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**THE ROLE OF EXPORTING AND TRADE  
FOR ENTRY OVER THE BUSINESS CYCLE**

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# The Role of Exporting and Trade for Entry over the Business Cycle\*

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## Abstract

This paper studies the role of international trade and the export participation decisions of establishments for firm creation over the business cycle in a general equilibrium model. The model captures two key features of establishment and exporter dynamics: i) new establishments start small and grow over time and ii) exporters tend to be bigger and more productive than non-exporters. When the cost of creating establishments fluctuates with aggregate productivity, we find the model can generate procyclical fluctuations in the stock of domestic establishments and importers similar to the data. Without international trades, entry is weakly countercyclical. The model also generates fluctuations in the stock of importers, exporters, and domestic establishments of similar magnitude to those in the data. With an entry margin, we also find that output is hump-shaped following a productivity shock since investments in creating establishments and exporters generate an incentive to delay accumulating physical capital.

**JEL classifications:** E31, F12.

**Keywords:** Sunk cost, fixed cost, establishment heterogeneity, entry, exporter.

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## 1. Introduction

Recent research in international trade identifies an important theoretical link between the export decisions of establishments and the creation and destruction of establishments (see Melitz, 2003). In this framework, reductions in marginal trade costs, such as tariffs and transportation costs, generate a large increase in the share of establishments exporting (see Ruhl, 2003) and reduce the incentive to create new establishments (Baldwin and Forslid, 2006 and Alessandria and Choi, 2011). For instance, Alessandria and Choi (2011) find an 8 percent reduction in tariffs increases export participation by 92 percent but reduces the stock of domestic establishments by two percent. While the effect of trade on entry is well understood, the effect of trade for the dynamics of entry over the business cycle is less understood.<sup>1</sup> And given the large reduction in firm creation since the Great Recession this an important area of interest. In this paper, we study the relationship between international trade and establishment creation over the business cycle in a general equilibrium model of endogenous entry into production and exporting.

We begin by documenting a number of salient features of the business cycles of the stock of establishments, exporters, and importers. Consistent with previous research (see Chatterjee and Cooper, 1993; and Lee and Mukoyama, 2008), we find that both the number of new establishments and the stock of current establishments is procyclical in the U.S. We also find that when the number of domestic establishments is expanding so is the number of products being imported into the U.S. In contrast, we find that stock of U.S. establishment exporting tends to be mildly countercyclical. Finally, we find that fluctuations in the stock of establishments are about half as big as fluctuations in GDP, while fluctuations in the number of importers and exporters are about 1.5 times those of GDP, but half as volatile as trade flows.

To address the pattern of establishment creation and entry over the business cycle requires

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<sup>1</sup>Ghironi and Melitz (2007) do study some aspects of entry and trade over the business cycle.

a model that captures key features of establishment-level heterogeneity. For our purposes, we modify the general equilibrium model of endogenous export participation of Alessandria and Choi (2007) to include an entry decision. In that model, which captures the key differences between exporters and non-exporters documented by Bernard and Jensen (1999), establishments differ in their productivity, capital stock, and export status. To become exporters, consistent with the evidence in Das, Roberts and Tybout (2007), non-exporters incur a large, up-front sunk cost. To remain as exporters, establishments incur a smaller fixed cost. With heterogeneity in individual labor productivity and capital holdings, only the most productive non-exporters start exporting. Similarly, given the fixed cost of continuing in the export market, the least productive exporters exit the market. Over time, idiosyncratic productivity shocks lead establishments to enter and exit the export market. Thus, the model generates exporter hysteresis in that exporters continue to export even after they have become relatively unproductive. We augment this model by allowing free entry so that new establishments are created with a one-period delay by incurring another fixed costs. With the structure of export cost in the model, new plants start small and grow through time consistent with the data.

To capture the aggregate features about entry, we consider two types of shocks: shocks to productivity and shocks to fixed costs of creating establishments and exporters. When the productivity of creating establishments and exporters moves with aggregate productivity, we find the model does well at matching a number of features about the business cycle properties of establishments. The model generates procyclical fluctuations in the stock of establishments and importers (0.28 and 0.44 in the data vs. 0.25 and 0.59 in the model). With these procyclical fluctuations in the stock of establishments and importers, the model generates a positive correlation between the stock of establishments and importers as in the data (0.28 in the data vs. 0.07 in the model). The model also generates fluctuations in the number of exporters and importers that are about 1.6 times output

(1.51 and 1.74 in the data), and more moderate fluctuations in the stock of establishments (0.50 in the data vs. 0.77 in the model). Holding the technology for exporting and creating establishments constant leads to much smaller fluctuations in exporters, importers and domestic establishments.

We find that international trade and the export decision of establishments play an important role in the dynamics of establishment creation. When we eliminate international borrowing and lending so that the current account is always equal to zero, the volatility in the stock of establishments falls by 44 percent relative to the benchmark model while fluctuations in participation by exporters and importers are cut by 65 percent. Eliminating the ability to borrow from abroad implies that when the home country receives a positive productivity shock, it will devote relatively more resources towards physical capital accumulation and less towards the creation of establishments or exporters. When we further eliminate intratemporal trade and the potential to export, the model now predicts acyclical fluctuations in the stock of establishments (-0.01). As the other extreme case, we eliminate the fixed costs in exporting. As all producers engage in the foreign market without any fixed costs in exporting, there are greater incentive to create new establishments and export when there is a positive productivity shock. Thus the model predicts very strong procyclical fluctuations in the stock of establishment (0.98), and the stock of establishments becomes negatively related to importers (-0.10).

This paper is related to three lines of research. First, there is a closed economy literature that studies entry and exit of establishments over the business cycle (see Chatterjee and Cooper, 1993; Devereux, Head and Lapham, 1999; Cook, 2001; and Comin and Gertler, 2006). These papers abstract from plant heterogeneity. More recent work by Campbell (1998), Samaniego (2007), Veracierto (2008), and Lee and Mukoyama (2008) consider aggregate fluctuations in models with heterogeneous establishments but abstract from international trade. Second, the international real

business cycle model of Backus, Kehoe and Kydland (1994) has been extended to include exporting<sup>2</sup> by Ghironi and Melitz (2005) and Alessandria and Choi (2007). Our approach differs from that in Ghironi and Melitz (2005), which also considers entry, in that we allow the underlying structure of establishment heterogeneity to differ and we allow for physical capital accumulation. We find including physical capital to be important for the propagation of shocks, since the durability of investments in establishments and exporters differ from that of physical capital. Finally, there is a third, partial equilibrium literature that studies the export decisions of establishments. Baldwin (1988), Baldwin and Krugman (1989) and Dixit (1989) develop models of export decisions with an exogenous exchange rate process.<sup>3</sup> Das, Roberts and Tybout (2007) develop these models further and use them to estimate the sunk costs of exporting. As partial equilibrium studies these papers cannot address the cyclical features of exporting or entry.

The paper is organized as follows. The next section discusses evidence on the dynamics of exporter participation and establishments over the business cycle. Section 3 develops a two-country dynamic general equilibrium model with establishment and exporter dynamics. In section 4, we subject the model to country-specific shocks to productivity and examine the quantitative implications of the model for the exporter participation and establishment creation over the business cycle. Section 5 explores the sensitivity of the model to changes in the structure of trade, trade costs, fixed costs, the elasticity of substitutions, and the durability of investments in establishments. Section 6 concludes.

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<sup>2</sup>Cook (2002) and Head (2002) study entry in an international business cycle model but abstract from plant heterogeneity or the decision to export.

<sup>3</sup>Other papers that study the export decision include Roberts and Tybout (1997), Aw, Chung and Roberts (1998) and Clerides, Lach, and Tybout (1998).

## 2. Evidence

In this section we discuss some evidence about the fluctuations in the number of establishments, importers, and exporters<sup>4</sup> from 1975 to 2006. Our measure of the number of establishments is essentially a count of active private manufacturing establishments and our measure of importers and exporters are based on counts of the number of goods imported and exported (see the data appendix for more details). While these measures of changes in the number of goods imported or exported need not correspond to changes in the number of foreign establishments active in the U.S. market or U.S. establishments active overseas, we do find that these measures are highly correlated with the participation by establishments, at least for US exporters<sup>5</sup>

Table 1 reports the business cycle properties of real GDP, real exchange rate, real exports and imports, number of manufacturing plants, number of establishments, numbers of exporters and importers in the U.S. The data are constructed from the annual U.S. economy from 1975 through 2006.<sup>6</sup> The data show that the stock of establishments is about 50 percent as volatile as GDP and procyclical. The number of manufacturing plants has about the same volatility (48 percent as volatile as GDP), and procyclicality. The correlation between the stock of establishments and GDP is 0.28, and the correlation between number of manufacturing plants and GDP is 0.21. Lee and Mukoyama (2008) attribute the procyclicality of the number of manufacturing establishments primarily to movements in the entry margin rather than the exit margin since entry rates vary by nearly seven times as much as exit rates.

Second, the data show that the exporters and importers are highly volatile. Exporters and

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<sup>4</sup>Ghironi and Melitz (2007) discuss fluctuations in these margins in the US from 1989 to 2001. Alessandria and Choi (2007) study fluctuations in exporting to a panel of countries from 1996 to 2003.

<sup>5</sup>This measure of the number of goods exported is highly correlated (0.80) and of similar magnitude (percent standard deviation of 3.4 vs 4.6) as a measure based on the number of exporters from 1984 to 1992 in Bernard and Jensen (1999) and from the Exporter Database from 1996 to 2006. Based on this we conclude that our goods based measures are also likely to reflect participation decisions by establishments.

