td>
<td>Log of real exchange rate of country i during period t. Defined as foreign currency per U.S. dollar.</td>
</tr>
<tr>
<td>$fdi_{it}$</td>
<td>U.S. foreign direct investment into country i during period t. Defined in millions of US dollars deflated by the U.S. consumer price index.</td>
</tr>
<tr>
<td>$i^S_{it}$</td>
<td>Log of short–term nominal interest rate. Defined as the money market interest rate.</td>
</tr>
<tr>
<td>$i^L_{it}$</td>
<td>Log of long–term nominal interest rate. Defined as 10–year government bond interest rate.</td>
</tr>
</tbody>
</table>

U.S. FDI abroad ($fdi_{it}$) was obtained from the U.S. Bureau of Economic Analysis (BEA) database. Countries consistently reported on an individual basis in the BEA’s data over the sample period was the primary factor in determining which countries would be included in the GVAR model. Many countries not included in the model are reported by the BEA in a composite category termed “other.” However, it difficult to determine exactly which countries make up the BEA’s “other” categories in a given year. A secondary concern is data availability for developing or emerging economies. Often data of sufficient quality or duration is problematic to source for these countries, making it difficult to include them in the model. The BEA reports U.S. FDI outflows in nominal terms, therefore the U.S. consumer price index was used to deflate U.S. FDI outflows.\(^{32}\)

\(^{32}\) Another variation used was U.S. FDI outflows divided by U.S. nominal GDP. Results were qualitatively unchanged.
The logarithm of the money market rate was used as the short–term nominal interest rate ($i_{it}^S$). Data was primarily obtained from the IFS database. However, no data was available for Austria, Belgium, Finland, France, and the Netherlands beginning in 1999Q1 following the introduction of the euro. Therefore, to be consistent, the euro area money market interest rate was obtained from the European Central Bank used for all euro area countries in the sample from 1999Q1 and onward. Norway was also incomplete in the IFS database. Data for Norway was instead obtained from the Norwegian Central Bank (Norges Bank) for 1995Q1–2013Q4 and from Oslo Børs from 2014Q1–2015Q4.\textsuperscript{33}

Finally, the logarithm of the 10–year government bond yield was used as the long–term nominal interest rate ($i_{it}^{L}$). Data was primarily obtained from the OECD Main Economic Indicator database. OECD data for Mexico was incomplete and instead the 6–month to 2–year government bond yield was obtained via the U.S. Federal Research Economic Database (FRED).\textsuperscript{34} Data for Brazil, Hong Kong, Malaysia, and Singapore were also unavailable from the OECD database. The long term interest rate published by the Central Bank of Brazil (Banco Central do Brasil) was used for Brazil instead.\textsuperscript{35} A reliable source of data of sufficient duration was unable to be obtained for Hong Kong, Malaysia, and Singapore (SE Asia).

**Trade and Aggregation Weights**

Each of the country–specific models are comprised of both domestic variables and weighted cross–section averages of foreign variables. These foreign variables are commonly referred to as the “star” variables as a superscript asterisk is used to denote them. The weights for these foreign variables are constructed using annual data on bilateral trade shares from 1995–

\textsuperscript{33} Oslo Børs took over the duties of publishing interest rates from Norges Bank at the end of 2013.

\textsuperscript{34} The 10–year bond yield for Mexico was unavailable prior to 2001.

\textsuperscript{35} Series code TJLP from the Central Bank of Brazil.
2015 obtained from the United Nations COMTRADE database. A trade weight between countries $i$ and $j$ is calculated as the sum of exports from $i$ to $j$ and imports from $j$ to $i$ divided by the total amount of trade $i$ conducts with all countries in the sample. The fixed trade weight matrix in Table 4.3 is then constructed using the average trade weight over the period 1995–2015 such that each row sums to one.\textsuperscript{36}

The trade weight matrix is responsible for linking together the countries and regions of the model and illustrates the degree to which a country or region depends upon another. For example, the U.S. and the U.K. have very similar shares in euro area trade and account for nearly half (over 48\%) of total euro area trade. The euro area accounts for over 58\% of U.K. trade, with the U.S. and the euro area combining to account for over 73\% of U.K. trade. The euro area also accounts for over 64\% of trade in Scandinavia, with the U.K. and the euro area combining to account for over 81\% of Scandinavian trade. The simple message is that these countries are key in the transmission of shocks in western Europe.

