Forward-Looking Importers Under Expected Exchange Rate Fluctuations [*]

Job Market Paper

Chen Carol Zhao

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Abstract

This paper presents theory and empirical evidence on that a forward-looking potential importer facing sunk costs will respond to *expectation of future* exchange rate fluctuations. It indicates the importance of sunk costs in firms' decisions to import goods. Building upon a heterogeneous-firm framework, the model makes a variety of predictions about the effect of anticipated fluctuations in the domestic currency exchange rate. First, changes in the expectation of future exchange rates lead to entry/exit of marginally productive firms, reshaping the extensive margin of imports and inducing significant changes in aggregate import values. Second, the firm level marginal benefit/loss of importing diminishes as expected appreciation/depreciation continues, due to the impact of continued entry/exit on markups. This changing marginal benefit/loss consequently weakens the adjustment of the extensive margin in the long run. Third, firms present heterogeneous responses to forward exchange rate fluctuations in the presence of sunk costs, which are related to their accessibility to credit and other firm-level characteristics including the size of sunk costs. Using disaggregated transaction level data of Chinese imports from the United States, combined with data on the US dollar-RMB future rates on the non-deliverable forward market, this paper confirms that the extensive margin of import significantly responds to forward exchange rate premiums. This paper also finds evidence on firms' heterogeneous responses to anticipated exchange rate changes that support the model predictions by merging import data with firm-level balance sheet data.

JEL: F31, F14, F12, F41

Keywords: Expectation of exchange rates, Import, Forward-looking, Heterogeneous firms, Extensive margin, Heterogeneous response

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1 Introduction

It is well known that theories of heterogeneous firms and trade, since the work of Melitz (2003), emphasize the importance of sunk costs in explaining firm-level decisions to participate in international trade. The presence of sunk costs suggests that firms would take into account expectations of future conditions when making their decisions. Yet, the international economics literature remains mostly silent about how a firm responds to future *expected* exchange rate changes, though the recent development of the literature has witnessed a surge of studies that explore firm-level trade responses to *current* exchange rate fluctuations (e.g., Berman, Martin and Mayer (2012), Amiti, Itskhoki and Konings (2014), among others). This paper fills a gap in the literature by answering the question about whether this forward-looking behavior plays an important role in firms' decisions and by examining the firm-level responses to changes in the forward exchange premium.

The paper first constructs a model studying a firm's optimal responses to anticipated exchange rate changes in the presence of sunk costs. The model predicts that potential importing firms should respond to expected appreciations through the extensive margin. The model also makes a variety of predictions about the heterogeneity of firm-level responses to changes in exchange rate expectations. The paper next tests for the presence of forward-looking behavior in import decisions using disaggregate transaction level Customs data of Chinese imports from the United States between 2000 and 2006. Over this period, rapid growth in aggregate import value was driven by a dramatic increase in the number of importers. During much of this period, exchange rates between US dollars and Renminbi (RMB) were fixed. However, beginning in 2003, forward rates begin observably appreciating in anticipation of future currency reform. Using the forward premium between USD and RMB as a proxy for expectation of future exchange rate appreciation, I find that firms' import decisions respond not only to current but also to future exchange rate changes.

In many ways, China's exchange rate reform offers an ideal natural laboratory to test firms' trade responses to an anticipated currency change. In July 2005, China announced and adopted a managed floating exchange rate regime to replace a peg to the US dollar. Due to China's growth trajectory, the announcement had been preceded by widespread anticipation of future currency reform and appreciation of the RMB. Thus, unlike many cases in which floating exchange rates are characterized by random walk expectations, China had clear and substantial, though time-varying movements in its forward premiums based on fundamentals (which were subsequently supported by the realized appreciation in the latter half of the decade). Unlike most non-credible fixed exchange rate regimes, China's forward premiums during this period were not driven by the probability of a currency or other crisis. In general, since China had a closed capital account during this period, forward premium on exchange rates had little impact on domestic financial conditions relative to their impacts on traded goods competitiveness. It should also be noted that since almost all imports from the US were invoiced in US dollars during the period, exchange rate pass-through should be large for imports. This makes it more natural to test for exchange rate effects for China using imports than exports which are also likely to be invoiced in US dollars.

To guide my empirical work, I develop a heterogeneous-firm model (based on a set-up similar to Gopinath and Neiman (2011)) to capture the extensive margin adjustment of firms' import decision. The novel element of the theory is the introduction of a dynamic setting to allow future exchange rates to influence current import decisions. Intuitively, the expected profit of importing increases as the domestic currency appreciates in the future. The sunk costs of importing could be recovered for marginally productive firms only if domestic currency value appreciates in the future. An expected appreciation induces more firms to start importing if expected benefits surpass the sunk costs of import. In such a way, the expectation of future exchange rate changes plays a role in current trade decisions, especially with substantial sunk costs of import. On the other hand, import values for existing importers depends largely on current exchange rates rather than future expectation. Thus, the "forward-looking" nature of the model influences import mainly through extensive margin rather than intensive margin.

The model further predicts that as more firms within a sector respond to forward appreciation expectations and begin importing, the competition within the sector will intensify. The markups for potential subsequent importers shrinks as each additional firm enters, and the import responses diminishes in the long run. When the market fully absorbs the expected exchange rate changes, import adjustment along the extensive margin may reach a long-run equilibrium. The model also shows that a heterogeneous impact of expected exchange rate fluctuations on current entry probabilities depending on firms' productivity, external credit accessibility and the size of sunk costs.

Empirically, to test model predictions, I employ a transactional level dataset of China's imports between 2000 and 2006. The data contains monthly bilateral import records between the United States and China, including detailed information about import quantities and HS product categories. I merge the Customs data with an annual survey of Chinese manufacturing firms. The latter contains rich information about firms' production and financial status. Two alternative econometric models are used to identity whether forward appreciation encourages current import decision. First, both Probit and linear probability models are used to estimate the forward premium's effect on individual firms' entry probabilities after controlling for current (spot) exchange rate changes. Secondly, a dynamic model estimated with GMM quantifies the marginal influence of future fluctuations on the number of importers within each HS-6 category. Both models show a significant response to anticipated exchange rate changes along the extensive margin. The response is robust to various forward premium measurements. Along the intensive margin, the tests find little adjustment of import value for existing importers. Additionally, following the approach of Bernard et al. (2007), I further decompose the total changes of import value into changes along the extensive and intensive margins respectively. The number of importers (i.e., extensive margin) responds significantly to forward exchange rate appreciations, while the import value of existing importers (i.e., intensive margin) does not adjust significantly.

Also, several subsequent empirical tests are conducted to verify the model's predictions. An interaction of forward premiums with firms' productivity measurements show that the marginal response is weaker for firms with high productivity. An interaction of forward premiums with the duration of the anticipation of appreciation shows that the response along the extensive margin diminishes as expected appreciation continues. This is consistent with the theory, in which the marginal profit of importing shrinks as the number of importers rises due to narrowing markups. The mechanism is identified by regressing entry probability on a predicted marginal increase of importers brought by future exchange rate changes.

Firms with varying abilities to overcome sunk costs display different degrees of response to changes in the forward rates. Firms with small sunk costs and adequate finance are more likely to react under exchange rate movements. On the other hand, financially constrained firms face larger barriers, especially for those within the sector depending heavily on external financing. By merging the import transaction data with firms' balance sheet data, I can show that firms' import responses to forward rates closely depend on firm-level characteristics, e.g., financial status, firms' accessibility to external financing, ownership, and location.[1]

Among all factors, it shows that productivity and location are the predominant ones that determine the magnitude of the responses. Location may be especially important in China as inland firms likely face much higher fixed costs of importing due to transport and other infrastructure costs.

Note, the results are not driven by the importance of processing trade in China. To rule out noise from firms engaging in "two-way" trade,[2] I test the model predictions based on the pure ordinary trade sample after excluding all transactions related with "exporting-oriented" import. The results are similar to those based on the full sample, and they suggest that previous conclusions are little affected by the "two-way" trade pattern.

My study is related to five strands of literature. First, it contributes to the vast literature in international trade which explains heterogeneous firm-level participation in international trade in the presence of sunk costs. The representative work is Melitz (2003) and subsequent extensions of the Melitz Model. For example, Ghironi and Melitz (2005) and Alessandria and Choi (2007) explore export decisions with fixed costs under a dynamic setting. Based on the heterogeneous-firm framework, Chaney (2008) derives trade elasticity along both intensive and extensive margins (where the intensive margin infers trade volume per firm and the extensive margin refers to number of firms). Helpman, Melitz and Rubinstein (2008) exploits trade flows between country pairs to infer country-specific fixed costs, and provides estimates of both the intensive and extensive margins of trade. In addition, many firm-level empirical studies aim to support the heterogeneous trade model, e.g., Hummels and Klenow

[1]This heterogeneous response is justified in previous literature both theoretically (e.g., Bodnar, Dumas and Marston (2002) and Bartram, Brown and Minton (2010)) and empirically (e.g., Hung (1997); Williamson (2001)).

[2]The "two-way" trade refers to assembling or processing trade with imported intermediate inputs.

(2005) and Bernard, Jensen and Schott (2006). It is worth noting that Roberts and Tybout (1997) quantifies the effect of exporting experience on the trade decisions and find that sunk costs to be significant. Also, Das, Roberts and Tybout (2007) develops a dynamic structural model of export and estimate sunk costs of exporting quantitatively. My paper documents the response of firm's import decision to forward fluctuations, and points out the importance of sunk costs to import decision under a dynamic setting.

Secondly, the paper is closely related to those studies exploring explanations for the "in-elasticity" of trade responses (in term of both quantity and price) to exchange rates fluctuations, e.g., Dong (2012) and Devereux and Engel (2002). My paper is especially close to those who seeking "micro-foundations" with heterogeneous firms to explain "in-elasticity" patterns observed at aggregate level, e.g., Berman, Martin and Mayer (2012), Amiti, Itskhoki and Konings (2014) and Gopinath, Itskhoki and Neiman (2011). They offer various explanations for the "in-elasticity" of prices (or volume) adjustment to exchange rates changes. By adding a forward-looking aspect to firm's import decisions, my study contributes a new element for the "micro-foundation" literature in that it helps to explain the "in-elasticity" of trade response to current exchange rates at the dis-aggregate level.[3] My paper holds that firms' "pre-reactions" to expected exchange rate fluctuations should also be taken into consideration when exploring trade elasticity to exchange rate changes.

Third, it relates to the literature in international macro which explores the"backward and forward looking" nature for firms' pricing decisions, e.g., Fuhrer and Moore (1995) and Fuhrer (1997). Some earlier works, e.g., Ethier (1973) and Froot and Klemperer (1989), identify sales decision of the representative firm under future changes of currency value. My study borrows such an "forward-looking" nature, and introduces it into the new trade theory. It shows that such a "backward and forward looking" nature also exists when it comes to firm's trade decisions under expected fluctuations, a previously unexplored topic. It displays a different mechanism for future expectation on contemporaneous export decision upon a heterogeneous-firm framework.

Fourth, my study is close to those exploring export responses to the volatility of exchange rate fluctuations, e.g., Viaene and de Vries (1992), Hooper and Kohlhagen (1978), Cushman (1988) and Wong, Ho and Dollery (2012). The empirical test especially relates with dis-aggregate level analysis using China's Customs data, e.g., Tang and Zhang (2012) and Li et al. (2012). However, few of them tackles import side and my study fills in the gap with firm-level analysis.