<sup>6</sup>The detailed description of data are reported in Appendix. All the data are H-P filtered with the smoothing parameter of 6.25 after taking logarithm.



importers are about 1.5 and 1.7 times as volatile as GDP, respectively, suggesting that there are many producers at the margin for exporting. So, when there are changes in productivity or demand for their goods, many of marginal exporters enter or exit foreign markets. However, we also find that the exporters and importers are about half as volatile as trade flows. Thus the data suggest that both the extensive and intensive margins are important for the volatility of trade flows. We also observe that exporters are countercyclical whereas importers are procyclical. The correlation between exporters and GDP is -0.35, whereas the correlation between importers and GDP is 0.44. We also find that when the stock of establishments rises, so does the stock of importers<sup>7</sup> (correlation of 0.28), while the stock of exporters tends to falls (correlation is -0.37). The negative comovement between establishments and exporters is only possible if not all establishments export and the incentive to export varies relative to the incentive to enter. Finally, we find a positive correlation between entry and the real exchange rate,<sup>8</sup> but essentially no correlation between exporters and importers and the real exchange rate.

### 3. The Model

In this section, we develop a model with infinitely lived consumers and heterogeneous establishments to study the role of trade and exporting on the entry decisions of establishments over the business cycle. The model combines elements of Ghironi and Melitz (2005) framework of entry and exporting with the establishment exporter dynamics of Alessandria and Choi (2007). Each period there is a mass of existing establishments distributed over productivity, countries, and export status. Establishment level productivity is stochastic and generates movements of establishments into and out of exporting. Each period, some establishments shutdown, and new establishments are created

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<sup>7</sup>We focus on the comovement between private establishments rather than manufacturing establishments since this will be consistent with the model we develop in the next section; however, we present statistics for manufacturing establishments for completeness.

<sup>8</sup>The real exchange rate is defined as foreign price over domestic price. An increase in exchange rate means a real depreciation.

by incurring a sunk cost.

There are two countries, *home* and *foreign*. Each country is populated by a continuum of identical, infinitely lived consumers with mass of one. Each period, the economy experiences an event  $s_t$ . Let  $s^t = (s_0, s_1, \dots, s_t)$  denote the history of events from period 0 up to and including period  $t$ . The probability of a history  $s^t$ , conditional on the information available at period 0, is given as  $\pi(s^t|s_0)$ . The initial realization of an event at period 0,  $s_0$ , is given.

In each country there is a large number of monopolistically competitive intermediate good producers each producing a differentiated good. The many intermediate good producers are indexed  $i \in \{0, N(s^t)\}$ , where  $N(s^t)$  is the mass of intermediate good producers in  $s^t$ .<sup>9</sup> An intermediate good producer uses capital and labor inputs to produce its variety of intermediate input. Producers differ in terms of total factor productivity, capital, location of production and destination markets of sales. All establishments sell their product in their own country, but only some establishments export. Similar to Das, Roberts and Tybout (2007), to export, an establishment incurs a fixed cost that depends on its export status in the previous period. There is a (relatively) high up-front sunk cost  $f_0(s^t) > 0$  that must be borne to gain entry into the export market. In subsequent periods, to continue exporting, establishments incur a lower but nonzero period-by-period fixed continuation cost  $f_1(s^t) < f_0(s^t)$ . If an establishment does not pay this continuation cost, then it ceases to export. In future periods, the establishment can begin exporting only by incurring the entry cost  $f_0(s^t)$  again. The cost of exporting implies that the set of goods available to consumers differs across countries and is changing over time. We assume that the fixed costs must be incurred in the period of exporting.

In each period some establishments die and new ones are created. Consistent with the

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<sup>9</sup>To be precise, the index is reassigned each period based on shutdown producers and new producers so that all the establishments are indexed within the mass of producers.

evidence in Lee and Mukoyama (2008) finding small cyclical fluctuations in the exit rate of plants, all the establishments are assumed to face a constant death probability  $n_d$ . Thus, only  $n_s = 1 - n_d$  fraction of establishments survives the next period. New establishments can be created by incurring a sunk cost of  $f_E(s^t)$ . An entrant can actively produce goods and sell their products from the following period on. Establishments differ by their technology, export status, and location of production.

In each country, competitive final goods producers purchase intermediate inputs from those establishments actively selling in that country.<sup>10</sup> The cost of exporting implies that the set of goods available to competitive final goods producers differs across countries. The entry and exit of exporting establishments implies that the set of intermediate goods available in a country is changing over time. The final goods are used for both domestic consumption and investment.

In this economy, there exists a complete set of one-period state-contingent nominal bond denominated in the home currency. Let  $B(s^{t+1}|s^t)$  denote the home consumer's holding of the bonds purchased in state  $s^t$  with payoff in state  $s^{t+1}$ . Let  $B^*(s^{t+1}|s^t)$  denotes the foreign consumer's holding of this bond. The state-contingent bond  $B(s^t)$  pays 1 unit of home currency if  $s^t$  occurs, and 0 otherwise. Let  $Q(s^{t+1}|s^t)$  denote the nominal price of the bond  $B(s^{t+1})$ . All the intermediate and final good producers are owned by domestic consumers. It is assumed that these ownership claims cannot be traded.

### *Consumers*

Home consumers choose consumption, labor, and bond holdings to maximize their utility:

$$(1) \quad \max \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi(s^{t+1}|s_0) U[C(s^t), L(s^t)],$$

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<sup>10</sup>There is no value added in this stage of production. The final good production technology regulates a country's preferences over local and imported varieties.

subject to the sequence of budget constraints,

$$(2) \quad P(s^t) C(s^t) + \sum_{s^{t+1}} Q(s^{t+1}|s^t) B(s^{t+1}) \leq P(s^t) W(s^t) L(s^t) + B(s^t) + P(s^t) \Pi(s^t),$$

where  $\beta$  is the subjective time discount factor with  $0 < \beta < 1$ ;  $P(s^t)$  is the price of the final good;  $C(s^t)$  is the consumption of final goods;  $W(s^t)$  is the real wage rate; and  $\Pi(s^t)$  is the sum of real profits from the home country producers. The instantaneous utility function is given as  $U(C, L) = [C^\gamma (1 - L)^{1-\gamma}]^{1-\sigma} / (1 - \sigma)$ , where  $1/\sigma$  is the intertemporal elasticity of substitution, and  $\gamma$  is the share parameter for consumption in the composite commodity.

The problem of foreign consumers is analogous to this problem. Prices and allocations in the foreign country are represented with an asterisk. Money has no role in this economy and is only a unit of account. The foreign budget constraint is expressed as

$$(3) \quad P^*(s^t) C^*(s^t) + \sum_{s^{t+1}} \frac{Q(s^{t+1}|s^t)}{e(s^t)} B^*(s^t) \leq P^*(s^t) W^*(s^t) L(s^t) + \frac{B^*(s^t)}{e(s^t)} + P^*(s^t) \Pi^*(s^t),$$

where \* denotes the foreign variables and  $e(s^t)$  is the nominal exchange rate with home currency as numeraire.<sup>11</sup>

### ***Final Good Producers***

In the home country, final goods are produced using only home and foreign intermediate goods. A final good producer can purchase from any of the home intermediate good producers but can purchase only from those foreign intermediate good producers that are actively selling in the home market. The set of foreign intermediate good producers actively selling in the home country is denoted by  $X^*(s^t)$ , where  $i \in X^*(s^t)$  if the  $i_{\text{th}}$  producer is a foreign exporter in  $s^t$ .

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<sup>11</sup>An increase in  $e(s^t)$  means a depreciation of domestic currency.

The production technology of a final good producer is given by a constant elasticity of substitution (CES) function

$$(4) \quad D(s^t) = \left\{ \lambda \left[ \int_0^{N(s^t)} y_h^d(i, s^t)^\theta di \right]^{\frac{\rho}{\theta}} + (1 - \lambda) \left[ \int_0^{N^*(s^t)} y_f^d(i, s^t)^\theta di \right]^{\frac{\rho}{\theta}} \right\}^{\frac{1}{\rho}},$$

where  $D(s^t)$  is the output of final goods and  $y_h^d(i, s^t)$  and  $y_f^d(i, s^t)$  are inputs of intermediate goods purchased from home establishment  $i$  and foreign establishment  $i$ , respectively. The parameter  $\lambda$  determines the weight of home goods in final good consumption. The elasticity of substitution between intermediate goods that are produced in the same country is  $1/(1 - \theta)$ , and the elasticity of substitution between home and foreign aggregate inputs is  $1/(1 - \rho)$ . With the two entry margins of the model, the measure of varieties available for use in production of the composite home and foreign good changes over time. With a typical Dixit-Stiglitz aggregator there is a benefit to using smaller amounts of a greater number of varieties.

The final goods market is perfectly competitive. In each period  $t$ , given the final good price at home  $P(s^t)$ , the  $i_{\text{th}}$  home intermediate good price at home  $P_h(i, s^t)$  for  $i \in [0, N(s^t)]$ , and the  $i_{\text{th}}$  foreign intermediate good price at home  $P_f(i, s^t)$  for  $i \in X^*(s^t)$ , a home final good producer chooses inputs  $y_h^d(i, s^t)$  for  $i \in [0, N(s^t)]$ , and  $y_f^d(i, s^t)$  for  $i \in X^*(s^t)$  to maximize profits,

$$(5) \quad \Pi_F(s^t) = \max P(s^t) D(s^t) - \int_0^{N(s^t)} P_h(i, s^t) y_h^d(i, s^t) di - \int_0^{N^*(s^t)} P_f(i, s^t) y_f^d(i, s^t) di,$$

subject to the production technology (4) and the constraint that  $y_f^d(i, s^t) = 0$  for  $i \notin X^*(s^t)$ .