Individual countries are aggregated into the regions shown in Table 4.1 via the use of weights constructed via purchasing power parity (PPP) GDP data obtained from the World Bank International Comparison Program database. The weight is constructed by taking the PPP GDP value of each country within a region and dividing by the total sum across that region, such that the weights add up to one within the region. These weights are then used to aggregate groups of countries together into a single region within the model. It should be noted that these aggregation weights are not the same, or used for the same purpose, as the trade weights used in constructing the foreign variables.

\textsuperscript{36} A time varying trade weight matrix, using a rolling 3–year average, was also used. Results remained robust.
<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Canada</th>
<th>Switzerland</th>
<th>Euro Area</th>
<th>U.K.</th>
<th>Japan</th>
<th>Latin America</th>
<th>Scandinavia</th>
<th>SE Asia</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
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<td>0.0629</td>
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<td>0.0939</td>
<td>0.2515</td>
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<td>0.2399</td>
<td>0.0158</td>
<td>0.1031</td>
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</tr>
</tbody>
</table>

Note: Trade weights are computed as shares of imports and exports displayed by rows such that a row, but not a column, sums to one. Source: United Nations COMTRADE database, 1995–2015.
Unit Root Tests

The next step is to determine the integration order of the individual data series in the model. Table 4.4 presents augmented Dickey–Fuller (ADF) test statistics for the levels, first, and second differences of the country/region–specific domestic and foreign variables. The lag length employed by the ADF test was selected via the Akaike Information Criterion (AIC) with the lag length restricted to be a maximum of 4.37 Note that no test statistics are available for domestic exchange rates and FDI in the U.S. as the U.S. is the reference country for these variables in the model. Also, no test statistics are available for the long–term interest rate in SE Asia as data for this region was unavailable. As expected, the variables of the model are consistently I(1) in their integration order. The only notable exception is the interest rate variables. Both the short and long–term interest rate variables show mixed evidence of being I(1). However, more often than not these variables are indicated by their test statistics to be I(1). Also, time plots of each of the individual interest rate series display a downward trend over time for all countries over the sample period. Therefore, to be consistent, all variables in the model are treated as I(1) and the model is estimated in first differences.38

Country/Region–Specific Models

The same specification is not imposed across all country/region–specific models. The model for the U.S. includes real GDP (y_{U.S.}), the short–term nominal interest rate (i^{S, U.S.}), and the long–term nominal interest rate (i^{L, U.S.}) as domestic variables. FDI and the real exchange rate are not included as domestic variables in the U.S. model as the U.S. is the reference country for these variables. The foreign real exchange rate (e^{*, U.S.}) and foreign FDI (fdi^{*, U.S.}) are included in the U.S. model as foreign variables, implying that the value of the U.S. dollar and outward U.S.

37 Results are consistent when the lag length is restricted to maximum of 6.
38 Results are robust when the model is estimated treating interest rates as I(0).
<table>
<thead>
<tr>
<th>Variables</th>
<th>Canada</th>
<th>Switzerland</th>
<th>Euro Area</th>
<th>U.K.</th>
<th>Japan</th>
<th>Latin America</th>
<th>Scandinavia</th>
<th>SE Asia</th>
<th>U.S.</th>
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</thead>
<tbody>
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<td>-3.00</td>
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<td>Japan</td>
<td>Latin America</td>
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<tr>
<td>--------------------</td>
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Note: Test statistics derived from univariate AR(p) models based on AIC order selection, with p ≤ 4, for the sample period 1995Q1 - 2015Q4. The 95% critical value of the ADF statistic for regressions with a trend is -3.45 and -2.89 for regressions without a trend.
FDI are determined outside the U.S. model. No other foreign variables are included in the U.S. due to its size and importance in the international economy. A similar argument has been used by Pesaran, Shuermann, and Weiner (2004).

Canada, the U.K., Switzerland, the euro area, Scandinavia, Japan, and Latin America include \((y_i, e_i, fdi_i, i^S_i, i^L_i)\) as domestic variables and \((y^*_i, i^{S^*}_i, i^{L^*}_i)\) as foreign variables in their respective country/region–specific models. Notice, however, that not included is the real exchange rate \((e^*_i)\) and FDI \((fdi^*_i)\) as foreign variables. This is because they have a close relationship to their domestic counterparts due to their sharing of the same reference country (U.S.) and have therefore been omitted. Lastly, SE Asia includes \((y_i, e_i, fdi_i, i^S_i)\) as domestic variables and \((y^*_i, i^{S^*}_i, i^{L^*}_i)\) as foreign variables in its region–specific model. The difference from above is that the long–term nominal interest rate is not included as a domestic variable as data was not available.