Last, this paper is also related to models addressing firm's import decisions, as well as those focusing on the relationship between imports and productivity, or between imports and welfare improvement,

[3] In the field of international macroeconomics, previous studies finds that aggregate-level variables, such as import (export) price, volume, display a lack of sensitivity to current (past) exchange rate fluctuations. For example, Chinn (2004) documents that US import elasticity to exchange rate changes is not statistically significant; a partial pass-through of exchange rate to import price is documented for major developed countries in Campa and Goldberg (2005) and Hooper, Johnson and Marquez (1998), and the pass-through coefficient is declining during the past decade in Marazzi and Sheets (2007).

e.g., Gopinath and Neiman (2011), Halpern, Koren and Szeidl (2011), Amiti and Konings (2007) and Broda and Weinstein (2004).

The paper is organized as follows. Section 2 builds a model to capture import responses to expected exchange rate fluctuations. Section 3 shows the mechanism for marginal effects among firms. Section 4 describes data and measurements, and offers a short description of changes of import. Section 5 presents empirical tests and results for extensive margin, intensive margin response and marginal response with firms' characteristics. Section 6 provides some robustness and Section 7 concludes.

2 Model

2.1 Production Side

Following the set-up in Gopinath and Neiman (2011), I derive a model to capture importers' response to the changes of domestic currency value. Let's assume the firm i draws productivity A_i from a uniform distribution on $(0, A_{\max})$, and the production function follows

$$Y_i = A_i (K_i^{\alpha} L_i^{1-\alpha})^{1-\mu} X_i^{\mu} \tag{1}$$

Given its productivity A_i, firm i chooses capital input K_i, labor input L_i and intermediate input X_i. The intermediate input bundle X_i is composed by both domestic products Z_i and imported products M_i. The elasticity of substitution between domestic and foreign inputs is ρ. By employing a CES form aggregation, the final intermediate input bundle follows:

$$X_i = [Z_i^{\rho} + M_i^{\rho}]^{\frac{1}{\rho}}, \text{where } \rho < 1 \tag{2}$$

Let's include exchange rates into consideration, the cost of the foreign intermediate input bundle is dominated by domestic currency exchange rate e,[4] where e is the price of domestic currency in term of foreign currency. Then the cost of the intermediate input bundle becomes

$$P_{xi} = [P_{Zi}^{\frac{\rho}{\rho-1}} + (P_{Mi}/e)^{\frac{\rho}{\rho-1}}]^{\frac{\rho-1}{\rho}} \tag{3}$$

Normalizing the cost of domestic input to be unit one, the intermediate input bundle becomes (4). Since imported inputs M_i is assumed to be less expensive than the domestic ones Z_i, the intermediate input bundle is always less than one if firm i imports.

$$P_{xi} = [1 + (P_{Mi}/e)^{\frac{\rho}{\rho-1}}]^{\frac{\rho-1}{\rho}} \leq 1 \tag{4}$$

In this way, an appreciation of local currency stands for a decrease in the cost of imported intermediate

[4]For simplicity, I use a representative foreign exchange rate e to denominate all foreign intermediate input, even if firm imports from multiple products

inputs, hence a decrease in cost of intermediate inputs bundle given firm i imports. [5]

$$\frac{\partial P_{xi}}{\partial e} < 0 \tag{5}$$

For simplicity, I assume that the imported varieties are homogeneous with a uniform price of P_{Mi}, and the quantity of each imported variety is M_i consequently. By minimization production cost, firm's unit production cost becomes

$$C_i = \frac{1}{\mu^\mu(1-\mu)^{1-\mu}} \frac{P_V^{1-\mu} P_{Xi}^\mu}{A_i}, \text{ where } P_V = \alpha^{-\alpha}(1-\alpha)^{-1+\alpha} r^\alpha w^{1-\alpha} \tag{6}$$

P_V denotes the cost excluding intermediate inputs. Since capital price r and labor price w are exogenously given for all firms, P_V is constant and identical for all firms. The heterogeneity of production cost only depends on productivity A_i and its import status. Production cost of firm i can be simplified as (7).

$$C_i = \phi \frac{P_{Xi}^\mu}{A_i} \tag{7}$$

2.2 Demand Side

Firms engage in monopolistic competition in the market. The demand function for firm i follows

$$Q_i = o P_i^{-\delta}, \delta > 1 \tag{8}$$

where o is a constant, P_i is the price charged by firm i, and Q_i is market demand quantity firm i faces. By maximizing its profit, firm i sets a constant mark-up over the unit cost C_i according to (9).

$$P_i = \frac{\delta}{\delta - 1} C_i \tag{9}$$

Combining demand and production, profit of production π_i takes the form of (10).

$$\pi_i = P_i Q_i - C_i Q_i = \omega\left(\frac{P_{Xi}^\mu}{A_i}\right)^{1-\delta}, \text{ where } \omega \text{ is a constant} \tag{10}$$

Thus, without considering the suck cost of production or importing, profit of firm i depends on its productivity A_i as well as its importing status.

2.3 Import Decision: A General Case

In the following part, I show that firm i makes its import decision depending on both current exchange rate e and future exchange rate $\bar{e}$. Firstly, I define two scenarios based on firm's previous import status

[5] In the model, I assume it is producer currency pricing, which is corresponding to the reality that most of China's imports from US are invoiced in USD. Thus appreciation of RMB directly pass-through to import price for Chinese producers.

in $t-1$. One scenario is that firm i had already been an importer at $t-1$, and takes value function with the form of $V_{imp}(e)$ at time t. The other scenario is defined as following: if the firm had not imported at $t-1$, its value function takes the form of $V_{non}(e)$. If the firm i under the second scenario decides to start importing at t, it pays for an initial sunk cost F_{imp} to start import. For both scenario, firm i can generate profit of π_{imp} if it imports at t; while it generates a profit of π_{non} if it does not.

Following my definition, firms under the above two scenarios incur the value function of $V_{imp}(e)$ and $V_{non}(e)$, respectively. The value functions are the maximum value by choosing import or not at time t, which take the form as (11) and (12) respectively.

$$V_{imp}(e) = \max_{\text{import or not}} \{\pi_{imp}(e_t) + \beta E V_{imp}(\bar{e}|e), \pi_{non} + \beta E V_{non}(\bar{e}|e)\} \tag{11}$$

$$V_{non}(e) = \max_{\text{import or not}} \{\pi_{imp}(e_t) - F_{imp} + \beta E V_{imp}(\bar{e}|e), \pi_{non} + \beta E V_{non}(\bar{e}|e)\} \tag{12}$$

Then, to generalize the change patterns of future exchange rate, I assume that expected future exchange rate fluctuation follows AR(1) process, and depends on the current fluctuation $e_t - e_{t-1}$, i.e., $\bar{e}_{t+1} = e_t + \theta_t(e_t - e_{t-1}) + \epsilon_t$, where ϵ is a random white noise, and θ_t is an expected appreciation/depreciation speed at time t. Under my assumption, θ_t is a key parameter to govern the expectation for future changes.

There are several regimes for future exchange rate fluctuations. Firstly, when $\theta_t > 0$, and current exchange rate initially appreciates, i.e. $e_t - e_{t-1} > 0$, market foresees a lasting future appreciation.[6] This situation is corresponding to the context of China's exchange rate reform, for which market anticipates RMB one-way appreciation in the long run. Secondly, with $e_t - e_{t-1} < 0$ and $\theta_t > 0$, it refers to a depreciation stage. Market anticipates a long-lasting future depreciation. Thirdly, there are other regimes when $\theta_t < 0$, the expected future exchange rate tends to fluctuate around its initial value. These cases are more likely to happen under a fixed exchange rate regime or a long-term equilibrium state.

For convenience, I use the first regime as the setup for model, i.e., $\theta > 0$ and $e_t > e_{t-1}$. It's corresponding to an anticipated domestic currency appreciation. Model predictions under other regimes, e.g. depreciation and equilibrium fluctuations, could be derived following similar approach. Combining equation (3) and (10), I can verify that $\frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial e} > 0$, marginal profit of import increases as domestic currency appreciates. Under lasting one-way appreciation regime, importing becomes more attractive for producers.

First of all, let's focus on the group of existing importers. The Lemma 1 predict import decision for those who had already imported at $t-1$, proof is attached in Appendix 1.

Lemma 1. *Under the expected appreciation regime, import is always a dominant strategy at t for*

[6] $\theta_t > 0$ is likely to happen during a exchange rate re-evaluation stage, or when currency is adjusting to its long-run equilibrium value.

existing importers who had imported at $t-1$.

Lemma 1 suggests existing importers never exit from importing under the expected one-way appreciation regime. Thus, the adjustment in the number of importers, i.e. extensive margin, depends on the entry of non-importers at time $t-1$. For those non-importers in $t-1$, the value function $V_{non}(e)$ follows (12). The cut-off exchange rate e^* satisfies the indifference condition as the following.

$$EV_{imp}(\bar{e}|e^*) - EV_{non} = \frac{1}{\beta}F_{imp} - \frac{1}{\beta}[\pi_{imp}(e^*) - \pi_{non}] \tag{13}$$

According to Lemma 1, value function for existing importers follows $V_{imp} = \pi_{imp} + \beta EV_{imp}$ under the appreciation expectation. For those less productive producers or those with substantial sunk cost of import, I can verify that $V_{non} = \pi_{non} + \beta EV_{non}$ always holds. [7] Putting them together into the left hand side of equation 13, the indifference condition becomes the following

$$\pi_{imp} - \pi_{non} + \sum_{n=1}^{N} \beta^n [\pi_{imp}(\bar{e}_{t+n}) - \pi_{non}] = F_{imp} \tag{14}$$

From the above equation, the difference of value between import and non-import depends on series of future marginal benefit of import over non-import. It turns out to be affected by both productivity A and exchange rate e.

$$\frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial A} > 0, \text{and } \frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial e} > 0 \tag{15}$$

Similarly, future marginal profit of import is increasing with future exchange rate, that is $\frac{\partial[\pi_{imp}(\bar{e}) - \pi_{non}]}{\partial \bar{e}} > 0$. Then $EV_{imp}(\bar{e}) - EV_{non}(\bar{e})$ is an increasing function of expected future exchange rate $\bar{e}_{t+n}$. Since under my assumption, the exchange rate evolves according to $\bar{e}_{t+1} = e_t + \theta_t(e_t - e_{t-1}) + \epsilon_t$, thus the magnitude of $EV_{imp}(\bar{e}) - EV_{non}(\bar{e})$ is governed by θ, the expected appreciation magnitude.[8] In other words, θ affects current import decision through the expected future marginal benefit of import versus non-import in the future.

[7]To figure the value function of V_{non}, I use a trial and error method. If we assume that $V_{non} = \pi_{non} + \beta EV_{non}$, there exists a cut-off exchange rate e^* satisfying the indifference condition; while if we assume that $V_{non} = \pi_{imp} + \beta EV_{imp} - F_{imp}$, the indifference condition can only be satisfied under the condition of $F_{imp} \leq \frac{\pi_{imp} - \pi_{non}}{1-\beta}$.

[8]Actually, marginal benefit of import is governed by a series of θ_{t+n}, which is predicted at time t for exchange rate growth rates at different future stages $t+n$. In the empirical part, for simplicity, I use an identical θ_t to represent θ_{t+n}, the anticipated exchange rates in the future.