Solving the problem in (5) gives the input demand functions,

$$(6) \quad y_h^d(i, s^t) = \lambda^{\frac{1}{1-\rho}} \left[ \frac{P_h(i, s^t)}{P_h(s^t)} \right]^{\frac{1}{\theta-1}} \left[ \frac{P_h(s^t)}{P(s^t)} \right]^{\frac{1}{\rho-1}} D(s^t), \quad i \in [0, N(s^t)],$$

$$(7) \quad y_f^d(i, s^t) = (1-\lambda)^{\frac{1}{1-\rho}} \left[ \frac{P_f(i, s^t)}{P_f(s^t)} \right]^{\frac{1}{\theta-1}} \left[ \frac{P_f(s^t)}{P(s^t)} \right]^{\frac{1}{\rho-1}} D(s^t), \quad i \in X^*(s^t),$$

where  $P_h(s^t) = \left[ \int_0^{N(s^t)} P_h(i, s^t)^{\frac{\theta}{\theta-1}} di \right]^{\frac{\theta-1}{\theta}}$ , and  $P_f(s^t) = \left[ \int_{i \in X^*(s^t)} P_f(i, s^t)^{\frac{\theta}{\theta-1}} di \right]^{\frac{\theta-1}{\theta}}$ . The zero-profit condition in the perfectly competitive market determines the price level of the final good as

$$(8) \quad P(s^t) = \left[ \lambda^{\frac{1}{1-\rho}} P_h(s^t)^{\frac{\rho}{\rho-1}} + (1-\lambda)^{\frac{1}{1-\rho}} P_f(s^t)^{\frac{\rho}{\rho-1}} \right]^{\frac{\rho-1}{\rho}}.$$

### ***Intermediate Good Producers***

An intermediate good producer can sell its product costlessly in its own market. However, it is costly to sell its product abroad. Intermediate good producers that export to the foreign country face two types of international trading costs. To enter the foreign market, an intermediate good producer has to pay a (relatively) high initial entry cost  $f_0(s^t)$ . This permits the producer to export in the current period. From the following period on, to continue exporting, the producer has to pay a lower but nonzero continuation costs  $f_1(s^t)$  ( $< f_0(s^t)$ ). These costs are measured in foreign labor units augmented by foreign country-specific productivity  $A^*(s^t)$ .<sup>12</sup> Thus, an intermediate good producer faces the fixed costs of exporting as

$$(9) \quad f_0(s^t) = \bar{f}_0 e(s^t) \left[ \frac{W^*(s^t)}{A^*(s^t)} \right], \quad f_1(s^t) = \bar{f}_1 e(s^t) \left[ \frac{W^*(s^t)}{A^*(s^t)} \right],$$

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<sup>12</sup>Paying fixed exporting costs in home labor units instead of foreign labor units does not change the results qualitatively. In the sensitivity analysis, we will consider the case without the shocks to fixed costs.

where  $\overline{f_0}$  and  $\overline{f_1}$  are positive constants. Since the trade costs depend on the export status of the producers last period, the total amount of export costs paid by domestic exporters are given as

$$(10) \quad G(s^t) = \int_{i \in X(s^t)} \{f_0(s^t) [1 - m(i, s^{t-1})] + f_1(s^t) m(i, s^{t-1})\} di,$$

where  $m(i, s^t)$  is an indicator function denoting the export status of the  $i_{\text{th}}$  intermediate good producer in  $s^t$ . Here  $m(i, s^t) = 1$  if the  $i_{\text{th}}$  foreign intermediate good producer is an exporter in  $s^t$ , 0 otherwise. These trade costs imply that only some,

$$(11) \quad N_X^*(s^t) = \int_{i \in X^*(s^t)} m^*(i, s^t) di,$$

of foreign intermediate goods are available to home final good producers in state  $s^t$ .

An intermediate good establishment produces its differentiated good with a Cobb-Douglas production technology,

$$(12) \quad F(i, s^t) = A(s^t) a(i, s^t) k(i, s^{t-1})^\alpha l(i, s^t)^{1-\alpha} = y_h^d(i, s^t) + y_h^{*d}(i, s^t),$$

where  $y_h(i, s^t)$  and  $y_h^*(i, s^t)$  are the amounts of good  $i$  sold in the home and foreign intermediate goods markets, respectively, and  $k(i, s^{t-1})$  and  $l(i, s^t)$  are the capital and labor inputs of the establishment  $i$ . Capital used in production is augmented by investment of final goods,  $v(i, s^t)$ . The law of motion for capital is given by

$$(13) \quad k(i, s^t) = (1 - \delta)k(i, s^{t-1}) + v(i, s^t),$$

where  $\delta$  is the depreciation rate. The term  $a(i, s^t)$  denotes the establishment-specific productiv-

ity of the  $i_{\text{th}}$  establishment. The establishment-specific productivity is independently, identically distributed across countries, establishments, and time,  $\ln a(i, s^t) \stackrel{iid}{\sim} N(0, \sigma_a^2)$ . The country-specific productivity  $A(s^t)$  may be correlated across countries and evolves according to a vector autoregressive process (VAR) with the foreign country-specific productivity,  $A^*(s^t)$ ,

$$(14) \quad Z(s^t) = MZ(s^{t-1}) + \varepsilon(s^t), \quad \varepsilon(s^t) \stackrel{iid}{\sim} N(0, \Omega),$$

where  $M$  is a coefficient matrix;  $Z(s^t) = [\ln A(s^t), \ln A^*(s^t)]'$  and  $\varepsilon(s^t) = [\varepsilon(s^t), \varepsilon^*(s^t)]'$ .

Consider the problem of a home intermediate good producer with the establishment-specific productivity  $a(i, s^t) = a$ , capital stock  $k(i, s^{t-1}) = k$ , and the export status  $m(i, s^{t-1}) = m$  in state  $s^t$ . The intermediate good producer chooses current prices  $P_h(i, s^t)$ ,  $P_h^*(i, s^t)$ , inputs of labor  $l(i, s^t)$ , investment  $v(i, s^t)$  and the export decision  $m(i, s^t) = m'$  to solve

$$(15) \quad V(a, k, m, s^t) = \max \Pi_h(a, k, m; s^t) + m' \Pi_h^*(a, k, m; s^t) \\ + n_s \sum_{s^{t+1}} \sum_{a'} Q(s^{t+1} | s^t) \phi(a') V(a', k', m'; s^{t+1}) \\ + (1 - n_s) \sum_{s^{t+1}} \sum_{a'} Q(s^{t+1} | s^t) k,$$

$$(16) \quad \Pi_h(a, k, m; s^t) = P_h(i, s^t) y_h(i, s^t) - P(s^t) W(s^t) l(i, s^t) - P(s^t) x(i, s^t),$$

$$(17) \quad \Pi_h^*(a, k, m; s^t) = e(s^t) P_h^*(i, s^t) y_h^*(i, s^t) - m f_1(s^t) + (1 - m) f_0(s^t),$$

subject to the production technology (12), the law of motion for capital (13), and the constraints that supplies to home and foreign intermediate goods market  $y_h(i, s^t)$  and  $y_h^*(i, s^t)$  are equal to demands by home and foreign final good producers  $y_h^d(i, s^t)$  and  $y_h^{d*}(i, s^t)$  from (6) and its foreign analogue. Here,  $\phi(a')$  denotes the probability of an idiosyncratic shock  $a'$ . If a producer receives



the death shock, it sells its capital stock  $k$  and shuts down without any production.

Let the value of the  $i_{\text{th}}$  producer if it exports in  $s^t$  be

$$(18) \quad V^1(a, k, m; s^t) = \max \Pi_h(a, k, m; s^t) + \Pi_h^*(a, k, m; s^t) \\ + n_s \sum_{s^{t+1}} \sum_{a'} Q(s^{t+1}|s^t) \phi(a') V(a', k', 1, s^{t+1}) \\ + (1 - n_s) \sum_{s^{t+1}} Q(s^{t+1}|s^t) k,$$

and let the value of the  $i_{\text{th}}$  producer if it does not export in  $s^t$  be

$$(19) \quad V^0(a, k, m; s^t) = \max \Pi_h(a, k, m; s^t) + \sum_{s^{t+1}} \sum_{a'} Q(s^{t+1}|s^t) \phi(a') V(a', k', 0, s^{t+1}) \\ + (1 - n_s) \sum_{s^{t+1}} Q(s^{t+1}|s^t) k,$$

Then, the actual value of  $i_{\text{th}}$  producer can be defined as

$$(20) \quad V(a, k, m, s^t) = \max \{V^1(a, k, m, s^t), V^0(a, k, m, s^t)\}.$$

Clearly the value of a producer depends on its export status, and is monotonically increasing and continuous in  $a$ . Moreover  $V^1$  intersects  $V^0$  from below only once.<sup>13</sup> Hence, it is possible to solve for the establishment-specific productivity at which a establishment is indifferent between exporting or not exporting; that is, the increase in establishment value from exporting equals the cost of exporting. This level of technology differs by the establishments current export status. The critical

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<sup>13</sup>If the difference between  $f_0$  and  $f_1$  is very large,  $V^1 > V^0$  for all  $\ln a \in (-\infty, \infty)$  for some  $s^t$ . Since the data show that some of the previous exporters exit from foreign markets each period, it is assumed throughout that the shocks are small enough that this does not occur.

level of technology for exporters and nonexporters,  $a_1(s^t)$  and  $a_0(s^t)$ , satisfy

$$(21) \quad V^1(a_1(s^t), k, 1, s^t) = V^0(a_1(s^t), k, 1, s^t),$$

$$(22) \quad V^1(a_0(s^t), k, 0, s^t) = V^0(a_0(s^t), k, 0, s^t).$$

Among last period exporters, only those with productivity greater than  $a_1(s^t)$  will continue to export in state  $s^t$ . Likewise, the critical technology of a nonexporter is denoted by  $a_0(s^t)$ .