Now that the variables to be included in each of the country/region–specific models have been specified, the order of the individual country/region–specific VARX*(\(p_i,q_i\)) models is determined. Note that \(p_i\) refers to the lag length of the domestic variables in the model for country/region \(i\), and \(q_i\) refers to the lag length of the foreign variables. The lag length of the domestic and foreign variables in a country/region–specific VARX* model need not be the same. Order selection was performed via the Akaike information criterion (AIC) where both \(p_i\) and \(q_i\) were restricted to be no more than 4. Order selection of the VARX*\((p_i,q_i)\) models is summarized in Table 4.5.\(^{39}\)

Cointegration is also considered. The number of cointegrating relationships present in each of the country/region–specific VARX* models is also summarized in Table 4.5. Johansen’s

---

\(^{39}\) A better performing, stable, specification was not found.
Table 4.5 — VARX* Order and Number of Cointegrating Relationships in Individual Models

<table>
<thead>
<tr>
<th>Country</th>
<th>VARX*(p,q)</th>
<th># Cointegrating Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>1 1</td>
<td>5</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3 3</td>
<td>4</td>
</tr>
<tr>
<td>Euro Area</td>
<td>3 3</td>
<td>3</td>
</tr>
<tr>
<td>U.K.</td>
<td>3 4</td>
<td>3</td>
</tr>
<tr>
<td>Japan</td>
<td>4 4</td>
<td>4</td>
</tr>
<tr>
<td>Latin America</td>
<td>4 3</td>
<td>3</td>
</tr>
<tr>
<td>Scandinavia</td>
<td>4 4</td>
<td>1</td>
</tr>
<tr>
<td>SE Asia</td>
<td>4 2</td>
<td>4</td>
</tr>
<tr>
<td>U.S.</td>
<td>1 1</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: VARX*(p,q) is based on AIC order selection with p ≤ 4 and q ≤ 4.

trace statistics, described in Pesaran, Shin, and Smith (2000), are used to determine the rank of the cointegrating space. Unrestricted constants and restricted trend coefficients are included in the individual country/region error correction VARX* models. The number of cointegrating relationships summarized in Table 4.5 follow from the trace statistics shown in Table 4.6.

Weak Exogeneity and Residual Serial Correlation

One of the main assumptions of a GVAR model is that the foreign variables present in each of the country/region–specific VARX* models are weakly exogenous. Therefore, a formal test must be conducted to ensure this requirement is satisfied. The weak exogeniety assumption, à la Johansen (1992) and Granger and Lin (1995), in the context of cointegrating models implies there is no long–run feedback from the domestic variables to the foreign variables, without ruling out feedback in the short–run between the two variable sets. This involves testing the joint significance of the estimated error correction terms in auxiliary equations for the country/region–specific foreign variables, as described in Johansen (1992) and Harbo, Johansen, Nielsen and Rahbek (1998). The lag orders for the test were chosen to be the same as the underlying VARX*
<table>
<thead>
<tr>
<th>Country</th>
<th>Canada</th>
<th>Switzerland</th>
<th>Euro Area</th>
<th>U.K.</th>
<th>Japan</th>
<th>Latin America</th>
<th>Scandinavia</th>
<th>95% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r=0</td>
<td>285.98</td>
<td>235.38</td>
<td>273.18</td>
<td>231.83</td>
<td>201.14</td>
<td>195.74</td>
<td>140.05</td>
<td>122.96</td>
</tr>
<tr>
<td>r=1</td>
<td>204.24</td>
<td>139.38</td>
<td>156.41</td>
<td>146.21</td>
<td>136.42</td>
<td>122.48</td>
<td>91.58</td>
<td>91.81</td>
</tr>
<tr>
<td>r=2</td>
<td>135.02</td>
<td>81.28</td>
<td>88.54</td>
<td>84.19</td>
<td>82.42</td>
<td>78.20</td>
<td>54.64</td>
<td>64.54</td>
</tr>
<tr>
<td>r=3</td>
<td>79.88</td>
<td>42.51</td>
<td>41.28</td>
<td>36.83</td>
<td>44.09</td>
<td>37.90</td>
<td>23.73</td>
<td>41.03</td>
</tr>
<tr>
<td>r=4</td>
<td>33.44</td>
<td>15.11</td>
<td>15.14</td>
<td>11.60</td>
<td>12.21</td>
<td>10.37</td>
<td>9.36</td>
<td>20.98</td>
</tr>
</tbody>
</table>
Table 4.6 - Continued