2.3.1 Import Decision: Infinite Number of Firms Exist Within A Sector

For non-importers in time $t-1$, by inserting explicit profit function (10), the cut-off productivity A^* could be pined down for non-importing group at $t-1$, which solves the equation (16).

$$\omega(\frac{P(e)_x^\mu}{A_i})^{1-\delta} - \omega(\frac{P_d^\mu}{A_i})^{1-\delta} + \beta[EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e)] = F_{imp} \tag{16}$$

In previous subsection, it follows $EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e^*)$ is an increasing function of both current exchange rate e and expected future exchange rate $\bar{e}_{t+n}$. Hence, the left hand side of (16) is an increasing function of both productivity A_i, exchange rate e and future exchange rate $\bar{e}_{t+n}$, which is governed by θ. In other words, exchange rates, including both e and $\bar{e}$ are complementary with firm's productivity A_i on its import decision. Hence, under an one-way appreciation setting, we have the following prediction:

$$\text{If } \theta > 0, \text{ then } A^* \downarrow; \text{ The large } \theta \text{ is, the lower } A^* \text{ becomes.}$$

However, these predictions could be extended to other settings. For example, under a one-way depreciation regime ($\theta > 0$), anticipation of future exchange rate movement dis-encourages firm from importing, i.e. through the adjustment of extensive margin. Namely, e_t initially begins to decrease, i.e., $e_t < e_{t-1}$, we have the following

$$\text{If } \theta > 0, \text{ then } A^* \uparrow; \text{ The large } \theta \text{ is, the larger } A^* \text{ becomes.}$$

On the other hand, during a fixed exchange rate regime or under an equilibrium exchange rate value ($\theta < 0$). Market's expectation of future exchange rate fluctuates around a steady value. Thus there is little change in the expected marginal benefit of import over non-import. Since few firms start to import from abroad, there is no significant adjustment through extensive margin.

Proposition 1. *As market expects domestic currency appreciates (depreciates) in the future, i.e. $\theta > 0$, the cut-off productivity of importing firms decreases (increases) and, hence, there are more (less) firms start to import from abroad.*

Proposition 2. *As expected domestic currency appreciates (depreciates) in the future, the most responsive entered importers are those with lower productivity, which leads to an adjustment of extensive margin.*

Proposition 3. *The larger the magnitude of expected appreciation (depreciation) θ is, the larger adjustment in term of extensive margin follows.*

2.3.2 Import Decision: Finite Firms Exist Within A Sector

This part focuses on a long-run adjustment of extensive margin when there are a finite firms within a sector. Based upon a similar setting of Atkeson and Burstein (2008), I assume that there are a finite number of firms within the sector s and each firm produces a variety of differentiated good. Firms engage monopolistic competition within the sector s. Consumers in the market have a nested CES demand over the varieties of goods. The elasticity of substitution across varieties within the sector s is δ, while elasticity of substitution across sectors is η, and $\delta > 1$, $\delta > \eta > 0$. The representative firm i faces the following demand function.

$$Q_{s,i} = oP_{i,s}^{-\delta} P_s^{\delta-\eta}, \text{where o is constant}, \delta > \eta > 0, \delta > 1 \tag{17}$$

The price index P_s in sector s becomes

$$P_s = [\sum P_{i,s}^{1-\delta}]^{\frac{1}{1-\delta}} \tag{18}$$

Also, $\sigma_{s,i}$ is the elasticity among different products within sector s, and $\sigma_{s,i}$ follows

$$\sigma_{s,i} = -\frac{d \log Q_{s,i}}{d \log P_{s,i}} = \delta(1 - S_{i,s}) + \eta S_{i,s} \tag{19}$$

where $S_{i,s}$ is the market share of firm i in the sector s, it is defined as $S_{i,s} = \frac{P_{i,s}Q_i}{\sum_{i'} P_{i',s}Q_{i'}} = (\frac{P_{i,s}}{P_s})^{1-\delta}$.

Inserting $S_{i,s}$to (19), there is the explicit function for $\sigma_{i,s}$

$$\sigma_{i,s} = \delta[1 - (\frac{P_{i,s}}{P_s})^{1-\delta}] + \eta(\frac{P_{i,s}}{P_s})^{1-\delta} \tag{20}$$

The optimal price P^* set by firm i is obtained by solving the maximizing profit problem, i.e. $P^* = \frac{\sigma_{i,s}}{\sigma_{i,s}-1}C_i$. Then market share also could be pined down by inserting P^* into $S_{i,s}$. By putting P^* into profit function, the profit of firm i in sector s becomes

$$\pi_i = o\frac{1}{\sigma_{i,s} - 1}(\frac{\sigma_{i,s}}{\sigma_{i,s} - 1})^{-\delta} C_i^{1-\delta} P_s^{\delta-\eta} \tag{21}$$

where $\sigma_{i,s}$ is defined in (19) , and C_i is production cost defined in (6). To to specific, $C_i^{imp} = \phi\frac{P_{Xi}^{\mu}}{A_i}$ if firm imports and $C_i^{non} = \phi\frac{1}{A_i}$ if it does not, where ϕ is a constant. Thus we have $C_i^{imp} < C_i^{non}$.

For convenience, let's define that $G(S_{i,s}) = \frac{1}{\sigma_{i,s}-1}(\frac{\sigma_{i,s}}{\sigma_{i,s}-1})^{-\delta}$, depending on import status, firm i's profit function with or without imported intermediate inputs becomes (22) and (23), respectively.

$$\pi^{imp} = G^{imp}(S_{i,s})(C_i^{imp})^{1-\delta} P_s^{\delta-\eta} \tag{22}$$

$$\pi^{non} = G^{non}(S_{i,s})(C_i^{non})^{1-\delta} P_s^{\delta-\eta} \tag{23}$$

By combining the above two together, the marginal profit of import follows $\pi^{imp}-\pi^{non} = [G^{imp}(S_{i,s})C_i^{imp} - G^{non}(S_{i,s})C_i^{non}]P_s^{\delta-\eta}$. Put it into the cut-off productivity condition in (16), the following equation holds.

$$[G^{imp}(S_{i,s})C_i^{imp} - G^{non}(S_{i,s})C_i^{non}]P_s^{\delta-\eta} + \beta[EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e^*)] = F_{imp} \tag{24}$$

If currency appreciates in the long-run, more firms start to import and it drives down average cost of production, as well as price index within the sector s, i.e., $P_s = [\sum_i(\frac{\sigma_{i,s}}{\sigma_{i,s}-1}C_i)^{1-\delta}]^{\frac{1}{1-\delta}}$. As more firms start to import with the anticipation of local currency value, the elasticity faced by importers $\sigma_{i,s}$ becomes larger. The market share for importers decreases due to larger number of new entrants. Thus, the first item in the import marginal profit function of (24) , i.e. $[G^{imp}(S_{i,s})C_i^{imp} - G^{non}(S_{i,s})C_i^{non}]P_s^{\delta-\eta}$, becomes smaller in the long run than in early stage with less entrants. Similarly, expectation future marginal profit of import $EV_{imp}(\bar{e}|e^*) - EV_{non}$ becomes smaller gradually. Combining together, the cut-off productivity in (24) has been pushed up even under the one-way future currency appreciation in the long run. [9]

In Appendix 3, I illustrate this prediction in detail. I also conduct a tests for the relationship between firm's entry probability and number of firms within the sector. The result is listed in Table A-1 of Appendix, it documents the mechanism whereby the number of firms rises with future exchange rates, which tends to diminish current entry probability of firms. Combining the above together, the cut-off productivity of importing A^* is higher than the initial stage with appreciation. It suggests a declining number of new entrants as appreciation continues in the long run.

Symmetrically, following the same logic, I also conclude that when market anticipates a long-lasting depreciation, the marginal loss of importing decreases in the long run. It muffles exit of existing importers, which lead to an declining response in term of extensive margin to future exchange rate fluctuations in the long run.

Proposition 4. *If the market expects a currency appreciation(depreciation) to last in the long run, a diminishing marginal profit(loss) of importing reduces entry (exit) of potential importers (existing importers). Hence there is declining response in term of extensive margin to expected exchange rate fluctuation in the long run.*

2.4 Decompose Aggregate Import Response to Forward Exchange Rate

In the previous section, the extensive margin responds to expected future exchange rate changes. Does adjustment along the intensive margin play a role in the total import response to future exchange rate fluctuations? To answer this question, the marginal effect of future exchange rates $\bar{e}$ on aggregate

[9] In a simplest case with homogeneous firms, when $P_s = N^{\frac{1}{1-\delta}}P_i$, and $S_i = \frac{1}{N}$. Also since more firms imported intermediate input which reduced production cost, it leads to more entrants of less productive firms in the market initially. However, in the long run, as average price index within sector s declines, market share of importers drops. Profit of importing becomes less than before, the threshold of surviving firms within sector s is driven up, which lead to a smaller N. Then $\sigma = \delta + \frac{1}{N}(\eta - \delta)$ is driven up, lead to a smaller value of $G^{imp} - G^{non}$.

changes of import value X, i.e., $\frac{d \ln X}{d \ln \bar{e}}$, is decomposed into two components, the extensive margin ($\frac{d \ln Extin}{d \ln \bar{e}}$) and the intensive margin ($\frac{d \ln Intin}{d \ln \bar{e}}$) respectively.

In the Appendix 2, the first component, i.e., the extensive margin $\frac{d \ln Extin}{d \ln \bar{e}}$, equals the product of the productivity distribution parameter ϑ and the expected marginal change of the productivity cut-off due to future exchange rate fluctuations ζ, that is $\frac{d \ln Extin}{d \ln \bar{e}} = \zeta\vartheta$. Note $\zeta > 0$ and $\vartheta > 0$.

On the other hand, the cost minimizing import value of existing importers does not depend on future exchange rate fluctuations $\bar{e}$ if outputs for each period are fixed. Therefore, there is no marginal effect of $\bar{e}$ on intensive margin, $\frac{d \ln Intin}{d \ln \bar{e}} = 0$. On the other hand, if the firm is free to choose output between periods, it allocates less to the current period when facing a future reduction of input cost. Thus, in this case, current import value (intensive margin), negatively responds to future exchange rate appreciation, i.e., $\frac{d \ln Intin}{d \ln \bar{e}} < 0$.

Thus, the positive effect of aggregate import value to future exchange rate fluctuations $\frac{d \ln X}{d \ln \bar{e}}$ is dominated by the response of the extensive margin while intensive margin hardly contributes or even reduces the positive aggregate marginal effect:

$$\frac{d \ln X}{d \ln \bar{e}} \leq \frac{d \ln Extin}{d \ln \bar{e}}$$

.

Proposition 5. *The positive elasticity of the aggregate import value to expected exchange rate changes mainly comes through adjustment along the extensive margin rather than intensive margin.*

3 Extension: Heterogeneous Marginal Response

As predicted in the model, an expected appreciation or depreciation of domestic currency induces an increase or decrease of the marginal benefit of importing. Due to the presence of a sunk cost of importing, it leads to a decrease or increased cut-off for the level of productivity at which it makes sense to import, creating adjustment along the extensive margin.

In this sense, firm-level heterogeneity of sunk costs and the ability to finance payments may lead to a different level of response to future exchange rate fluctuations. In this sense, firm-level factors, e.g., fixed cost of importing, financial status, ownership and location, may shift any firm's response to an expected currency appreciation or depreciation.