### ***Entrants***

In each period, new intermediate good producers can be created by incurring a fixed cost  $f_E(s^t)$ . Similar to the export costs, the entry cost is measured in domestic labor units augmented with country-specific productivity,

$$(23) \quad f_E(s^t) = \bar{f}_E \left[ \frac{W(s^t)}{A(s^t)} \right].$$

An establishment incurs the entry cost one period before its production. Once the entry cost is incurred, establishments newly accumulate capital before the realization of the establishment-specific productivity. In the beginning of next period, establishments receive an idiosyncratic productivity shock from the distribution which is the same as incumbents,  $\phi(a)$ . All the entrants face the same probability of death as incumbents. As the entrants did not export last period, the entry condition is given as

$$(24) \quad V^E(s^t) = -f_E(s^t) - P(s^t) k_E(s^t) + n_s \sum_{s^{t+1}} \sum_{\eta'} Q(s^{t+1}|s^t) \phi(a') V(a', k', 0, s^{t+1}) \\ + (1 - n_s) \sum_{s^{t+1}} Q(s^{t+1}|s^t) k_E(s^t) \geq 0,$$

where  $k_E(s^t)$  is the capital stock of new establishments. Let the mass of entrants who pay the entry cost in  $s^t$  be  $N_E(s^t)$ , while the mass of incumbents be  $N(s^t)$ . As only  $n_s$  fraction of incumbents and entrants survives the next period, the mass of producers evolves as

$$(25) \quad N(s^t) = n_s [N(s^{t-1}) + N_E(s^{t-1})].$$

Let the mass of nonexporters be

$$(26) \quad N_N(s^t) = N(s^t) - N_X(s^t).$$

The trade costs imply that only a fraction  $n_X(s^t) = N_X(s^t)/N(s^t)$  of home intermediate goods are available in the foreign country in  $s^t$ .

From (21), (22), and the independence of the establishment-specific productivity, the fraction of exporters in  $s^t$  among survived exporters in  $s^{t-1}$  and the fraction of exporters in  $s^t$  among survived nonexporters in  $s^{t-1}$ ,  $n_1(s^t)$  and  $n_0(s^t)$ , respectively, can be defined as

$$(27) \quad n_1(s^t) = \frac{n_s N_X(s^{t-1}) \phi(a > a_1(s^t))}{n_s N_X(s^{t-1})} = \phi(a > a_1(s^t)),$$

$$(28) \quad n_0(s^t) = \frac{n_s N_N(s^{t-1}) \phi(a > a_0(s^t))}{n_s N_N(s^{t-1})} = \phi(a > a_0(s^t)).$$

The law of motion for the masses of exporters and nonexporters are given as

$$(29) \quad N_X(s^t) = n_s \{n_1(s^t)N_X(s^{t-1}) + n_0(s^t)[N_N(s^{t-1}) + N_E(s^{t-1})]\},$$

$$(30) \quad N_N(s^t) = n_s \{[1 - n_1(s^t)]N_X(s^{t-1}) + [1 - n_0(s^t)][N_N(s^{t-1}) + N_E(s^{t-1})]\}, .$$

## A. Aggregate Variables

The aggregate capital available in  $s^t$  at home is defined as

$$(31) \quad K(s^t) = \int_0^{N(s^t)} k(i, s^t) di.$$

The investment,  $I_t$ , is given by the sum of individual investment less the capital stock received from dying establishments,

$$(32) \quad I(s^t) = \int_0^{N(s^t)} v(i, s^t) di + N_E(s^t) k_E(s^t) - n_d \left[ \int_0^{N(s^{t-1})} k(i, s^t) di + N_E(s^{t-1}) k_E(s^{t-1}) \right].$$

Nominal exports and imports are given as

$$(33) \quad EX^N(s^t) = \int_{i \in X(s^t)} e(s^t) P_h^*(i, s^t) y_h^*(i, s^t) di,$$

$$(34) \quad IM^N(s^t) = \int_{i \in X^*(s^t)} P_f(i, s^t) y_f(i, s^t) di.$$

Real exports and real imports are defined as,  $EX(s^t) = EX^N(s^t) / [e(s^t) P_h^*(s^t)]$  and  $IM(s^t) = IM^N(s^t) / P_f(s^t)$ , respectively. Nominal GDP of the home country is defined as the sum of value added from producers,

$$(35) \quad Y^N(s^t) = P(s^t) D(s^t) + EX^N(s^t) - IM^N(s^t).$$

Real GDP is defined as  $Y(s^t) = Y^N(s^t) / P_h(s^t)$ .

The total labor used for production,  $L_P(s^t)$  is given by

$$(36) \quad L_P(s^t) = \int_0^{N(s^t)} l(i, s^t) di.$$

Home labor hired by foreign exporters,  $L_X^*(s^t)$ , is given by

$$(37) \quad L_X^*(s^t) = \frac{\bar{f}_1}{A(s^t)} \int_{i \in X^*(s^t)} m(i, s^{t-1}) di + \frac{\bar{f}_0}{A(s^t)} \int_{i \notin X^*(s^t)} [1 - m(i, s^{t-1})] di,$$

and home labor hired by new establishments,  $L_E(s^t)$ , is given by

$$(38) \quad L_E(s^t) = \frac{\bar{f}_E N_E(s^t)}{A(s^t)}.$$

Aggregate profits are measured as sum of profits of operating establishments and capital resale revenues of shutdown establishments,

$$(39) \quad P(s^t) \Pi(s^t) = \Pi_F(s^t) + \int_0^{N(s^t)} [\Pi_h(i, s^t) + m(i, s^t) \Pi_h^*(i; s^t)] di \\ + n_d \left[ \int_0^{N(s^{t-1})} k(i, s^t) di + N_E(s^{t-1}) k_E(s^t) \right]$$

## B. Equilibrium Definition

In an equilibrium, variables satisfy several resource constraints. Market clearing in final goods requires  $C(s^t) + I(s^t) = D(s^t)$ , and  $C^*(s^t) + I^*(s^t) = D^*(s^t)$ . Intermediate goods market clearing conditions requires  $y_h^d(i, s^t) = y_h(i, s^t)$  for  $i \in [0, N(s^t)]$ ,  $y_f^d(i, s^t) = y_f(i, s^t)$  for  $i \in X^*(s^t)$ ,  $y_f^{d*}(i, s^t) = y_f^*(i, s^t)$  for  $i \in [0, N(s^t)]$ , and  $y_h^{d*}(i, s^t) = y_h^*(i, s^t)$  for  $i \in X^*(s^t)$ . Labor market clearing requires  $L(s^t) = L_P(s^t) + L_E(s^t) + L_X^*(s^t)$ , and  $L^*(s^t) = L_P^*(s^t) + L_E^*(s^t) + L_X(s^t)$ . The profits of establishments are distributed to the shareholders,  $\Pi(s^t)$ , and the foreign analogue. International bond market clearing implies  $B(s^{t+1}) + B^*(s^{t+1}) = 0$ . Finally, writing the budget constraints in units of the local currency permits us to normalize the price of consumption in each country as  $P(s^t) = P^*(s^t) = 1$ .

An equilibrium of the economy is a collection of allocations for home consumers  $C(s^t)$ ,  $L(s^t)$ ,

$B(s^{t+1})$ ; allocations for foreign consumers  $C^*(s^t)$ ,  $L^*(s^t)$ ,  $B^*(s^{t+1})$ ; allocations for home final goods producers  $D(s^t)$ ,  $y_h^d(i, s^t)$  for  $i \in [0, N(s^t)]$ , and  $y_f^d(i, s^t)$  for  $i \in X^*(s^t)$ ; allocations for foreign final good producers  $D^*(s^t)$ ,  $y_f^{d*}(i, s^t)$  for  $i \in [0, N^*(s^t)]$ , and  $y_h^{d*}(i, s^t)$  for  $i \in X(s^t)$ ; allocations and prices for home intermediate good producers  $l(i, s^t)$ ,  $v(i, s^t)$ ,  $y_h(i, s^t)$ , and  $P_h(i, s^t)$  for  $i \in [0, N(s^t)]$ ,  $y_h^*(i, s^t)$  and  $P_h^*(i, s^t)$  for  $i \in X(s^t)$ ; allocations and prices for foreign intermediate good producers  $l^*(i, s^t)$ ,  $v^*(i, s^t)$ ,  $y_f(i, s^t)$  and  $P_f(i, s^t)$  for  $i \in X^*(s^t)$ ,  $y_f^*(i, s^t)$  and  $P_f^*(i, s^t)$  for  $i \in [0, N^*(s^t)]$ ; the export statuses of home and foreign intermediate good producers  $m(i, s^t)$  for  $i \in [0, N(s^t)]$  and  $m^*(i, s^t)$  for  $i \in [0, N^*(s^t)]$ ; labor used for exporting costs  $L_X(s^t)$  and  $L_X^*(s^t)$  at home and foreign; labor used for creation of new establishments  $L_E(s^t)$  and  $L_E^*(s^t)$  at home and foreign; real wages  $W(s^t)$  and  $W^*(s^t)$ , nominal exchange rates  $e(s^t)$ ; and bond prices  $Q(s^{t+1}|s^t)$  that satisfy the following conditions: (i) the consumer allocations solve the consumer's problem; (ii) the final good producers' allocations solve their profit maximization problems; (iii) the intermediate good producers' allocations, prices, and export statuses solve their profit maximization problems; (iv) the establishment entry conditions hold; and (v) the market clearing conditions hold.