<table>
<thead>
<tr>
<th>Country</th>
<th>SE Asia</th>
<th>95% Critical Value</th>
<th>U.S.</th>
<th>95% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r=0</td>
<td>179.76</td>
<td>91.81</td>
<td>117.85</td>
<td>57.45</td>
</tr>
<tr>
<td>r=1</td>
<td>108.38</td>
<td>64.54</td>
<td>54.71</td>
<td>36.09</td>
</tr>
<tr>
<td>r=2</td>
<td>54.72</td>
<td>41.03</td>
<td>15.80</td>
<td>18.26</td>
</tr>
<tr>
<td>r=3</td>
<td>24.39</td>
<td>20.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Critical values obtained from Mackinnon, Haug and Michelis (1999) at the 5% significance level. Canada, Switzerland, the Euro area, the U.K., Japan, Latin America, and Scandinavia include 5 domestic variables and 3 foreign variables. SE Asia includes 4 domestic variables and 3 foreign variables. The U.S. includes 3 domestic variables and 2 foreign variables.

models. Results are shown in Table 4.7. The null hypothesis that the foreign variables are weakly exogenous is unable to be rejected in all cases. This suggests that the assumption of weak exogeneity is satisfied.

Table 4.7 – F Statistics for Weak Exogeneity of the Country/Region–Specific Foreign Variables

<table>
<thead>
<tr>
<th>Country</th>
<th>y*</th>
<th>e*</th>
<th>fdi*</th>
<th>iS*</th>
<th>iL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>F(5,64)</td>
<td>2.02</td>
<td>-</td>
<td>-</td>
<td>0.68</td>
</tr>
<tr>
<td>Switzerland</td>
<td>F(4,47)</td>
<td>0.48</td>
<td>-</td>
<td>-</td>
<td>1.56</td>
</tr>
<tr>
<td>Euro Area</td>
<td>F(3,48)</td>
<td>0.08</td>
<td>-</td>
<td>-</td>
<td>0.22</td>
</tr>
<tr>
<td>U.K.</td>
<td>F(3,44)</td>
<td>1.99</td>
<td>-</td>
<td>-</td>
<td>0.49</td>
</tr>
<tr>
<td>Japan</td>
<td>F(4,38)</td>
<td>0.76</td>
<td>-</td>
<td>-</td>
<td>0.34</td>
</tr>
<tr>
<td>Latin America</td>
<td>F(3,42)</td>
<td>0.10</td>
<td>-</td>
<td>-</td>
<td>0.88</td>
</tr>
<tr>
<td>Scandinavia</td>
<td>F(1,41)</td>
<td>1.56</td>
<td>-</td>
<td>-</td>
<td>2.19</td>
</tr>
<tr>
<td>SE Asia</td>
<td>F(4,48)</td>
<td>0.48</td>
<td>-</td>
<td>-</td>
<td>0.18</td>
</tr>
<tr>
<td>U.S.</td>
<td>F(2,70)</td>
<td></td>
<td>0.03</td>
<td>0.27</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: * denotes statistical significance at the 5% level. Null hypothesis: foreign variables are weakly exogenous. Tests were carried out using lag orders of the underlying VARX* models shown in Table 4.5.

Finally, tests are performed to check for serial correlation in the residuals of the each of the country/region–specific VARX* models. This provides insight into how well the model specification is performing. Table 4.8 presents results for the F statistic version of the familiar

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40 This does not have to be the case. Results using AIC to select lag orders did not alter the test results in any meaningful way.
LM test for serial correlation.\footnote{See Godfrey 1978a, 1978b.} It is comforting to see that the model specification performs rather well; only 3 out of 42 cases reject the null hypothesis of there being no serial correlation of the residuals. In fact, several model specifications were tried, but a better performing, stable specification was not found.