To see this, assume firm i incurs substantial fixed cost of import of F_{imp}, which is denoted in domestic currency. A fraction d of F_{imp} could be covered by external finance, and the rest of $(1-d)$ is paid from its own cash flow. The firm repays an amount $z(A)$ in the end if it operates successfully (the amount of $z(A)$ is a function of firm's productivity A), otherwise a liquidity residual rF_{imp} should be claimed by an external creditor. The probability of successful operation is λ, and $0 < \lambda < 1$.

Then, the firm chooses to optimize its profit subject to incetive compatible and individual rationality conditions.

$$\max_{Y_i} P_i Y_i - C_i Y_i - (1-d)F_{imp} - \lambda z(A) - (1-\lambda) r F_{imp} \tag{25}$$

$$\text{s.t. } P_i Y_i - C_i Y_i - (1-d)F_{imp} \geq z(A)$$

$$-dF_{imp} + \lambda z(A) + (1-\lambda) r F_{imp} \geq 0$$

Then, the profit of production follows (26) if the firm operates successfully in time t.

$$\pi_{imp}(e) = (\frac{P(e)_x^{\mu}}{A_i})^{1-\delta} - (1-d)F_{imp} - z(A) \tag{26}$$

Also, investors only fund the firm if their net return exceeds their outside option normalized to zero. By exploiting this condition, we have $z(a) = \frac{d-(1-\lambda)r}{\lambda} F_{imp}$. After inserting $z(A)$ into the profit function π_{imp} in equation of (26), the profit for importing firms holds

$$\pi_{imp}(e) = (\frac{P(e)_x^{\mu}}{A_i})^{1-\delta} - [(1-d) + \frac{d-(1-\lambda)r}{\lambda}]F_{imp} \tag{27}$$

From (27), profit $\pi_{imp}(e)$ is an increasing function of both productivity A_i and exchange rates e. Comparing profits of importing firms π_{imp} with non-importing firms π_{non} (where $\pi_{non} = (\frac{1}{A_i})^{1-\delta}$), then it becomes

$$\frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial d} < 0, \text{ and } \frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial F_{imp}} < 0 \tag{28}$$

As previous, the "cut-off" import condition in (16): $\pi_{imp}(e) - \pi_{non} + \beta[EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e)] = F_{imp}$. Combining condition (15) and (28), there are offsetting effects between e, $\bar{e}$ and d, F_{imp}, summarized as following $\frac{\partial A^*}{\partial e} < 0$, $\frac{\partial A^*}{\partial \bar{e}} < 0$, $\frac{\partial A^*}{\partial d} > 0$, $\frac{\partial A^*}{\partial F_{imp}} > 0$. In this sense, at the extensive margin, the cut-off productivity A^* follows equation (29).

$$\frac{\partial^2 A^*}{\partial e \partial d} < 0, \frac{\partial^2 A^*}{\partial e \partial F_{imp}} < 0 \tag{29}$$

Similarly since $EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e^*)$ is an increasing function of $\bar{e}$, a similar condition with respect to expected exchange rates $\bar{e}$ could be shown as below.

$$\frac{\partial^2 A^*}{\partial \bar{e} \partial d} < 0, \frac{\partial^2 A^*}{\partial \bar{e} \partial F_{imp}} < 0, \tag{30}$$

It is suggested that under an expected appreciation, the marginal response (entry) of extensive margin is smaller for those with larger sunk costs, or who largely depend on external finance; while under an expected depreciation, the marginal response (exit) along the extensive margin is smaller for those with larger sunk costs or who are financially constrained. Thus, I have the Propositions 6 and 7 as below.

Proposition 6. *An expected appreciation/depreciation leads to an adjustment along the extensive margin, the marginal response is smaller for those firms with larger sunk costs of import.*

Proposition 7. *An expected appreciation/depreciation of the domestic currency lead to an adjustment in extensive margin, the marginal response is smaller for those firms with larger external finance dependence or with adequate external financing.*

In addition, other firm characteristics, e.g. ownership, may also affect firms' access to external finance, especially for those with large sunk costs of import. Furthermore, firms in different locations face varying levels of import barrier and sunk cost of imports. Those characteristics are all potential factors affecting the import response toward future fluctuations. I list the following hypothesis without proof, but in the empirical part we would test the hypothesis.

Hypothesis 1. *An expected appreciation/depreciation of domestic currency encourages firm's entry/exit, the marginal effect is associated with firm's ownership and location.*

4 Data and Measurements

Our sample dataset is constructed by merging two panel data sets: 1) Customs data; and 2) Balance sheet data; with time series data on forward exchange rates.

The Customs data collected by Chinese Customs Office includes detailed transactional level import records at monthly frequency. The monthly census data covers all import transactions by Chinese firms. The data contains destination country, import volume for each eight-digit harmonized system (HS8) product, basic identifying information on the importing firm (e.g., firm's identification number, name, ownership etc.), and transaction type (i.e., whether it is ordinary or processing trade). Due to multiple entries, I calculate each firm's import for each specific HS 8-digit product from each destination country in the month, and treat the import as one observation.

The second data set is Annual Survey data of Chinese manufacturing firms collected by National Bureau of Statistics of China. It covers manufacturing firms of various ownership types with revenue above 5 million yuan (about US$ 600,000) during sample period. It records firm's identification, location, ownership type and balance sheet data. Firm's balance sheet records information about production and financial condition.

I merge the transactional-level Customs data with firm's survey data to form a sample with rich information. Firms are merged by firm's identification number, name, address (zip code) and telephone number which appear on both data sets. After merging the two, around 46 percent of total US-China bilateral import value is covered by the sample. Among those dropped observations, many are conducted by trade intermediaries, not by manufacturing firms. Thus, my sample captures mainly the import from large manufacturing firms for production purpose.

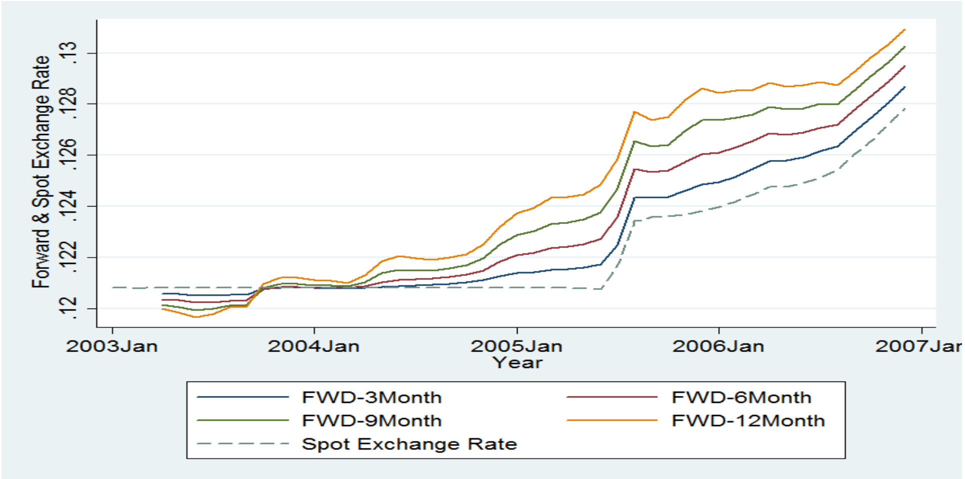


Figure 1: Forward & Spot Exchange Rate Fluctuations Between RMB and USD

The forward premiums are calculated based the forward exchange rate between USD and RMB, which is released by BOC, HK (Bank of China, HK). [10] It includes forward rates at various horizons, e.g., one-month, three-month, six-month, nine-month, one-year forward. I use forward exchange rates as proxies for market's expectation of future exchange rate fluctuations.

As we know, before July, 2005, China had a fixed exchange rate policy with the RMB pegged exchange rate to USD. The forward exchange premium between USD and RMB is almost fixed before 2003. The spot exchange rate between RMB and USD began appreciating after 2005 July, when the government officially announced the new policy. However, the market had anticipated such an appreciation much earlier than the real change, and forward exchange rates between USD and RMB had increased as early as 2003.

In early February 2003, Japan proposed a reform towards China's exchange rate regime at the G7 meeting. Since then, there had been widespread debate and discussions about the necessity and feasibility of exchange rate reform, and the Chinese government had faced increasing pressure to reform foreign currency policy. Western countries believed that RMB had been undervalued severely leading to a huge trade surplus. In the G7 meetings of 2004, more countries and global institutions including the IMF started to urge China to reform foreign exchange rate policy.

Graph 1 captures the changes of both spot and future exchange rates from 2003 to 2006. Note that the nominal exchange rate (the first graph) had been flat before the middle of 2005 and appreciated gradually afterwards. However, the forward exchange rates of RMB (including three, six, nine and twelve-month forward) appreciate as early as late 2003, especially for a nine-month and twelve-month forward exchange rate. In my test, I focus on the period from 2003 to 2006, when market had began forecasts an appreciation of RMB.

[10]It stands for a Non-deliverable forward data in a off-shore exchange rate market outside China mainland.

4.1 Measurements

In the test, I use the forward exchange rate between the USD and RMB as a proxy for market expectations of future exchange rates, I define a series of K-month forward premium between USD and RMB as $Fwd = ln[FXR_{T+k}/EXR_T]$, where FXR_{T+k} is K-month forward rate and EXR_T is current spot exchange rate.[11] For comparison, I use the annualized forward premium $\triangle(fwd)_k$, where $\triangle(fwd)_k = \frac{1}{k}Fwd$. The annualized forward rates serve as standard measurements to compare response between different time horizons.

The forward exchange rate reported in the foreign exchange market may be the most accurate and available forecast of future exchange rate fluctuations for firms engaging in foreign trade. Chinese firms are forbidden to engage in any trade of foreign exchange rate derivatives directly. Thus, it is less likely for firms to avoid future exchange rate risks through buying or selling derivatives, for example, via non-deliverable forwards. Firms can only adjust their trade response in advance to avoid foreign currency risk based on the forecasting of future exchange rate fluctuations. One possible sources of future exchange rate forecasts is the reported forward rates in an off-shore foreign exchange market, such as Hong Kong or Singapore exchange market.

For other variables in my empirical test, a firm's import value is calculated value at a specific "product-country-month" level, i.e., a specific HS8 product from a specific origin country within one month. Firm level characteristics, e.g. ownership, location, size and productivity, are extracted from firm's balance sheets in the survey data. Two measurements of productivity (TFP) are calculated to proxy productivity, using both OLS and OP methods, the latter of which follows Olley and Pakes (1996).

I employ various measures for firms financial status and access to external liquidity. These measurements are calculated at both firm and product level. The debt ratio (debt) is a firm's total liabilities divided by total fixed asset. Bank loans ($Loan$) are calculated as total bank loan supply to GDP ratio in the city where firm is located.

The external finance dependence index (EFD) is a constructed index for manufacturing industries' dependence on external finance. [12]

4.2 A First Glance at the Data

Using only Chinese Customs data, I describe changes in US-China bilateral trade during the sample period, i.e. from January 2003 to December 2006. The Customs data set offers us a comprehensive and complete record of the imports of China. I firstly focus on entry / exit and net increase in the

[11]The expected future exchange rate equals $Fwd * (1 + r^f)/(1 + r)$, where r^f and r are interest rate in foreign and domestic country respectively. Since interest rates change less frequently than exchange rate, the effect absorbed in year dummy in my regression. So I use forward change rate directly to measure market's expectation of future exchange rate.