#### 4. Calibration

We now describe the parameter values considered for our benchmark economy. The parameter values used in simulation exercises are reported in Table 2. The choice of the time discount factor,  $\beta$ , the rate of depreciation,  $\delta$ , capital's share parameter in production,  $\alpha$ , and risk-aversion parameter,  $\sigma$ , is standard in the literature,  $\beta = 0.96$ ,  $\delta = 0.10$ ,  $\alpha = 0.36$ , and  $\sigma = 2$ . The share parameter for consumption in the composite commodity,  $\gamma$ , is set to be equal to 0.383. With this value, people allocate 1/3 of total available time to work in the model.

The final good production parameters  $\rho$  and  $\theta$  determines the elasticity of substitution between composite domestic and foreign goods and the elasticity between varieties within a composite,

respectively. We set  $\theta = 5/6$  which gives a establishment's markup of 20 percent. This value of  $\theta$  is consistent with the elasticity estimated by Broda and Weinstein (2006). In the benchmark model, we set  $\rho = 0.75$  which gives the elasticity of substitution between home and foreign composite goods of 4. In the sensitivity analysis, we consider  $\theta \in [0.8, 0.96]$  and  $\rho \in [0, 0.8]$ .

The country-specific productivity process is an annualized version of that in Kehoe and Perri (2002). The shocks are persistent with an autocorrelation of 0.815 and there are no cross-country spillover. The volatility of the shock is set to be 0.013. The correlation between home and foreign shocks are set to be 0.25.

Establishments and capital are durable assets with different attributes. Lee and Mukoyama (2008) find the exit rate in the ASM from 1972 to 1997 is approximately 5.4 percent. Davis, Haltiwanger, and Schuh (1996) find a employment weighted exit rate of 2.3 percent per year. Since our emphasis is on the dynamics of entry and exporting over the business cycle, we would like a general equilibrium model that can reasonable replicate features of exit and entry in stocks of establishments. Thus, we set the exogenous exit rate,  $n_d$ , to be 5.4 percent. In the sensitivity analysis, we will consider a wide range of the exit rate,  $n_d \in [0.01, 0.10]$ . We set the sunk cost parameter,  $\overline{f_E}$ , to be 0.751 to normalize the mass of producers in a country to 1,  $N = 1$  in the steady state. The parameters  $\overline{f_0}$ ,  $\overline{f_1}$ ,  $\lambda$ , and  $\sigma_a$  jointly determine the amount of trade, characteristics of exporters and nonexporters, and the dynamics of export status. To set these parameters, we use the following four evidence: i) a stopper rate, the fraction of non-exporters among survived last period exporters, of 17 percent as in Bernard and Jensen (1999) based on the Longitudinal Research Database (LRD) of the Bureau of the Census 1984-1992; ii) an exporter rate, fraction of exporters among all establishments, of 21 percent based on the 1992 Census of Manufactures; iii) trade to GDP ratio, exports plus imports divided by two times of GDP, of 15 percent; and iv) exporter output premium, average output of exporters relative to average output of nonexporters in

logarithm, of 103 percent based on Bernard and Jensen (1999). Choosing these parameters jointly to match these statistics yields values of  $\overline{f_0} = 0.116$ ,  $\overline{f_1} = 0.036$ ,  $\lambda = 0.566$ , and  $\sigma_a = 0.450$ . The calibration suggests that previous nonexporters pay about 3.2 times more than continuing exporters to export their products in the foreign market in the steady state. With these parameter values together with the sunk cost of entry, about 13 percent of labor is used for creating new variety and about 3 percent for exporting. In the sensitivity analysis, we vary the parameter values to match these features in the model.

We focus on the effects of international trade on the dynamics of entry and exporting over the business cycle. To isolate the role of international trade on the business cycles, we also consider three alternative cases where there is no international borrowing and lending (financial autarky), no trade across countries (closed economy), no fixed costs in exporting (free trade).

In general, keeping track of distributions over productivity and capital of producers is computationally difficult. However, the assumption of iid in firm-specific productivity shocks greatly simplifies the analysis. As producers are either exporters or nonexporters with the same expectation about their next period firm-specific productivity, at any point in time producers will choose either a relatively low capital stock for the next period if they do not export today, or a relatively high capital stock for the next period if they do export today. Consequently, the distribution of the capital stock at home is completely summarised by the capital stock of exporters and nonexporters,  $K_1(s^{t-1})$  and  $K_0(s^{t-1})$ , and the masses of exporters and nonexporters,  $N_X(s^{t-1})$  and  $N_N(s^{t-1})$ . Similarly the foreign capital stock distribution is completely described by  $K_1^*(s^{t-1})$ ,  $K_0^*(s^{t-1})$ ,  $N_X^*(s^{t-1})$  and  $N_N^*(s^{t-1})$ . With these summary statistics for the distributions of capital stocks together with the properties of log-normality for the integration over establishments, we use the log-linearization method suggested by Klein (2000) in simulation exercises. The models are simulated for 1000 times with 100 periods.



## 5. Results

In this section, we examine the properties of the benchmark model. We first examine the properties of establishment dynamics. Then, we investigate the predictions of business cycles in the benchmark model. Lastly, we study the impulse response of major variables following a country-specific productivity shock at home.

### *Establishment employment dynamics*

Overall, the model captures some salient features on the evolution of employment at the establishment-level. Namely, establishments start out small and grow over time and exporters tend to be relatively big, but over time their productivity growth lags that at non-exporters (Bernard and Jensen 2004).

Figure 1 shows the steady state average employment relative to overall employment by export status and entry at the initial period. The employment level of entrants is about 6.9 percent lower than the overall average. Among these entrants, over time productive establishments become exporters and unproductive establishments remain as nonexporters. As time progresses more establishments from a cohort start exporting and the average employment level and capital stock increases toward that of incumbents. Initially nonexporters have a very low level of employment on average since they are unproductive and many of them have a low level of capital. The average employment of the initial nonexporters is about 27.7 percent lower than the overall average. From the following period, establishments that stop exporting due to low productivity receive a new productivity level drawn from the same distribution as other types of establishments. Thus, average employment becomes very close to that of entrants, although the average employment is slightly lower than that of the initial entrants as the exporter ratio of initial nonexporters is lower than that of initial entrants. Similar to the entrants, the average employment of the initial nonexporters

increases toward the average level of incumbents.

The initial continuing exporters have about 48.8 percent higher level of employment relative to the average employment since continuing exporters have a high level of capital and they access more markets as exporters. In the following period, some of these initial exporters receive bad productivity shocks and stop exporting. With this exit from the foreign market, the establishments reduce their capital stock and average size drops. From then on, the exporter ratio within this group converges toward the exporter ratio of incumbents, and the employment level diminishes toward the average employment level of incumbents. The model generates a large but temporary selection effect on exporting. Initially, the employment level of entrants into exporting is higher than that of continuing exporters. In the following period, the productivity level of this group becomes the same as that of initial continuing exporters. Also, the exporter ratios of these two groups are the same with iid productivity.

### ***Business cycles***

We now consider the aggregate properties of entry, importing, and exporting over the business cycle. The column dubbed *Benchmark* in Table 3 shows the benchmark model captures some of the key business cycle properties of the stock of establishments, importers, and exporters.<sup>14</sup> In terms of volatility, the model generates fluctuations in exporters and importers relative to output of 1.46, similar to the data, where they are 1.51 and 1.74, respectively. The stock of establishments fluctuates slightly more in the model than the data (0.77 vs. 0.50). The model also matches the cyclicalities of establishments and traders. The stock of establishment is procyclical (correlation with output of 0.25 in the model and 0.28 in the data). Importers are more procyclical, with a correlation with output of 0.59 (0.44 in the data). However, in the model, the exporters are procyclical while

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<sup>14</sup>All the variables are H-P filtered with the smoothing parameter of 6.25 after taking logarithm.

in the data they are countercyclical (0.13 vs. -0.35).

Real exports and imports are about twice as volatile as output in the model (3.33 and 3.63 in the data). The real exchange rate, exports and imports in the model are procyclical as in the data.<sup>15</sup> The correlations with output are 0.43, 0.32 and 0.66, respectively, in the model (0.18, 0.40 and 0.86 in the data). The model also captures the independence of exporters and importers with real exchange rate. In the model, the correlations between exporters and importers with real exchange rate are -0.02 and 0.02, respectively (they are 0.04 and 0.00 in the data). One interesting feature of the data is that the stock of establishments is positively correlated with importers whereas it is negatively correlated with exporters. The model also predicts positive relationship between the stock of establishments and importers with the correlation of 0.07 (0.28 in the data), although the model predicts no correlation between the stock of establishments and exporters. The correlation in the model is -0.00 (-0.37 in the data). Overall, from productivity shocks, the benchmark model generates business cycle fluctuations in the stock of establishments, exporters, and importers similar to those in the data.

### *Impulse-responses*

To examine the dynamics of the economy, we plot the responses of key variables to a one-time one standard deviation country-specific productivity shock at home in the panels of Figure 2. The top panel plots the dynamics of entry and the stock of establishments in home and foreign. When there is a positive shock at home, there is a large increase in the creation of new establishments of 14.6 percent at the initial period. Over time, the incentive to create new establishment falls. After 4 years, entry falls below the initial steady state level. From the 8th year following the shock, the mass of entrants rises toward the steady state level. With the rise and fall in entrants, the stock

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<sup>15</sup>The model inherits both the successes and failures of the international RBC model of Backus et al. (1994). In particular, the model fails to generate relative price fluctuations of the appropriate magnitudes.

of producers in the domestic country rises for 4 years and then gradually falls toward its long run level. The stock of importers also rises initially by more than the stock of domestic establishments. The rise in importers is less persistent and falls below the steady state level after three periods. These dynamics of entry suggest that initially entry by importers is complementary to entry by domestic establishments, while in the long-run, entry by domestic establishments substitutes for that by importers. In contrast to the dynamics of entry, the stock of exporters rises gradually from the initial period for 7 years. These increases in exporting reflect both the greater value of exporting of domestic establishments from being more productive and reduced competition overseas from a contraction in the stock of establishments

The bottom panel of Figure 2 depicts the typical macroeconomic aggregates studied in international business cycle models. As is normal, risk-sharing leads consumption to rise in both countries and a shift in production and investment towards the relatively more productive country. However, unlike a model without entry, the dynamics of investment and output are hump-shaped, peaking in the fourth year.<sup>16</sup> These unusual hump-shaped dynamics reflect hump-shaped dynamics of labor used in production. Initially, labor is more productively used in the creation of establishments and the stock of exporters. Once these forms of organizational capital are accumulated, labor can be more effectively used in the production of goods. Thus, we see that investment in organizational capital precedes investment in physical capital.