<table>
<thead>
<tr>
<th>Country/Region – Specific Regressions</th>
<th>F Statistic</th>
<th>y</th>
<th>e</th>
<th>fdi</th>
<th>i^S</th>
<th>i^L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>F(4,66)</td>
<td>0.6</td>
<td>0.49</td>
<td>1.51</td>
<td>0.05</td>
<td>1.83</td>
</tr>
<tr>
<td>Switzerland</td>
<td>F(4,51)</td>
<td>1.66</td>
<td>1.32</td>
<td>0.92</td>
<td>1.49</td>
<td>0.88</td>
</tr>
<tr>
<td>Euro Area</td>
<td>F(4,52)</td>
<td>1.82</td>
<td>1.94</td>
<td>0.7</td>
<td>2.58*</td>
<td>1.45</td>
</tr>
<tr>
<td>U.K.</td>
<td>F(4,49)</td>
<td>0.54</td>
<td>1.5</td>
<td>0.81</td>
<td>0.86</td>
<td>0.96</td>
</tr>
<tr>
<td>Japan</td>
<td>F(4,43)</td>
<td>0.19</td>
<td>0.24</td>
<td>0.8</td>
<td>0.42</td>
<td>0.92</td>
</tr>
<tr>
<td>Latin America</td>
<td>F(4,47)</td>
<td>1.18</td>
<td>0.45</td>
<td>0.9</td>
<td>0.42</td>
<td>1.46</td>
</tr>
<tr>
<td>Scandinavia</td>
<td>F(4,46)</td>
<td>4.44*</td>
<td>0.43</td>
<td>1.14</td>
<td>0.28</td>
<td>0.4</td>
</tr>
<tr>
<td>SE Asia</td>
<td>F(4,52)</td>
<td>0.82</td>
<td>0.67</td>
<td>0.15</td>
<td>0.55</td>
<td>-</td>
</tr>
<tr>
<td>U.S.</td>
<td>F(4,70)</td>
<td>2.59*</td>
<td>-</td>
<td>-</td>
<td>0.43</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Note: * denotes statistical significance at the 5% level. Null hypothesis: residuals are not serially correlated.

Dynamic Properties of the Model and Discussion

The dynamic properties of how a currency depreciation of a particular country or region, vis-à-vis the U.S. dollar, affects outgoing U.S. FDI across the globe are studied via generalized impulse response functions (GIRFs). Literature on GVAR models has primarily adopted the GIRF approach to deriving impulse response functions as it produces the same results regardless of the ordering of the countries and variables in the model.\footnote{See, for example, Pesaran et al. (2004), Pesaran and Smith (2006), and Dées et al. (2007).} This is primarily because a particular ordering would be hard to entertain or justify in the context of a global model and the use of \textit{a priori} restrictions on long–run properties of the model \textit{à la} Blanchard and Quah (1989) can be complicated due to the high dimensionality and cross sectional interactions of the model.
While the model allows for the possibility of an exchange rate shock originating in any of countries or regions of the model, with the exception of the U.S., only three countries/regions will be considered to keep analysis focused. These are:

- A positive, 1 standard deviation shock (1.26% increase) to U.K./U.S. real exchange rate.
- A positive, 1 standard deviation shock (1.27% increase) to euro/U.S. real exchange rate.
- A positive, 1 standard deviation shock (1.19% increase) to Scandinavia/U.S. real exchange rate.

These three shocks represent a strengthening of the U.S. dollar relative to the U.K., euro area, and Scandinavia.

Figure 4.1 displays the impact an increase in the U.K. real exchange rate has on U.S. FDI worldwide. Results show that an increase in the U.K. real exchange rate decreases U.S. FDI into the U.K. and also the euro area. For the U.K., there is a statistically significant reduction in U.S. FDI amounting to more than $713,000 in the quarter following a real exchange rate shock. This result is consistently statistically significant seven quarters following the shock and often greater than a $500,000 reduction per quarter. For the euro area, there is a statically significant reduction in U.S. FDI amounting to more than $190,000 in the second quarter following a real exchange rate shock. This becomes statistically significant in a consistent manner five quarters following the shock and is consistently larger than $110,000 per quarter. The U.K. exchange rate does not appear to affect U.S. FDI in other countries/regions of the world.

Figure 4.2 displays the impact an increase in the euro area real exchange rate has on U.S. FDI worldwide. Results show that an increase in the euro area real exchange rate decreases U.S. FDI into the U.K. and the euro area. The euro area real exchange rate shock results in a statistically significant reduction of U.S. FDI into the U.K. that amounts to more than $283,000...
Confidence bounds (95%) were obtained via 1000 bootstrap replications.

Figure 4.1 – Impulse Response of Shock to U.K. Real Exchange Rate

43 Confidence bounds (95%) were obtained via 1000 bootstrap replications.
in the quarter following a shock. However, this quickly dissipates and is statistically insignificant after two or more quarters. The euro area experiences a statistically significant reduction in U.S. FDI two quarters after a shock to the euro area real exchange rate. This reduction peaks at over $430,000 in the third quarter following a shock and is consistently more than a $200,000 reduction in the quarters that follow. U.S. FDI into other countries and regions do not appear to respond to a change in the euro area exchange rate.