[12]This index is calculated firstly by Rajan and Zingales (1998) based on US manufacturing firms, I make use of the updated vision in Manova, Wei and Zhang (2011).

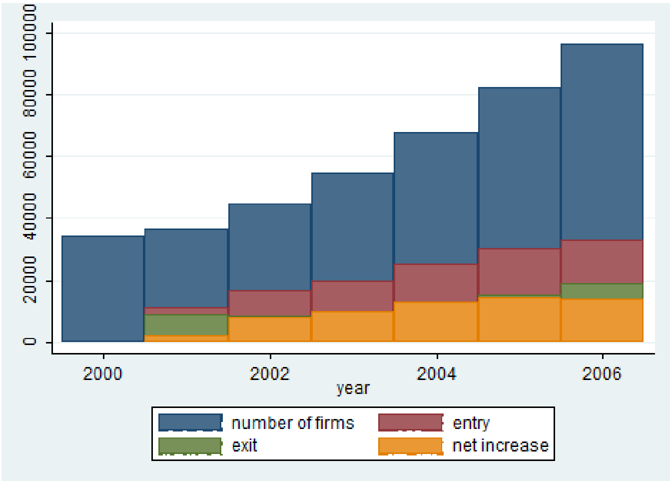
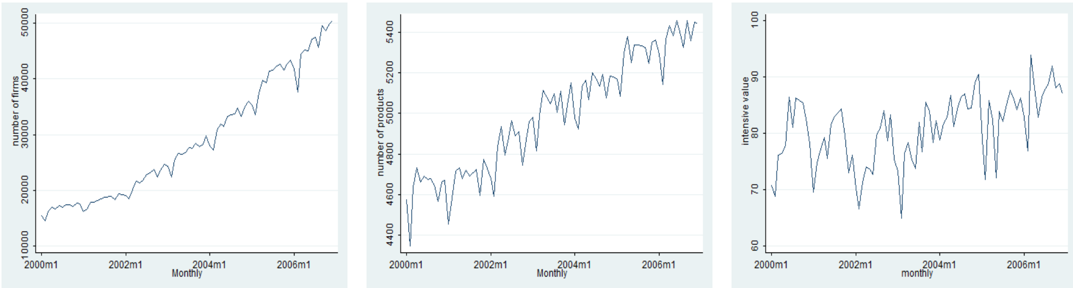


Figure 2: Number of Importers from U.S.



(a) Firm Number (b) Products Number (c) Average Value

Figure 3: Decompose Import Change

number of importers. In Graph 2, the number of importers from U.S. is less than 20000, and began to rise significantly after 2002, and then towards 50000 in 2006. I record a change of numbers with entry and exit. In the year of 2000, the exit rate is as high as the entry rate, thus the net increase of firms is not significant. China's entry into WTO at the end of 2001 is the major reason for the sharp spike of entry and exit afterwards. Starting from 2002, the entry and net increase had been steadily rising. In 2005, there is the highest net increase of firms among all years, which coincides with the expected exchange rate reform during that time. However, the exit rate also starts to rise in 2005 and the net entry number is slightly declining during 2005 to 2006. The change in net number of importers is mainly attributable to increased entry of importers.

Besides the number of firms, I further decompose the change in aggregate import value into changes in number of firms and products (extensive margin), and changes of average import value per firm (intensive margin). Graph 3 displays import changes by different margins. In Figure 3(a), the number of importers has a steadily increasing trend in spite of monthly fluctuations. The number of firms has tripled from 2001 to 2006. The increase along the extensive margin at the firm level has a significant effect on the rise of import values at the aggregate level. The second Figure 3(b) shows the total number of HS8 products imported by Chinese firms from the US. Although it shows a steadily rising pattern, the rising magnitude is less than 20 percent. In average, each firm imports approximately 4 to 5 varieties of products from the US. In Figure 3(c), it shows the average import value by firm during the sample period. The average import value for each importer is very volatile and also has been rising from 2001 to 2006. Combining the graphs together, it indicates that entry of importers counts for a dominant weight in the total import increase during the sample period.

Table 1: Decomposing China's Import From US

year	firm #	entry%	exit%	product#	add%	drop%	growth	ext. firm	ext. product	int.
2002	44896	37%	18%	6286	11	9	34%	66%	4%	30%
2003	54798	36%	17%	6417	7	8	30%	73%	2%	25%
2004	67817	37%	18%	6416	5	5	34%	70%	0%	30%
2005	82265	37%	19%	6535	6	4	24%	89%	3%	8%
2006	96278	34%	20%	6603	5	4	24%	72%	0%	27%
average	62444	36%	18%	6451	7	6	29%	74%	2%	24%

Notes: Firm's entry and exit is denoted as percentage of total number of firms of the year. Add and drop of Product at HS-8 level is also percentage of total number of products. The last three columns represent the percentage of each margin's contribution to aggregate growth rate of import value. All values have been rounded off.

Table 1 offers detailed information on each components of import growth between China and US during 2002 to 2006, after the entry into the WTO. The annual entry rate of new importers is more than 35 percent of the existing number of firms, which is also much larger than the exit rate associated with a large net increase in importers. Focusing on HS-6 varieties of imported products, I find that there is no obvious rise in terms of imported varieties. Declining rates of existing product variety is almost as great as increasing rates of new variety. Further, by decomposing growth rates of import value into three different margins, extensive margin at firm level alone contributes 74 percent on average, intensive margin contribute 24 percent and extensive margin at product counts only 2 percent. Thus, a large proportion of import growth comes from entry of new firms or increase of import values rather than importing new products.

Table 2: Frequency Distribution of Import Within One Year

Months with Import			Continuing Months with Import		
Months	percent	Cumulative	Months	percent	Cumulative
1	3.82	3.82	1	8.53	8.53
2	4.03	7.85	2	6.17	14.70
3	4.34	12.19	3	5.39	20.09
4	4.61	16.81	4	5.26	25.35
5	4.87	21.68	5	5.04	30.39
6	5.05	26.73	6	5.11	35.50
7	5.40	32.13	7	4.82	40.32
8	5.76	37.89	8	5.98	46.30
9	6.42	44.31	9	4.33	50.63
10	7.76	52.07	10	11.66	62.29
11	12.75	64.82	11	2.51	64.80
12	35.19	100.00	12	35.19	100.00

Notes:All values have been rounded off.

In table 2, it displays the distribution of frequency for Chinese firms importing from the US. Within one year, more than 35 percent of firms import every month and more than 55 percent of them import over 10 months. If I focus on continuing months with imports, more than 35 percent of firms import every month and more than 49 percent of firms import over 10 months which one year. It suggests that most of importers import at a very high frequency level. Once a firm starts importing, it will continuing import in the future. This pattern indicates that two facts: (1) once firm starts importing, it less likely to drop out which supports the prediction in Lemma 1; (2) a sunk cost exists for initializing import which induces firms to continue import.

5 Empirical Tests

5.1 Tests of Extensive Margin Response

In this part, I test how entry probability changes with forward exchange rate fluctuations. Our dependent variable $Entry$ is defined to be a dummy variable of import status: $Entry = 1$ if firm imports at time t but didn't import in time $t-1$; otherwise, $Entry = 0$. $\triangle fwd_{t,t+k}$ is an annualized forward premium between USD and RMB. It covers one, three, six, nine and twelve-month forward premiums ($k = 1, 3, 6, 9, 12$). I also construct an annual average forward premium ($Av\triangle fwd$), which is defined as $\sum\limits_{k=1,3,6,9,12} 1/4\triangle fwd_{t,t+k}$. The baseline specification follows equation (31).

$$\Pr(Entry = 1)_{it} = \psi[\beta_1 \triangle fwd_{t,t+k} + \beta_2 x_{it} + \beta_3 gexr_t + F_t] \tag{31}$$

In addition to the forward exchange rate premium $\triangle fwd$, I include an exchange rate growth rate ($gexr$) over the past six-months to control for the realized change of exchange rates. x_{it} is a vector of firm level control variables. X_{it} including size and a two-way trade dummy. The former is a logarithm of number of employees and the latter is an indicator for whether the firm is simultaneously conducting exports. Also, an annual dummy F_t is included to control for trend. The year dummy also helps to control for the effects brought by the changes of import policies.[13] It also controls the shifts of inflation rates in both China and US. In the test, to make the monthly-based series variables stationary, I de-trended $\triangle fwd$ and $gexr$, prior to regression.

Two kinds of econometric models are used in the baseline test: Probit and linear probability regression. For the latter, I add a firm-level fixed effect into the specification. The baseline result is reported in Table 3. In Table 3, all of forward premiums $\triangle fwd$, including one, three, six, nine and twelve-month forward premiums all have positive coefficients in determining the possibility of $Entry$ at time t. The annual average forward premium rate within one year $Av\triangle fwd$ positively increases entry probability according to the results. Entry probability also positively depends on growth rate of past exchange rate $gexr$. It suggests that current import decision depends not only on realized fluctuations but also expectations of future changes. The two-way trade dummy has negative coefficient, which

[13] e.g. the Chinese government had announced to release import license toward private firms during my sample period, I control such effects by adding annual dummies into my regressions.

Table 3: Baseline Regression: Entry Probability with ForwardPremium

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Probit Regression						Linear Probability Regression					
	Entry Av Fwd	Entry 1-month	Entry 3-month	Entry 6-month	Entry 9-month	Entry 12-month	Entry Av Fwd	Entry 1-month	Entry 3-month	Entry 6-month	Entry 9-month	Entry 12-month
△Fwd	0.668***	0.773***	0.848***	0.568***	0.476***	0.399***	0.446***	0.418***	0.523***	0.414***	0.364***	0.330***
	(0.0946)	(0.0781)	(0.1114)	(0.0955)	(0.087)	(0.0865)	(0.031)	(0.0247)	(0.0364)	(0.0314)	(0.0288)	(0.0286)
Exrgrowth	1.645***	2.358***	2.159***	1.373***	1.223**	1.146**	0.709***	0.994***	0.985***	0.558***	0.461***	0.420***
	(0.5262)	(0.5358)	(0.543)	(0.5216)	(0.5183)	(0.5179)	(0.167)	(0.1703)	(0.174)	(0.1647)	(0.1631)	(0.1628)
Eirm control	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Export dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm fixed effect							yes	yes	yes	yes	yes	yes
Marginal△Fwd	0.245	0.283	0.311	0.208	0.174	0.146						
N	190322	190322	190322	190322	190322	190322	190322	190322	190322	190322	190322	190322
Adj. R-sq							0.369	0.369	0.369	0.369	0.369	0.369

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

suggests the probability of import is muted for those who firms engage both export and import at the same time.

By comparing the coefficients among various forward premiums, I find that the magnitudes tend to be larger for one and three month forward premiums. But the coefficients become smaller as the time interval becomes longer, especially as the time interval exceeds six months. For example, in Probit regressions in Column 1-4, the three-month forward premium has the largest coefficient of 0.848, while it reduces to 0.399 for a twelve month forward premium.

In the right-hand side panel of Column 5-8, I find a similar pattern in the linear Probability regression. It suggests that an anticipated appreciation of domestic currency encourages more firms to start importing from abroad, and the effects are strongest for a short-run anticipation, especially for a three-month forward.