## 6. Sensitivity

In this section, we clarify the source of entry dynamics through a series of alternate models. First, we examine the importance of international trade on the dynamics of establishments by imposing restrictions on intertemporal and intratemporal international trade. Second, we study

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<sup>16</sup>Cook (2001) also finds a hump-shaped output response in a model with a one-period delay of entry.

the role of the structure of fixed costs of exporting and sunk costs. Third, we vary the exit rate to examine the influence of the durability of investment in entry relative to exporting or physical capital accumulation for the model's properties. Lastly, we examine the sensitivity of the model to the substitutability of goods within and across countries.

### ***Financial autarky***

To isolate the role of international trade on the dynamics of exporters and the stock of establishments, we consider two alternative cases for international trade. Specifically, we first consider a world with no international borrowing and lending (financial autarky). The results are reported in column dubbed *Financial autarky* of Table 3. With financial autarky, the current account always equals zero. Thus, when a country experiences a positive productivity shocks and wants to accumulate capital, it can not do so by borrowing from abroad. Consequently, international trade is less volatile compared to the benchmark model. With this limitation, the number of exporters becomes about 35 percent as volatile as that under benchmark case and the stock of establishment fluctuates by 44 percent less. The stock of domestic establishments is more stable because, with the limited intertemporal trade, the expected gains from creating a new establishment becomes less variable as the expansion of sales through entering foreign markets are more limited. Limiting asset trade does not substantially alter the cyclicalities of the number of domestic establishments, exporters, or importers.

### ***Closed economy***

To isolate the role of international trade, we consider a version of our model with no international trade (column titled *Closed economy* of Table 3. Without trade, the stock of establishments is less volatile (0.55 vs. 0.77 in the benchmark model) and acyclical (-0.01 vs. 0.25 in the benchmark). Now, when the domestic economy has a positive productivity innovation, it can neither use foreign

goods or varieties to build up its capital stock and thus must devote more resources itself to physical investment. This bids the wage rate up by more, increasing the cost of creating establishments. Moreover, since domestic establishments only sell at home, the expected value of entering rises by less. Hence entry becomes both smoother and countercyclical.

### *No fixed costs in exporting*

As an extreme case of trades, we consider a free trade economy where the fixed costs of trades are zero all the time. In this case, all producers in the economy are exporters, and thus all variety are available in two countries. The results are shown in the 6th column of Table 3. Without fixed costs in exporting, the stock of establishment is slightly less volatile (0.75 vs. 0.78 in the benchmark) and strongly procyclical (0.98 vs. 0.25 in the benchmark), whereas the importers are less volatile (0.75 vs. 1.46 in the benchmark) and countercyclical (-0.12 vs. 0.59 in the benchmark). The stock of establishments and importers become negatively related (-0.10) as results of cyclicity of the stock and importers. With free trades, a newly created establishment automatically enters the foreign market without incurring any costs. Thus, there is a strong incentive to create new establishments when there is a positive shock at home. On the other hand, foreign country reduces the stock of establishments as the demand for goods fall in the foreign country following a positive home country shock. With these strong procyclicity, the stock of establishments is negatively related to importers.

### *No shocks to export costs*

Here we study the role of our assumption that fixed costs of exporting vary with the entry costs and productivity. Specifically, we assume that a continuing exporter and new exporter have to hire  $\bar{f}_0$  and  $\bar{f}_1$  units of foreign workers, respectively, all the time. Thus, the productivity level does not affect the required labor for exporting. The simulation results are reported in the 7th column

of Table 3. Eliminating the shocks to export costs primarily affects the volatility and cyclical of establishments actively trading. The volatility of exporters relative to that of output falls from 1.46 to 0.70. However, the volatility of establishment stock is not affected by the shocks. Without shocks to export costs, a rise in productivity raises the wage rate of the country, raising the cost of entry by foreign exporters, making the mass of foreign exporters (home importers) countercyclical (-0.41 vs 0.59 in the benchmark model) and less correlated with the stock of domestic establishment (-0.21 vs 0.07 in the benchmark model)

### *No shocks to any fixed costs*

Now we assume that there are no shocks to either the fixed costs of exporting or entry. The business cycle statistics for this case are reported in the 8th column of Table 3. Without any shocks to fixed costs, the volatility of exporters rises to 0.96, and the stock of establishments become very stable. Without the shocks, it becomes more costly to create establishments in good times as the wage rate rises but the establishment creation technology remains the same with a positive shock at home. The volatility of domestic establishments relative to output falls to 0.10. With less investment in the creation of establishments in the foreign country, the foreign wage rate does not rise as much as the case with shocks to sunk costs of entry. Thus, more establishments in the home country find it profitable to enter the foreign market following a positive shock at home, making the mass of exporters procyclical with the correlation between exporters and output of 0.25. At the same time, more foreign producers enter the home country as the home wage rate does not rise by as much with less use of workers in creating establishments. Thus, importers also becomes procyclical with the correlation of 0.32. Due to these dynamics, the stock of establishments and exporters are negatively correlated (-0.16), and the stock of establishments and importers are essentially uncorrelated (-0.02).

### *Durability of entry*

We now consider how the properties of establishments influence the properties of the model. We start by examining the influence of establishment durability for the model properties. To do so, we allow the annual exit rate (probability of death) to vary from 1 percent to 10 percent. The results are summarized in the panel of Figure 3. Panel (a) shows how the steady state labor allocated to creation of establishments and exporters varies with the exit rate. The use of labor for exporting is not sensitive to the exit rate. However, the use of labor in creating a new establishment is quite sensitive to the exit rate. As we increase the exit rate from 1 percent to 10 percent, the labor used by new exporters increases by 0.9 percentage points and the labor used by continuing exporters falls by 0.6 percentage points. However, the labor used for creating new establishments rises by 10.8 percentage points. In the steady state, the ratio of new establishments relative to all establishments is given as  $n_d/(1 - n_d)$ . Thus, as we increase the exit rate, more establishments should be created in the steady state, and more of labor should be used for creating new establishments. However, since we maintain the same exporter ratio and the fraction of exporters that stop exporting next period, total labor used for exporting remains quite stable across a wide range of exit rates.

Panel (b) shows that the volatility of exporters and establishments rises with the exit rate. With a high exit rate, investments in establishments or exporters are less durable, so the ratio of entrants to incumbents is quite high. Thus, when there are shocks to the economy, an increase in new exporters or establishments will have a greater effect on stock of exporters or establishments.

The exit rate also influences the correlation of the stock of domestic establishments with importers, exporters, and output (Panel c). As we raise the exit rate, the stock of domestic establishments becomes strongly procyclical and importers becomes strongly correlated with domestic entry. Thus, with high exit rates, the gain from the low costs of creating establishments or importers spurs substantial entry in the same market. With a very low exit rate, importers become



negatively correlated with domestic establishments since there is very little incentive to increase variety through a persistent investment in the stock of less productive establishment when the same resources can be used to persistently raise the stock of relatively more productive establishments. Similarly, with the low exit rate, the stock of domestic establishments is positively correlated with exporters, since investments in exporting will be more durable.

### *Armington elasticity*

Here we examine the role of the substitutability of goods within and across countries. These elasticities affect our model in two ways. First, the elasticity of substitution between goods that are produced in a same country,  $1/(1 - \theta)$ , is directly linked to the markup of producers and hence the incentive to export and create establishments. Second, the elasticity of substitution indirectly affects the economy through its effect on the marginal value of an additional variety, since with more goods you can produce the same amount of resources (see Benassy 1996). The variety effect is determined by the elasticity of substitution in the CES final good production function and decreases with the elasticity of substitution.<sup>17</sup>

Consider first the effect of the elasticity of substitution between goods within a country. Figure 4 summarizes the results for  $\theta \in [0.80, 0.96]$ . The volatility of stock of domestic establishments is not sensitive to the elasticity of substitution while the stock of exporters becomes less volatile as we raise the elasticity. When the elasticity is low, the variety effect is large as an additional variety is highly valued. Thus, when the mass of exporters rises, it increases the market share of their composite products in the foreign country by more. This results in a large fluctuation of mass of exporters. Moreover, since with low  $\theta$ , the gains to additional domestic and imported establishments are relatively high, it is worthwhile to invest in creating more variety at home following a positive

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<sup>17</sup>Feenstra (1994) and Broda and Weinstein (2006) emphasize these gains to increased variety.

productivity shock. Hence the correlations of output and importers with domestic establishments are relatively high with low  $\theta$  and the correlation of exporters becomes quite negative (Panel b of Figure 4).