Figure 4.3 displays the impact an increase in the Scandinavian exchange rate has on U.S. FDI worldwide. Results show that positive shock to the Scandinavian real exchange rate does not have an impact on U.S. FDI into Scandinavia, but does have an impact on U.S FDI into the euro area. A plausible explanation for this is simply that the amount of U.S. FDI into Scandinavia is relatively small. During 2014 the U.S. accounted for about 6.7% of total FDI received by Sweden, 8.2% of total FDI received by Norway, and 2.7% of FDI received by Denmark.\footnote{Calculations based on data obtained from OECD International direct investment database, 2016.}

However, as shown by Table 4.3, Scandinavia and the euro area share a strong trade relationship. This may explain why a Scandinavian exchange rate shock propagates to the euro area, resulting in decreased U.S. FDI. A positive shock to the real Scandinavian exchange rate results in a reduction in U.S. FDI into the euro area that is statistically significant after two or more quarters. The amount of the reduction peaks at over $145,000 in the third quarter follow a shock, and is consistently more than $100,000 in following quarters.

Several discussion points arise from these results. First, U.S. outbound FDI declines in response to an appreciation of the U.S. dollar. This runs counter to what is implied by, for example, Klein and Rosengren (1994). It does, however, tend to agree with Egger, Egger, and Ryan (2009) and Lui (2010). Egger, Egger, and Ryan (2010) show that a result such as this is
Figure 4.2 – Impulse Response of Shock to Euro Area Real Exchange Rate
theoretically possible. They suggest that countries with a relatively heavier orientation towards foreign affiliate production versus exporting, such as the U.S., reduce outbound FDI as their home currency appreciates. The results of this paper appear to lend additional support to this.

Second, exchange rate movements do not appear to propagate through FDI. In other words, U.S. FDI doesn’t appear to be affected outside of the immediate area where the exchange rate shock originates. For example, a shock to the real exchange rate originating in the euro area does not have an appreciable affect to U.S. FDI into Japan, southeast Asia, and Latin America. Also, U.S. FDI into areas relatively close to the euro area geographically, such as Switzerland and Scandinavia, does not appear affected as well. Additionally, while not one of the three shocks of focus in this section, results also indicate that U.S. FDI does not respond to an appreciation of the U.S. dollar vis-à-vis Japan or southeast Asia. Overall, there is little evidence that a depreciation of one region’s currency vis-à-vis the U.S. dollar has any impact on U.S. outbound FDI into other regions.

Third, and perhaps most importantly, the magnitudes of these responses are very small. Using Figure 4.1 as an example, the potential drop in U.S. FDI into the U.K. following a depreciation of the British pound relative to the U.S. dollar totals, approximately, $2,585,939. This number is relatively small considering this is at the macroeconomic level. To put this in perspective, according to UNCTAD’s 2016 World Investment Report the overall amount of FDI received by the U.K. from the rest of the world during 2015 was over 39 billion dollars. This means the total reduction in U.S. FDI received by the U.K. following an approximate 1.3% increase in the U.K./U.S. real exchange rate amounts to far, far less than 1% of total FDI received by the U.K.

45 After two years the drop in U.S. FDI in the U.K. is approximately $4,780,861.
Figure 4.3 – Impulse Response of Shock to Scandinavian Real Exchange Rate
in 2015. Not only that, but the magnitude of the responses in Figures 4.2 and 4.3 are generally even smaller.

These results call into question the real world impact exchange rates actually have on U.S. outward FDI. Yes, in some cases it appears exchange rate movements have a statistically significant impact on the amount of outward FDI. However, the size of the impact experienced by the receiving country is very, very small relative to the overall amount of FDI received. One can only conclude that exchange rates do not appear to have any economically meaningful impact upon U.S. outbound FDI at the macroeconomic level.

Conclusion

This paper re-examines how exchange rate movements affect FDI using a GVAR model, a relatively new empirical technique to modeling interactions in a global economy. Quarterly U.S. outbound FDI into 22 countries making up 8 different regions is considered over the period 1995–2015. Results provide some evidence that a deprecation of a host country’s currency relative to the U.S. causes a reduction in U.S. FDI received by the host country. This appears to be limited to the immediate region of the country experiencing a currency depreciation. In other words, exchange rate movements do not appear to propagates to other parts of the world through U.S. outbound FDI.