5.1.1 Alternative Tests: Dynamic Panel Regression

Let's focus on the relationship between forward premiums and the changes in the number of firms importing a same product. Since the adjustment of total number of importers is a gradual process, and tend to reach an equilibrium in long run. I use a dynamic GMM model as an alternative test for extensive margin. Also, this econometric model controls for the possible simultaneity and endogeneity problems. By following the method of Arellano and Bond (1991), I assume the regressors as endogenous and instrument them using lagged levels in the differenced equation. [14]

$$\ln Num_{pt} = \beta_1 \triangle fwd_{t,t+k} + \beta_2 gexr_t + F_p + F_t + \varepsilon_{pt} \tag{32}$$

In the specification of (32), the dependent variable is the logarithm of firm numbers (Num_{pt}) importing each variety of HS-6 product at t. The independent variables include both the forward premium $\triangle fwd_{t,t+k}$ and past exchange rate growth rate $gexr_t$.

In this dynamic panel, I add fixed effects at HS-6 product level as well as year dummy. In Table 4, I find similar patterns as the Probit and liner probability regressions. Once again the positive coefficients of forward premiums and past exchange rate changes suggest that entry decision is influenced by both realized and expectation of exchange rate fluctuations. The extensive margin responds significantly to an expected appreciation after considering for potential simultaneity and endogeneity issues.

[14] According to a Arellano-Bond test, past import variables is lagged up to three months in the regressions.

Table 4: Alternative Dynamic Regression for Extensive Margin

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm# Av Fwd	Firm# 1-month	Firm# 3-month	Firm# 6-month	Firm# 9-month	Firm# 12-month
L.Firm#	0.0489***	0.0516***	0.0485***	0.0486***	0.0488***	0.0490***
	(0.0096)	(0.0096)	(0.0096)	(0.0095)	(0.0095)	(0.0095)
L2.Firm#	0.0320***	0.0352***	0.0315***	0.0314***	0.0314***	0.0314***
	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0075)
L3.Firm#	0.0240***	0.0268***	0.0238***	0.0231***	0.0223***	0.0227***
	(0.0062)	(0.0062)	(0.0062)	(0.0062)	(0.0062)	(0.0062)
△ Fwd	0.523***	0.362***	0.649***	0.555***	0.800***	0.711***
	(0.0994)	(0.0514)	(0.1056)	(0.1275)	(0.1244)	(0.1194)
Exrgrowth	0.100***	0.119***	0.0989***	0.0966***	0.0972***	0.103***
	(0.0067)	(0.0071)	(0.0067)	(0.0065)	(0.0064)	(0.0064)
Product Fixed	yes	yes	yes	yes	yes	yes
Year Dummy	yes	yes	yes	yes	yes	yes
N	66211	66211	66211	66211	66211	66211

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Independent variables lagged for two periods are included into regression
Constants are included into all regressions
Forward premiums are annualized for all regressions

5.2 Entry Response of Import with Time Horizon

To see the time pattern of entry response, I used rolling window regression to capture different magnitude of response under various durations of anticipated appreciation. Starting from the first signal of appreciation in early 2003, I regress entry response on 12-month forward premium for every quarter from 2003 to 2006. The graph 4 describes the time pattern. The horizontal axis shows the time indicating how long an market has anticipated the appreciation. The vertical axis is entry response coefficient at different time. It shows that entry response jumps dramatically around the fourth or fifth quarter of the expected shock. Then response drops quickly and goes towards stable status in the long run. [15]

In order to test heterogeneity in import response as expected appreciation endures according to Proposition 4, which predicts that firm's response to anticipated exchange rate fluctuations diminishes in long run. I add an iteration item $\triangle fwd * duration$ into original specification as in equation (33). Specially, $duration$ is a variable to indicate how long it lasts for market anticipating the one-way appreciation (depreciation). In my sample, $duration_t$ captures the length for an lasting expected RMB appreciation in foreign exchange market. Since the market had anticipated RMB appreciation as early as February 2003, $duration_t$ measures the time duration between current time and February

[15] The initial rise of response within the first three quarters may be due to delay in transportation or uncertain of future appreciation.

Figure 4: Number of Importers from U.S.

2003.

$$\Pr(Entry = 1)_{it} = \psi[\beta_1 \triangle fwd_{t,t+k} + \beta_2 \triangle fwd_{t,t+k} * duration_t + \beta_3 x_{it} + \beta_4 gexr_t + F_t] \tag{33}$$

The interaction $\triangle fwd * duration$ is the key variable to capture the different response at different time. If firm's response really weakens as time goes by, I expect to see a negative coefficient of variable $\triangle fwd * duration$. Both annual forward premium $\triangle Avfwd$, and six-month and twelfth-month forward premium ($\triangle fwd - 6month$ and $\triangle fwd - 12month$) are employed as independent variable of forward premiums. The results is listed in Table 5. Column 1 ,3 and 5 in Table 5 apply Probit estimation, and Column 2, 4 and 6 employ a linear probability regression. Besides forward premiums and exchange rate growth rates, both of the estimation include interaction item $\triangle fwd * duration$. As a robustness corresponding to dynamic GMM test in section 5.1.1, which is lasted in Column 7,8 and 9, I regress the number of importers importing a specific HS-6 product variety on forward premium $\triangle fwd$ and the iteration item $\triangle fwd * duration$.

Note that the coefficients of $fwd * duration$ are significantly negative in Columns 1 to 6, but insignificantly negative in Column 7,8 and 9. In the tests, the effect of forward premiums on firm's entry becomes less significant than previous results. The negative coefficients of $\triangle fwd * duration$ suggests my prediction is confirmed that the effect of forward premium on import disappears as appreciation (depreciation) lasts in the long run.

Table A-1 of Appendix documents the mechanism of the above changes among different durations. Column (1) and (2) shows a positive effects for forward appreciation $\triangle Fwd$ on entry probability, which is negatively related with the number of firms within the sector. In Column (3), the predicted marginal increase of firm numbers associated with forward appreciation $\triangle \widehat{Firm\#}$, plays a negative effect on current entry probability. According to Proposition 4, since forward premium induces more firms importing, the marginal benefit of importing becomes smaller due to a reducing market share.

Table 5: Baseline Regression: Response to Forward Premium at Different Time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Probit Entry	Linear Entry	Probit Entry	Linear Entry	Probit Entry	Linear Entry	Linear Firm#	Linear Firm#	Linear Firm #
△AvFwd	0.195	0.0252					0.187***		
	(0.1815)	(0.0246)					(0.0328)		
△Fwd-6m			0.120	0.0155				0.184***	
			(0.1762)	(0.0239)				(0.0324)	
△Fwd-12m					0.400**	0.0523**			0.193***
					(0.1725)	(0.0234)			(0.0318)
△Fwd ×Duration	-0.0455***	-0.00605***	-0.0441***	-0.00587***	-0.0558***	-0.00743***	-0.00869	-0.0101	-0.0130
	(0.0062)	(0.0008)	(0.0060)	(0.0008)	(0.0061)	(0.0008)	(0.0116)	(0.0115)	(0.0118)
Exrgrowth	0.110***	0.0151***	0.118***	0.0161***	0.130***	0.0178***	0.202	0.217	0.392
	(0.0131)	(0.0018)	(0.0132)	(0.0018)	(0.0137)	(0.0019)	(0.2786)	(0.2801)	(0.2914)
Quarter Dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm fixed	yes	yes	yes	yes	yes	yes			
Product fixed							yes	yes	yes
N	150976	187225	150976	187225	150976	187225	92860	92860	92860
Adj. R-sq		0.376		0.376		0.376	0.882	0.882	0.882

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions

The extensive margin adjustment is diminishing as expected appreciation lasts for a long time, which suggests the stimulating effect of domestic currency appreciation vanishes as more new entrants start importing.

5.3 Heterogeneous Response of Extensive Margin

5.3.1 Entry Response of Import with Firm's Productivity

In proposition 3, I predict that the adjustment in extensive margin tends to be larger for firms with lower productivity. I test this prediction by adding an interaction item $\triangle fwd_t * tfp_{it}$ as an independent variable according to the following specification (34).

$$\Pr(Entry = 1)_{it} = \psi[\beta_1 \triangle fwd_{t,t+k} + \beta_2 \triangle fwd_{t,t+k} * tfp_{it} + \beta_3 x_{it} + \beta_4 gexr_t + F_t] \tag{34}$$

The specification is similar to the baseline regression, which use an entry dummy as dependent variable. The iteration item of $\triangle fwd_t * tfp_{it}$ is the key variable in the test. If the prediction that firms with lower productivity are more likely to start import is valid, the iteration item $\triangle fwd_t * tfp_{it}$ has a significant negative coefficient.

Table 6: Baseline Regression: Entry Probability and Productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Probit Entry	Probit Entry	Linear Entry	Linear Entry	Probit Entry	Probit Entry	Linear Entry	Linear Entry
△Fwd-6m	1.454***	1.563***	0.624***	0.659***				
	(0.4384)	(0.4367)	(0.1456)	(0.1447)				
△ Fwd-12m					1.304***	1.412***	0.451***	0.482***
					(0.3846)	(0.3831)	(0.1293)	(0.1285)
△Fwd×TFPols	-0.0826**		-0.0195		-0.0841**		-0.0114	
	(0.0382)		(0.0125)		(0.0335)		(0.0111)	
△Fwd×TFPop		-0.0931**		-0.0228*		-0.0944***		-0.0143
		(0.0383)		(0.0125)		(0.0335)		(0.0111)
Export Dummy	yes	yes	yes	yes	yes	yes	yes	yes
Year Dummy	yes	yes	yes	yes	yes	yes	yes	yes
Firm Fixed			yes	yes			yes	yes
N	187283	187283	187283	187283	187283	187283	187283	187283
Adj. R-sq			0.37	0.37			0.37	0.37

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions

In the test, I employ two types of TFP measurements(using both OLS and OP methods, receptively) to stand for firm's productivity, denoted by tfp_{ols} and tfp_{op} respectively. Both Probit and linear probability regression are used in the test. The results are displayed in Table 6. I find that the coefficients of interaction items $\triangle fwd * tfp$ are significantly negative for most of the tests. The results using tfp_{op} as productivity is stronger than those tests with tfp_{op}. The results are also robust for both the six-month and twelve-month forward premiums. It suggests that less productive firms respond to an expected appreciation more than those firms with high productivity, which shapes the extensive margin changes during exchange rate fluctuations.

5.3.2 Entry Response of Import with Firm's Characteristics

In this subsection, I explore the relationship between the marginal effect of the forward premium on import and firm's characteristics. As in the Propositions 6, 7 and Hypothesis 1, firms' response to expected future exchange rate fluctuations varies with fixed cost of import, external finance accessibility, ownership and location. In specification of (35), I use z_{it} to denote all firm's characteristics associated with financial status or external credit accessibility, and interact them with forward premium, i.e. $\triangle fwd * Z_{it}$. To be specific, the heterogeneous variable Z_{it} includes bank loan supply ($Loan_{it}$), liability to asset ratio($Debt_{it}$).