Figure 5 shows how the model's properties vary with a wide range of the Armington elasticity, the elasticity of substitution between home and foreign aggregates,  $1/(1-\rho) \in [1, 5]$ . The volatility of the stock of establishments rises with the Armington elasticity but the increase is not large. With a low elasticity, the expenditure shares on home and foreign aggregates do not vary much over the business cycle. Thus, the value of new establishments are not sensitive to the aggregate shocks. With a high elasticity, however, the expenditure shares on imports vary more over the cycle resulting in greater fluctuations in the stock of establishments. The comovement of exporters, importers and entry with domestic establishments also varies with the elasticity of substitution (Panel b). As we make foreign and domestic goods more substitutable, the stock of domestic establishments become more strongly procyclical. The correlation of importers and exporters with the stock of domestic establishments are U-shaped and hump-shaped, respectively, in the Armington elasticity. These non-monotonic responses are due to two offsetting effects. First, increasing the Armington elasticity leads to greater reallocation from foreign to home goods following a positive productive shock. Second, the elasticity also affects the relative importance of the variety effect. As we have already seen, increasing the variety effect raises the comovement of importers and domestic establishments and lowers the comovement of exporters and domestic establishments. Thus, for relatively low values of the Armington elasticity the cost effect dominates while for relatively high values, the variety effect dominates.

## 7. Conclusion

This paper studies the dynamics of entry, importing, and exporting over the business cycle. In the data we find that the stock of establishments and importers tend to move together over

the business cycle, whereas the stock of establishments and exporters tend to move in opposite directions. We also find that fluctuations in the number of exporters and importers are about 1.5 times as large as fluctuation in output whereas the stock of establishments is about half as volatile as output.

To study the source of these fluctuations in entry, importing, and exporting, we develop a two-country general equilibrium model with fixed and sunk costs of exporting and establishment creation that are subject to destination aggregate productivity shocks. In this framework, exporters and establishments are durable assets but with different attributes than physical capital. Our model captures a number of key features of establishment heterogeneity relating to the size of both exporters and entrants. With sunk and fixed costs of exporting and entry, the model generates fluctuations in entry, exporting, and importing similar to the data.

We find an important role of international trade for the dynamics of entry. Without international borrowing and lending, we find international trade is too smooth and entry by importers is too much procyclical. Without international trade, we find that the stock of establishments becomes acyclical. Without any fixed costs in exporting, we find that the stock of establishments is highly procyclical and entry by importers is countercyclical. These results are somewhat sensitive to Armington elasticity and durability of investment in establishment creation, but seem to hold for a range of parameters consistent with the data.

Central to our analysis is the cyclical behavior of fixed costs of creating establishments and exporters. Similar to Samaniego (2007) and Mukoyama and Lee (2008), we require the productivity of labor used to create establishment and exporters to fluctuate with aggregate productivity, otherwise fluctuations in entry are inconsistent with the data. Thus, the aggregate productivity in the model is interpreted as the cyclical component of the productivity to be consistent with balanced growth. Perhaps, similar to Campbell's (1998) focus on vintage specific capital, these type of shocks

can be justified in a model with technology specific to particular vintages of establishments.

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## Appendix

The extensive margin of trade is measured as the number of distinct varieties imported or exported by the U.S. A variety is a country-good pair (example SITC code 99999 imported/exported with Canada). For exports, variety is measured as an average of the number of 5-digit SITC code and 7 digit TSUSA except in 1978 where TSUSA code was used and in 1989 and 1990 the growth rate based on SITC was used and averaged across the two years (these were years where the classification systems were substantially altered). For imports, goods were classified at the 5-digit SITC code level. A measure of export participation is also constructed from Bernard and Jensen (1999) using the annual entry and exit rates of exporters from 1984 to 1992 and the Exporter Database from 1996 to 2006 (using firms with 1+ employees). The Exporter database is in NAICS from 97 to 2005 and in SIC from 96. The 97-98 report contains information by SIC and NAICS for 97 and 98. The 1996 data was scaled based on the relative size of SIC to NAICS in 97. The stock of domestic establishments is measured as a count of the number of private manufacturing establishments and private establishments from the Quarterly Census of Employment and Wages. The manufacturing series is based on the SIC code from 1975 to 1990. From 1991 to 2000, the series is created using an average of SIC and NAICS measures of the growth rate of private manufacturing establishments. From 2001 on, the series is based on the growth rate based on the NAICS code. GDP, exports, imports and investment are from the BEA from 1975 to 2006 and are measured in real terms. Employment is based on the BLS private employment series. Net exports are measured as the real trade balance divided by real GDP. The real exchange rate is the trade-weighted real exchange rate broad index from the BEA. All series are logged (except net exports) and HP filtered using a smoothing parameter of 6.25.



Table 1: Volatility and Correlation

	GDP	RER	Exports	Imports	MFR plants	All est.	Exporters	Importers
<i>Volatility relative to output</i>								
	1.00	2.63	3.33	3.35	0.48	0.50	1.51	1.74
<i>Correlation</i>								
GDP	1.00	0.18	0.40	0.86	0.21	0.28	-0.35	0.44
RER	0.18	1.00	0.39	0.01	0.18	0.33	0.04	0.00
Exports	0.40	0.39	1.00	0.09	0.43	0.39	0.25	0.15
Imports	0.86	0.01	0.09	1.00	0.10	0.14	-0.41	0.37
MFR plants	0.21	0.18	0.43	0.10	1.00	0.75	-0.11	-0.08
All est.	0.28	0.33	0.39	0.14	0.75	1.00	-0.37	0.28
Exporters	-0.35	0.04	0.25	-0.41	-0.11	-0.37	1.00	-0.42
Importers	0.44	0.00	0.15	0.37	-0.08	0.28	-0.42	1.00

Table 2: Parameter Values

Preferences	$\beta = 0.960, \sigma = 2, \gamma = 0.383$
Production	$\lambda = 0.566, \rho = 0.750, \theta = 5/6,$ $\alpha = 0.360, \delta = 0.100, \sigma_a = 0.450, n_d = 0.054$ $M_{11} = M_{22} = 0.815, M_{12} = M_{21} = 0,$ $Var(\sigma_\varepsilon) = Var(\sigma_{\varepsilon^*}) = 0.013^2, Corr(\varepsilon, \varepsilon^*) = 0.250$
Sunk and fixed costs	$\overline{f_E} = 0.751, \overline{f_0} = 0.116, \overline{f_1} = 0.036$

Table 3: Business Cycle Statistics

	Data	Benchmark	Financial autarky	Closed economy	No fixed costs in exporting	No shocks to export costs	No shocks to all costs
<i>Volatility relative to output</i>							
RER	2.63	0.21	0.16	-	0.33	0.21	0.11
Exports	3.33	2.00	0.91	-	1.56	1.08	1.77
Imports	3.35	2.00	0.91	-	1.56	1.08	1.77
All est.	0.50	0.77	0.43	0.55	0.75	0.55	0.10
Exporters	1.51	1.46	0.52	-	0.75	0.69	0.96
Importers	1.74	1.46	0.52	-	0.75	0.69	0.96
<i>Correlation</i>							
(Y, RER)	0.18	0.43	0.51	-	0.64	0.25	0.31
(Y, Exports)	0.40	0.32	0.82	-	0.71	0.13	0.25
(Y, Imports)	0.86	0.66	0.76	-	-0.14	0.47	0.62
(Y, All est.)	0.28	0.25	0.02	-0.01	0.98	0.23	0.23
(Y, Exporters)	-0.35	0.13	0.55	-	0.98	-0.37	0.25
(Y, Importers)	0.44	0.59	0.92	-	-0.12	-0.41	0.32
(All est., Exporters)	-0.37	0.00	0.01	-	1.00	-0.02	-0.16
(All est., Importers)	0.28	0.07	0.16	-	-0.10	-0.21	-0.02
(RER, Exports)	0.39	0.11	0.03	-	0.83	0.45	0.47
(RER, Imports)	0.01	-0.11	-0.03	-	-0.83	-0.45	-0.47
(RER, All est.)	0.33	0.73	0.29	-	0.63	0.72	0.20
(RER, Exporters)	0.04	0.02	-0.33	-	0.63	0.38	0.58
(RER, Importers)	0.00	-0.02	0.33	-	-0.64	-0.38	-0.58
(Exports, Exporters)	0.25	0.95	0.86	-	0.69	0.51	0.91
(Imports, Importers)	0.37	0.95	0.86	-	0.69	0.51	0.91

Figure 1: Employments of Establishments

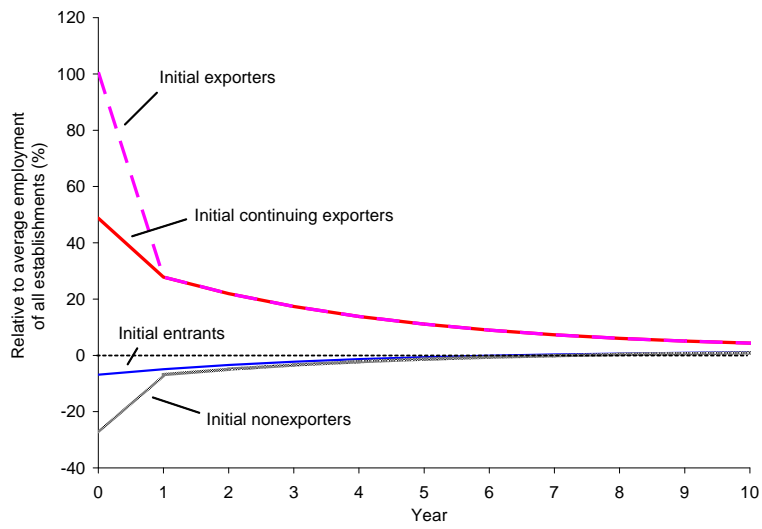
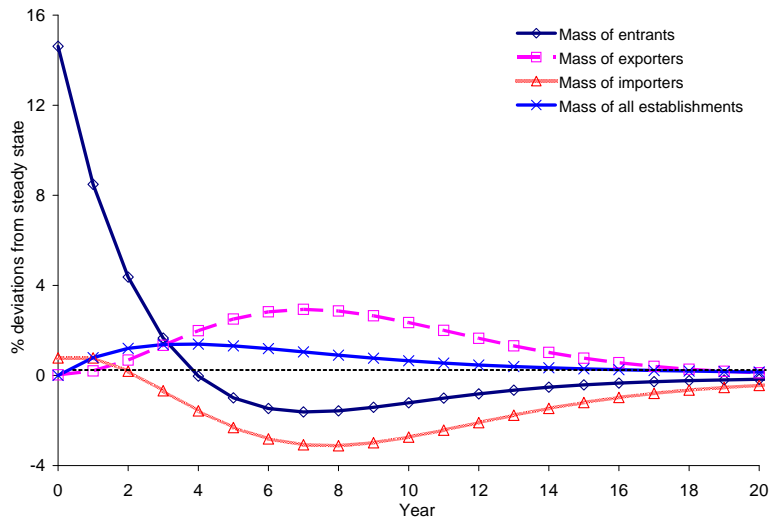