However, and more importantly, these results do not appear to be economically significant. The total reduction in U.S. FDI received by host countries amounts to much less than 1% of overall FDI received by the host countries in recent years. One is lead to conclude that exchange rates do not play any economically meaningful role in U.S. outbound FDI. The long time horizon associated with FDI projects suggests that multinational firms should expect exchange rates to fluctuate during the life of the project. Intuition then suggests that exchange
rates should not play a major role in determining FDI behavior. The results of this paper provide evidence as to the plausibility of this argument.
CHAPTER V
CONCLUSION

This three-essay dissertation makes three important contributions to the literature on FDI and its relationship with collateral and the exchange rate. First, I show how the value of pledged collateral varies with a firm’s productivity level. Second, I demonstrate how collateral affected the amount of ownership equity Japanese parent firms place in their foreign affiliates. Third, I illustrate that not only did an appreciation of the U.S. dollar have no economically meaningful impact on U.S. FDI outflows, but also that exchange rate movements do not appear to spread through U.S. outbound FDI to other parts of the world as well.

My first contribution follows from a theoretical model I developed illustrating that more productive firms are able to pledge a smaller amount of collateral relative to less productive firms for FDI projects requiring the same amount of external financing. Intuitively, more productive firms are safer investments in the eyes of lenders as their FDI projects are more likely to succeed relative to less productive firms. This grants more productive firms the ability to pledge less collateral relative to their less productive counterparts. Additionally, firms with a productivity level below a set threshold level need to pledge collateral of greater value than the amount borrowed. This may not be a feasible option for firms facing this situation and cause them to instead forego the FDI project.

I empirically examine the relationship between pledged collateral and productivity using firm-level data on Japanese FDI into the U.S. between 1980 and 2000. My results support an inverse relationship between productivity and pledged collateral implied by my theoretical model. My results are the strongest for 1991–2000, the period that followed the burst of Japan’s asset bubble and subsequent collapse of its banking system, which limited the access Japanese
firms had to external financing. My results suggest that the productivity level of a firm is important in determining the amount of collateral pledged to secure external financing during a time of financial crisis. A plausible explanation is that in the eyes of lenders more productive firms are more likely to be successful with their FDI projects, reducing the likelihood of default. This allows more productive firms to secure external financing with less collateral relative to less productive firms.

Several avenues exist for future research on this topic. My theoretical model can be extended to be sequential in nature. Often firms begin servicing a foreign market by first exporting before making the switch to FDI. Currently, my model only focuses on the FDI decision made by firms. However, it would be straightforward to extend the model to include the possibility of exporting as well. Including this option in the model may show that firms not meeting the productivity level cutoff necessary for their FDI project to be feasible have the option of exporting instead. Another avenue of future research concerns data on collateral pledged by firms. Currently I construct a proxy for a firm’s pledged collateral using available balance sheet data. Research moving forward should focus on developing a more accurate way of measuring or estimating pledged collateral.

My second contribution follows from the analysis of impulse response functions for Japanese foreign direct investment into 12 OECD countries from 1975 to 2000. Domestically–held land is a traditional form of collateral in Japan’s culture of corporate finance. A positive shock to land value increased ownership equity in foreign affiliates belonging to the same 2–digit standard industrial classification as their Japanese parent by approximately 4–8 percentage points. Ownership equity in foreign affiliates outside the 2–digit standard industrial classification of their Japanese parent does not appear to be affected by a positive land value shock. This may
be due to the fact that non-core affiliates are likely to require assets and knowledge that the parent may not possess but can easily obtain through shared ownership of the foreign affiliate.

However, it is important to keep in mind that these results are based on an interesting time period of Japan’s history. Land prices surged during the late 1980s, resulting in a large land price bubble which subsequently collapsed during the early 1990s. Land prices lost approximately half their value during the 1990s, sending Japan into financial crisis. Future research on this topic should consider the foreign affiliates of firms headquartered in countries other than Japan to see if these results are applicable to other countries as well. In addition, I only consider a demand side financial shock, collateral. Another avenue of future research is to extend this concept to a supply side financial shock, such as bank health, as the relative response of ownership equity to a financial shock may differ by the source or cause of the shock.