Further, to capture sunk cost's heterogeneity, I employ both the index of external finance dependence EFD_{pt} in Manova (2011) and a ratio of physical capital to total asset $Capital_{pt}$, as proxies for sunk cost of import. Sectors with a larger capital-labor ratio or that depend more on external financing are more likely to incur larger sunk costs of import and thus are expected to see a weaker response of entry under an expected currency appreciation.

$$\Pr(Entry = 1)_{it} = \psi[\beta_1 \triangle fwd_{t,t+k} + \beta_2 z_{it} + \beta_2 z_{it} * \triangle fwd_t + \beta_3 gexr_t + F_t] \tag{35}$$

In Table 7, the left hand side panel shows the result of the Probit regression and the right hand side shows the linear probability regression. In Column (1) and (2), the negative coefficient of $\triangle fwd * CAP$ indicates that more capital intensive sectors are less likely to react under favorable exchange rate fluctuations. Similarly, the external finance dependence interaction item $\triangle fwd * EFD$ has a negative coefficient, which suggests that more external finance dependent sectors are less likely to respond as well.

In Column (3) and (4), the interaction term with bank loan supply $\triangle fwd * Loan$ is not significant, suggesting external credit access plays little role in determining firms' response. On the other hand, the negative coefficient on the debt ratio interaction $\triangle fwd * Debt$ shows that firms with larger debt ratio have little response to future exchange rate fluctuations. It indicates that firm's financial status also influences its import response. Firms with adequate cash flow, or with smaller liability ratio tend to respond strongly to anticipated movements of exchange rate.

Hypothesis 1, indicates that firms' location and ownership structure may affect firm's response as well. In the above tests, I include location and ownership dummies, and explore their effects on marginal response of imports to changes in the forward premiums. The location dummy is an indicator

Table 7: Entry Probability with Firm's Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Probit Regression					Linear Probability Regression				
	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry
△Fwd	1.009***	0.706***	0.572***	1.287***	2.136***	0.659***	0.505***	0.418***	0.816***	1.004***
	(0.1072)	(0.1008)	(0.0958)	(0.1106)	(0.1249)	(0.0366)	(0.0337)	(0.0315)	(0.0378)	(0.0417)
△Fwd×TFP					-0.0642***					-0.0348***
					(0.0131)					(0.0045)
△Fwd×CAP	-10.01***				-1.017	-5.216***				-0.540
	(0.9627)				(1.1385)	(0.3481)				(0.4284)
△Fwd×EFD		-0.439***			0.0970		-0.250***			-0.0222
		(0.0717)			(0.0761)		(0.0261)			(0.0282)
△Fwd×Loan			-0.359		-0.109			-0.284***		0.0288
			(0.2302)		(0.2454)			(0.0919)		(0.0963)
△Fwd×Debt				-1.027***	-0.213**				-0.563***	-0.225***
				(0.0793)	(0.1074)				(0.0270)	(0.0396)
△Fwd×Coastal					-0.921***					-0.161***
					(0.0676)					(0.0394)
△Fwd×Ownership					-0.785***					-0.0887***
					(0.0322)					(0.0184)
TFPop					-0.170***					-0.0486***
					(0.0030)					(0.0035)
CAP	1.169***				0.567**	0.742***				0.214
	(0.2022)				(0.2242)	(0.1695)				(0.1728)
EFD		-0.0429***			-0.122***		0.0153			-0.0110
		(0.0144)			(0.0149)		(0.0111)			(0.0112)
Loan supply			0.130***		0.275***			0.0202		-0.0210
			(0.0444)		(0.0469)			(0.0231)		(0.0247)
Debt Ratio				0.0194	-0.125***				-0.0104	-0.0482**
				(0.0186)	(0.0221)				(0.0244)	(0.0252)
Exrgrowth	2.405***	1.696***	1.368***	2.984***	4.804***	1.128***	0.772***	0.561***	1.449***	1.911***
	(0.5413)	(0.5351)	(0.5219)	(0.5365)	(0.5688)	(0.1731)	(0.1696)	(0.1649)	(0.1718)	(0.1794)
Export Dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year Dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	183882	183882	190104	190267	182786	183882	183882	190104	190267	182786
Adj. R-sq						0.372	0.371	0.369	0.371	0.375

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions

for whether the firm locates in coastal cities or not. The coastal dummy $Coastal$ equals one if it locates in one of the coastal cities in China, and it equals zero otherwise. Trade barriers and transportation costs tend to be larger for inland firms than those located in coastal areas.

Based on China's context, a firm's ownership affects its ability to obtain external resources, e.g., bank loan or subsidies. Sate-owned firms are often labeled as "privileged group" comparing with their counter parties, e.g., domestic private firms. On the other hand, foreign invested firms are also considered as at an advantageous position for they can get external finance support from parenting firms. Hence, I combine SOEs and foreign invested firms as one group, and label them as "the privileged group". The rest of firms, namely, the domestic private firms belong to "unprivileged ones". The ownership dummy $Ownership$ equals one if it belongs "the privileged group", and $Ownership$ equals zero otherwise.

In Column (5) and (10), I include all heterogeneous characteristics, including location and ownership, into a single regression. The negative coefficient of $\triangle fwd * Coastal$ suggests that expected exchange rate appreciation has larger effects for non-coastal firms than coastal ones. Comparing with a low-barrier coastal firms, the expected exchange rate appreciation has larger marginal effects for non-coastal firms with high trade-barriers. Similarly, the negative coefficient of $\triangle fwd * Ownership$ suggests that private firms ("non-privileged group") have a larger response to forward exchange rate fluctuations than those "privileged groups". One possible reason lies in that private firms are more flexible in making trade decision and thus respond more efficiently than privileged ones.

By combining all firm level characteristics together into a single regression, I observe that some variables, such as financial status, productivity, ownership and location are of statistically significance, while the other variables, such as capital intensity, external finance dependence, become insignificant. It indicates that among all firm's characteristics, firm's financial status, productivity, ownership and location have the dominate effects that influence firm's import decision under expected exchange rate fluctuations.

5.4 Intensive Margin Regressions

In Proposition 6, I predict that the intensive margin does not respond significantly to anticipated exchange rate fluctuations. In this section, I test the changes of import volume for the existing "importer-product" bundles, i.e. intensive margin, to forward exchange rate fluctuations according to the equation of (36).

$$y_{itp} = \beta_1 \triangle fwd_{t,t+k} + \beta_2 x_{it} + \beta_3 gexr_t + F_{ip} + F_t + \varepsilon_{itp} \tag{36}$$

where the dependent variable y_{itp} is firm i's import volume from the US of product p in month t, $\triangle fwd$ is a k-month forward premium between RMB and USD at time t. I also control past exchange rate growth rate $gexr$. Also, x_{it} is a vector of firm level control variables, including the variables of firm size, and two-way trade dummy. I include fixed effects at the firm-product F_{ip} level, and add a year dummy F_t. A fixed effect linear regression is employed for the tests. I regress import value y_{itp} on various horizons of the forward premium. (including one, three, six, nine and twelve-month forward premiums and annual average forward premium $Av\triangle fwd_t$.)

Table 8: Table of Baseline regression: Intensive Margin and Forward Premium

	(1)	(2)	(3)	(4)	(5)	(6)
	△Firmvalue Av Fwd	△Firmvalue 1-month	△ Firmvalue 3-month	△Firmvalue 6-month	△Firmvalue 9-month	△Firmvalue 12-month
Av△fwd	-0.151	-0.0538	-0.0369	-0.176	-0.199*	-0.203*
	(0.124)	(0.0964)	(0.1441)	(0.1262)	(0.115)	(0.1141)
Exrgrowth	-0.00459	-0.00381	-0.00332	-0.00442	-0.00438	-0.00433
	(0.0071)	(0.0072)	(0.0073)	(0.007)	(0.007)	(0.007)
Export Dummy	yes	yes	yes	yes	yes	yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fiexed	Yes	Yes	Yes	Yes	Yes	Yes
N	190357	190357	190357	190357	190357	190357
Adj. R-sq	0.122	0.122	0.122	0.122	0.122	0.122

Robust standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

The result for the intensive margin is reported in Table 8. I find that forward premiums $\triangle Fwd$ become insignificant for most of the forward premiums, no matter for the single k-month forward premiums or the annual average forward premium. This suggests that future appreciation of domestic currency does not significantly influence import value of existing importers for there is no obvious evidence showing the adjustment of current "firm-product" bundle.

A potential reason for the unresponsiveness of the intensive margin would be due the fixed capacity of inventory for existing importers. Also, under the anticipation of fluctuations, exiting importers may even delay current imports awaiting for a more favorable price bargain in future.[16]

I also test the interaction item between forward premiums and firm's productivity following a similar approach in Section 5.1.3., and find the productive interaction item is insignificantly negative as well (See Table A-2 in Appendix Section). It indicates that there is no significant response pattern with respect to productivity. Neither kind of firms, no matter with low or high productivity, adjust import value significantly based on anticipation of future exchange rates changes.

[16]For robustness, I also use a dynamic panel regression, as those test in Section 5.1.2, to check the effect of the forward premium on import values for each product-country bundle. The result shows a similar pattern as above.

5.5 Decomposition of Intensive and Extensive Margins

Comparing my previous tests for both the extensive margin and intensive margin, I find only the extensive margin rather than the intensive margin responds significantly to future exchange rate fluctuations. In Proposition 6, I conclude that the changes of aggregate import response mainly depend on the extensive margin rather than intensive margin. In this part, using a simple calculation, I decompose aggregate changes into different margins to have a rough comparison of their contributions to aggregate changes.

According to the following equation (37), the aggregate changes of import value $\triangle import$ is decomposed to changes in firm numbers ($\triangle Num_i$), changes in product numbers ($\triangle Num_(p)$) and changes in import value per firm-product bundle ($\triangle Fimp_{ip}$). Note that the simple "back-of-the-envelope" calculation ignores the iteration effects between extensive margin and intensive margin, and only offers a rough calculation of the share for each margins.

$$\triangle import\% = \frac{\triangle Fimp_{ipt}}{Fimp_{ipt}} + \frac{\triangle Num_{pt}}{Num_{pt}} + \frac{\triangle Num_{it}}{Num_{it}} \tag{37}$$

The last three columns in Table 1 list the decomposition result of different margin's contribution to aggregate value changes. The sample period ranges from year 2002 to year 2006. The firm-level extensive margin (firm's entry) alone contributes around 70 % of the total increase in value. There is little effect of product adding to aggregate value growth, which has a share less than 5 %. The average import values per firm-product bundle is also increasing, but not as significant as firm level entry. When focusing on the average share listed at the bottom of the Table 1, and record the percentage changes it each item in equation (37) respectively. According to the calculation, among the total growth rate of 29%, increase of entry $\triangle Num_{it}$ (extensive margin at firm) counts for 74% and import value for existing firm $\triangle Fimp_{ipt}$ (intensive margin) counts for 24 %, and the rest of 2% comes from adding new products,$\triangle Num_{pt}$. In other words, the extensive margin at firm level (firms' entry) has a dominant share in the total increase of aggregate changes of import value.

Table 9: Response of Different Margins to Forward Exchange Rate

	(1)	(2)	(3)	(4)	(5)	(6)
	△value	△value	△value	△ Firm #	△ Firm#	△ Firm #
	Average Import per Firm			Number of Importers		
△ FWD3month	-0.674			0.477***		
	(2.4428)			(0.0842)		
△ FWD6month		-0.516			0.383***	
		(2.3326)			(0.0804)	
△ FWD12month			0.521			0.281***
			(1.9219)			(0.0662)
Product fixed	yes	yes	yes	yes	yes	yes
Year fixed	yes	yes	yes	yes	yes	yes
N	76033	76033	76033	76033	76033	76033

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions

After decomposition, I run a simple fixed effect regression to test how different margins respond to future exchange rate fluctuations. By treating each HS-6 digit product as a single unit, I define dependent variable as "number of firms importing each HS-6 product" to identify changes from extensive margin at firm level. On the other hand, I calculate the average import value per firm which importing each HS-6 products category, and treat it as approximate estimate for changes of intensive margin. Then I regress them on future appreciation separately to check its impact on two different margins. The Table 9 displays the results. After controlling product fixed effect and adding year dummies, the average import value per firm (intensive margin) does not show a significant coefficient, while the number of firms within each product niche responds to expected future exchange rate significantly. It servers as an empirical evidence for that changes of aggregate import mainly comes through extensive rather than intensive margin.