Figure 2: Responses to a Home Aggregate Productivity Shock

(a) Mass of Producers



(b) Major Variables

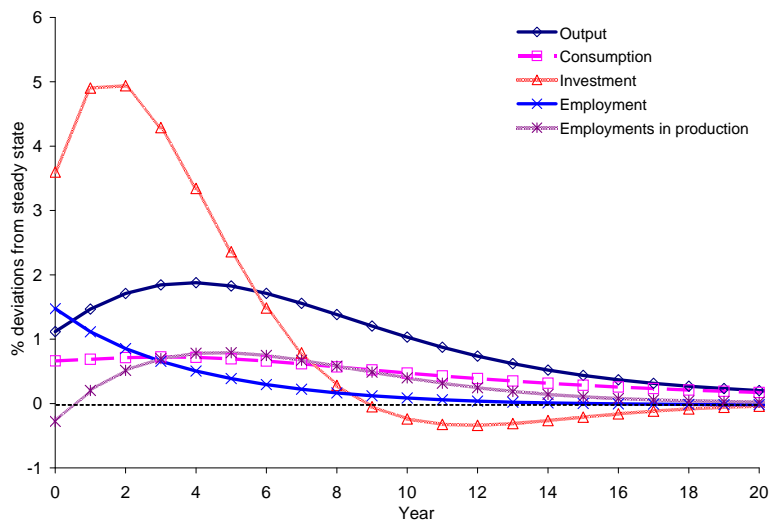
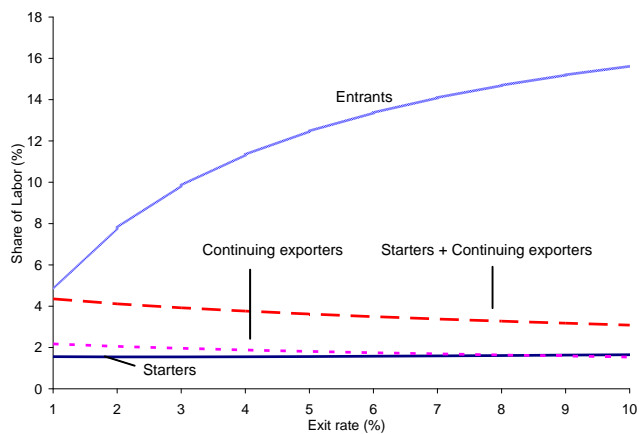
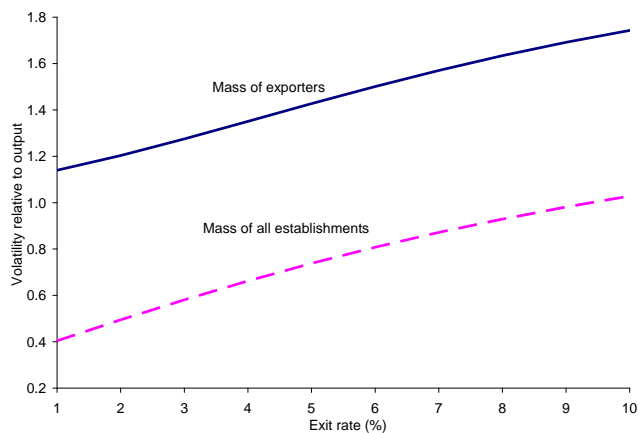


Figure 3: Sensitivity Analysis: Exit Rate

(a) Labor Shares for Sunk and Fixed Costs



(b) Volatility of Masses of Exporters and All Establishments



(c) Correlation with Mass of All Establishments

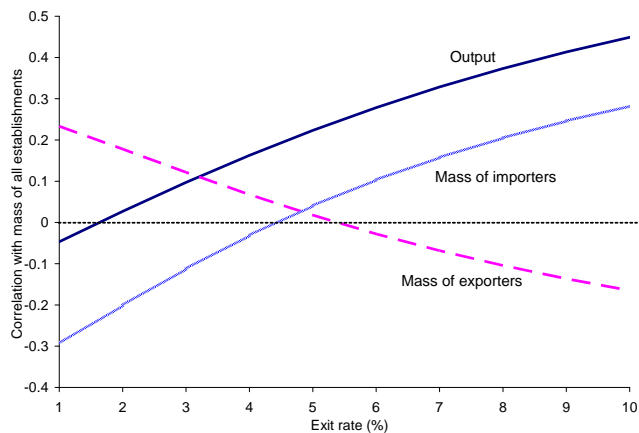
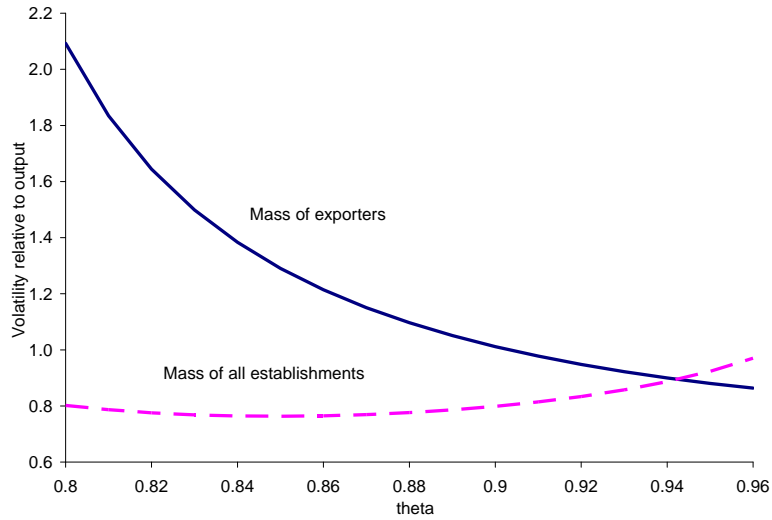


Figure 4: Sensitivity Analysis: Elasticity of Substitution Between Varieties within a Country

(a) Volatility of Masses of Exporters and All Establishments



(b) Correlation with Mass of All Establishments

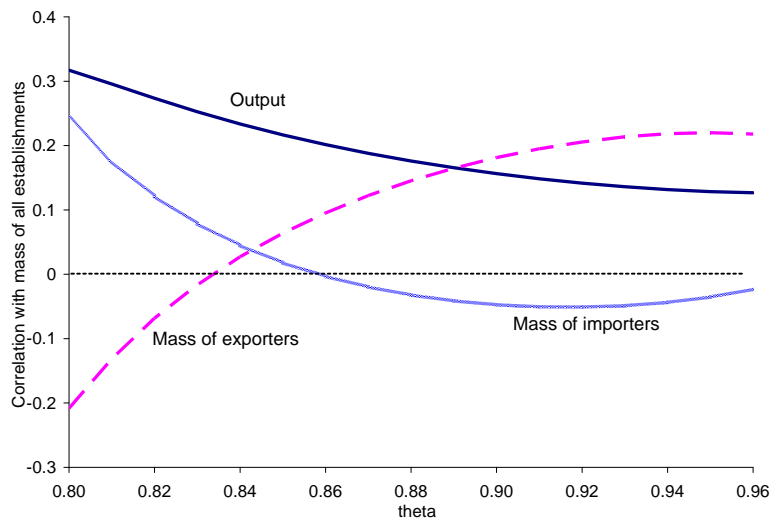
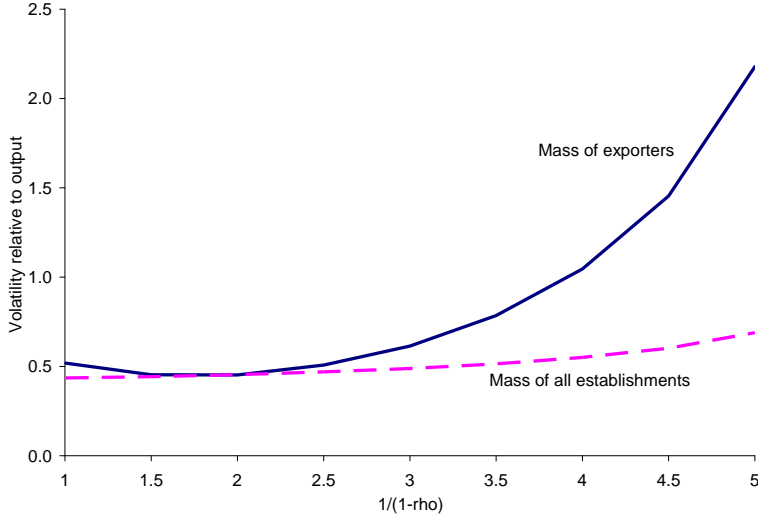


Figure 5: Sensitivity Analysis: Elasticity of Substitution between Home and Foreign Composites

(a) Volatility of Masses of Exporters and All Establishments



(b) Correlation with Mass of All Establishments