My third contribution follows from the use of a relatively new empirical technique known as global vector autoregression (GVAR) to model the interactions between the real exchange rate and U.S. outward FDI. My results indicate evidence of a statistical relationship between U.S. FDI outflow and a strengthening of the U.S. dollar. However, my results also indicate that an appreciation of the U.S. dollar relative one country or economic region does not appear to affect U.S. FDI outflow to other parts of the world. Finally, and perhaps most importantly, the actual size of the effect on U.S. FDI outflow is very small; amounting to much less than 1% of overall FDI received by host countries and economic regions in the model for recent years. I conclude that not only did an appreciation of the U.S. dollar have no economically meaningful impact on U.S. FDI outflows during this period, but also that exchange rate movements do not appear to spread through U.S. outbound FDI to other parts of the world as well.
Future research may consider outbound FDI from different source countries. For example, Japan is a popular candidate based on the observed increase in Japanese FDI into the U.S. during the 1980’s while the U.S. dollar was simultaneously depreciating. However, I believe future research should be more concerned with the possibility of new empirical applications of GVAR modeling. A GVAR model considers the feedback and interactions between many different host countries and economic regions around the world within a single model. I believe these to be attractive properties when considering something as global in nature as FDI. For example, one possible future application of GVAR modeling to FDI could be to follow. Literature has shown that a reduction of Japanese FDI into the U.S. during the 1990s can in part be explained by reduced access to credit resulting from Japan’s financial crisis of the 1990s.\textsuperscript{46} But was this reduction in Japanese FDI into the U.S. relatively uniform across the country, or confined to a particular region? To answer this question, a GVAR model could be used to analyze changes in the regional patterns of Japanese FDI into the U.S. resulting from a financial crisis in Japan.

\textsuperscript{46} See Klein, Peek, and Rosengren (2002).
APPENDICES

A.1 – Foreign affiliate Price and Output Relative to the Domestic Case

Domestic firms charge a price given by \( p_D = \frac{\sigma}{(\sigma-1)} \left( \frac{1}{\beta} \right) \) while foreign affiliates charge a price given by \( p_{FDI} = \frac{\sigma}{(\sigma-1)} \left( \frac{1}{\lambda \beta} \right) \). The price charged by foreign affiliates differs from the domestic case by markup factor \( \frac{1}{\lambda} > 1 \) since \( \lambda \epsilon (0,1) \). This illustrates that foreign affiliates charge a higher price. Due to the fact that output in both cases is decreasing in price, this implies that output of the foreign affiliate is lower relative to the domestic case.

A.2 – Proof of Proposition 1

\[
\frac{\partial \gamma^*}{\partial \phi} = \frac{1}{(1-\lambda)}
\]

\((1-\lambda)\) is positive since \( \lambda \epsilon (0,1) \), thus \( \frac{\partial \gamma}{\partial \phi} > 0 \)

\[
\frac{\partial \gamma}{\partial \beta} = - (\sigma-1)^{\lambda} \left( \frac{1}{\beta (1-\lambda)} \right) \left[ \frac{\sigma}{(\sigma-1)} \left( \frac{1}{\lambda \beta} \right) \right]^{1-\sigma}
\]

Note that \((\sigma-1) > 0\) as \( \sigma > 1 \) and \((1-\lambda) > 0\) as \( \lambda \epsilon (0,1) \), thus \( \frac{\partial \gamma}{\partial \beta} < 0 \)

Signing \( \frac{\partial \gamma^*}{\partial \lambda} \) is analytically difficult. Instead, equation (11) is plotted to examine how pledged collateral changes as the probability of success increases. Plot 1 depicts how pledged collateral changes as the probability of success increases, assuming the amount borrowed is less than the total market size. Pledged collateral is initially increasing but then becomes decreasing as the probability of success increases. However, as depicted in Plots 2 and 3, when the amount borrowed is equal to or greater than the total market size pledged collateral is unambiguously increasing in the probability of success.
A.3 – Proof of Proposition 3

\[ \frac{\partial \beta^*}{\partial \sigma} = \frac{\left( \frac{A}{\phi} \right)^{\frac{1}{\sigma}}}{(\sigma-1)^2} \left[ \ln \frac{A}{\phi} - 1 \right] \]

The sign of \( \frac{\partial \beta^*}{\partial \sigma} \) hinges upon \( \ln \left( \frac{A}{\phi} \right) \) where \( \frac{\partial \beta^*}{\partial \sigma} > 0 \) if \( \left( \frac{A}{\phi} \right) > e \). This implies that \( \frac{\partial \beta^*}{\partial \sigma} > 0 \) when \( \phi < \left( \frac{A}{e} \right) \)
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OECD. (2016). Main Economic Indicators, Long-Term Government Bond Yields: 6-Month to 2-Year for Mexico, retrieved from FRED, Federal Reserve Bank of St. Louis. Retrieved from https://fred.stlouisfed.org/series/IRLTST01MXA156N