6 Robustness Check

6.1 Subsample: With Only Expected Future Fluctuations

There is some concern about the effect of forward exchange rates on current status may associates with current fluctuations of exchange rate. To rule out this concern, I concentrate tests on subsample without current exchange rate fluctuations. Since there is no changes in the spot exchange rate under the fixed exchange rate regime. In the robustness, I capture the interval before the real announcement of exchange rate reform, during which there is only future exchange rate fluctuations but without current exchange rate fluctuations. The sample period starts from February 2003 to July 2005. The regression includes only forward premiums and excludes changes of spot exchange rates.

The results of the robustness test is displayed below. With the subsample, the effect of current fluctuations is dropped off from the entry probability. Exchange rate fluctuations' influence on current import decision comes only through the expected future fluctuations. The Probit regression is used in robustness test. All of the forward premiums have positive coefficients of firm's entry probability, after controlling firm's size, export status and adding quarterly dummies. Also, if comparing with the baseline regression, the magnitude of forward coefficients get much larger than baseline results. The marginal effect is around 0.4, larger than the baseline coefficients approximately around 0.2. It suggests that after ruling out the effects from current fluctuations, forward expectation still have strong effects on current import decisions.

Table 10: Robustness: With Only Future Exchange Rate Fluctuations

	(1)	(2)	(3)	(4)	(5)	(6)
	entry Av Fwd	entry 1-month	entry 3-month	entry 6-month	entry 9-month	entry 12-month
△ FWD	1.328*** (0.0986)	0.977*** (0.0938)	1.208*** (0.1073)	1.277*** (0.097)	1.289*** (0.091)	1.268*** (0.085)
marginal △ FWD	0.483	0.355	0.439	0.465	0.469	0.461
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
Export Dummy	yes	yes	yes	yes	yes	yes
Quarterly Dummy	Yes	Yes	Yes	Yes	Yes	Yes
N	113843	113843	113843	113843	113843	113843

* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

6.2 Subsample: With Only Ordinary Trade Sample

A unique feature of Chinese import is that a large portion of import belongs to a part of global value chain, according to Manova and Yu (2012). There are two types of global value chain trading: pure assembly and processing. Under the former regime, they receive foreign inputs from trade partner without payment, to who send final products after assembling; while under the latter regime, the Chinese exporters pay to purchase imported intermediate inputs, and sell out the final products.

Since processing trade takes a large portion of China total import value, especially during the sample period. If importers engages in export at the same time, their response to an expected currency fluctuation may offset by an opposite effect exerting on exporting. It is doubtable that importers engaging in processing trade (or assembling trade) may respond in a different way predicted in the model. To rule out this concern, I have a robust check by excluding processing trade observations and focus on pure ordinary trade sample.

The categorizing of ordinary trade and processing trade are conducted at transactional level. By dropping translations that belongs to processing (including assembling trade), my sample shrinks to 60 percent of original size. Using ordinary trade sample, the extensive margin response is robust, and I confirm my predictions for extensive margin respond to expectations of exchange rate fluctuations.

Table 11 shows the result in the test. Similar to previous baseline regression, I employ both a Probit regression and linear probability regression to test the effect of forward premium on entry probability. Once again both k-month forward premiums and the annual average forward premium are of significant and positive coefficients. By comparing results of ordinary trade sample with that of full sample, the magnitude of coefficients for ordinary trade are larger than that of full sample, indicating that the predictions are stronger for ordinary trade sample.

Table 11: Robustness: Ordinary Trade Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Probit						Linear Probability					
	Entry Av Fwd	Entry 1-month	Entry 3-month	Entry 6-month	Entry 9-month	Entry 12-month	Entry Av Fwd	Entry 1-month	Entry 3-month	Entry 6-month	Entry 9-month	Entry 12-month
△ Fwd	0.992***	0.859***	1.276***	0.940***	0.816***	0.746***	0.606***	0.500***	0.737***	0.586***	0.515***	0.479***
	(0.1141)	(0.0948)	(0.1341)	(0.1151)	(0.1047)	(0.1040)	(0.0394)	(0.0319)	(0.0460)	(0.0398)	(0.0364)	(0.0361)
Exrgrowth	2.888***	3.372***	3.668***	2.577***	2.351***	2.270***	1.304***	1.550***	1.718***	1.125***	0.988***	0.942***
	(0.6421)	(0.6540)	(0.6611)	(0.6367)	(0.6329)	(0.6325)	(0.2177)	(0.2222)	(0.2261)	(0.2150)	(0.2131)	(0.2127)
Export Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed							Yes	Yes	Yes	Yes	Yes	Yes
Marginal △Fwd	0.381	0.330	0.489	0.361	0.313	0.286						
Marginal △Exr	1.102	1.287	1.402	0.983	0.896	0.865						
N	127244	127244	127244	127244	127244	127244	127244	127244	127244	127244	127244	127244
adj. R-sq							0.381	0.381	0.382	0.381	0.381	0.381

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

Also, I check the intensive margin using the subsample of ordinary trade. The result is displayed in Table 12. However, forward premiums have an either insignificant or negative effect on intensive margin of import, which is similar to results using full sample. [17] Still, aggregate increase of ordinary trade corresponding to an expected currency appreciation mainly comes from new entrants rather than increase of import value of existing importers.

Table 12: Robustness: Intensive Margin and Forward Premium for Ordinary Trade

	(1)	(2)	(3)	(4)	(5)	(6)
	△Firmvalue Av Fwd	△Firmvalue 1-month	△ Firmvalue 3-month	△Firmvalue 6-month	△Firmvalue 9-month	△Firmvalue 12-month
△Fwd	-0.209	-0.0940	-0.162	-0.259	-0.231	-0.217
	(0.1623)	(0.1288)	(0.1892)	(0.1647)	(0.1499)	(0.1485)
Firm Control	yes	yes	yes	yes	yes	yes
Export Dummy	yes	yes	yes	yes	yes	yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fiexed	Yes	Yes	Yes	Yes	Yes	Yes
N	127253	127253	127253	127253	127253	127253
Adj. R-sq	0.154	0.154	0.154	0.154	0.154	0.154

Robust standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

6.3 Import Response by Groups

As a robustness check, to further investigate the heterogeneous response to forward exchange rate, I separate the full sample by firm's characteristics, e.g. productivity and size, to explore the marginal response. These regressions parallel to those regressions with interaction items with productivity and size. By comparing coefficients for each group, I aim to illuminate the heterogeneity in trade response to expected exchange rate fluctuations.

The result is shown in Table 13. I divided the full sample into three groups according to importers' size and productivity. According to size or productivity percentile, those groups are labeled as small, medium or large respectively.

After controlling product fixed effects and firm fixed effects, I find that both small and medium size groups have larger responses to both forward expectation and current exchange rate growth. The large size group responses only to lagged exchange rate fluctuations, but not to forward exchange rate fluctuations. Similarly, when it comes to productivity, only less productive group respond significantly to forward exchange rate changes, firms with larger productivity have little response.

[17] I test response of intensive margin with productivity as well (see Table A-2 in Appendix.), and find that there are no significant response from less-productive or more-productive firms in term of intensive margin. In other words, there is no pattern for productivity heterogeneity for intensive margin.

Table 13: Import Response by Groups

	(1)	(2)	(3)	(4)	(5)	(6)
	Size Small	Size Medium	Size Large	TFPop Small	TFPop Medium	TFPop Large
Av△fwd	0.0260***	0.0410***	0.0117	0.0383***	0.0006	0.0074
	(0.0087)	(0.0087)	(0.0125)	(0.0086)	(0.0081)	(0.0074)
Exgrowth	0.0234***	0.0234***	0.0214***	0.0241***	0.0174***	0.0325***
	(0.0419)	(0.0049)	0.0045	(0.0048)	(0.0050)	(0.0052)
Export Dummy	0.0023	-0.0053	-0.05635	-.0774***	-0.0412	0.0860***
	(0.0419)	(0.0331)	(0.0344)	(0.0253)	(0.0284)	(0.0331)
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Product Fixed	Yes	Yes	Yes	Yes	Yes	Yes
N	191375	263758	296544	247911	244070	259696
Adj. R-sq	0.6764	0.644	0.6425	0.6983	0.6526	0.6005

Robust Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions

This results support the proposition that less productive firms have a larger marginal adjustment in term of extensive margin to foreseen exchange rate fluctuations. The small size firms or low productive firms shape the changes of extensive margin significantly.

7 Conclusion

Our study provides a channel for the way that expectations of exchange rate fluctuations influences firms' decision to import. Using China's Customs data which covers the transit period with exchange rate reform, I quantitatively investigate how firms respond to changes in market expectations of exchange rates. A "forward looking" dynamic exists when firms make import decision. Its "forward looking" effect is as important as realized or past exchange rate fluctuations. I find import changes along the extensive margin, i.e., entry or exit of firms. The adjustment shows an obvious time pattern and disappears in the long run. The most sensitive importers are those with lower productivity. Also, I find firm's debt ratio and finance accessibility, ownership and location affect firm's response to future exchange rate fluctuations.

Our work is highly related with those studies that are seeking "micro-foundation" to aggregate level changes, e.g. elasticity of exchange rate changes. It offers a new mechanism of entry response with the existence of sunk cost under a dynamic setting. Also, firm level analysis offers richer information for explaining puzzling patterns, e.g., incomplete exchange rate pass-through and in-elasticity of trade volumes.

Further more, it offers implications to evaluate the consequences of exchange rate reform. Not only realized changes impact trade, but expected future ones could also play a role, and the effect may disappear in the long run. If taking into account market expectation, as well as the duration of expected shock, the actual adjustment of trade under the policy change be varying from original prediction.

Finally, according to my results, the most significant response comes from extensive margin at firm level rather than intensive margin. What does this "extensive-margin dominant" pattern imply for productivity or welfare change? How does it contribute to the aggregate changes? These questions are also left for future research.

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APPENDIX1

To prove Lemma 1, I start from define two cut-off exchange rate under the above two scenarios. There are two cut-off exchange rates for importers and non-importer at $t-1$. Under the first scenario, for those existing importers with a value function of $V_{imp}(e)$, I define a cut-off exchange rate e^{**} as follow.

$$\exists e^{**}, \text{ s.t.} \forall e > e^{**}, \text{ importer at } t-1 \text{ still imports at } t$$

$$\forall e \leq e^{**}, \text{ importer at t-1 stops importing at } t$$

Similarly, under the second scenario, if firm i had not been importing at $t-1$ (with a value function $V_{non}(e)$), there exists a cut-off exchange rate e^* for them.

$$\exists e^*, \text{ s.t.} \forall e > e^*, \text{ non-importer at } t-1 \text{ starts to import at } t$$

$$\forall e \leq e^*, \text{ non-importer at } t-1 \text{ still does not import at } t$$

Let's explore the two cut-off exchange rates e^{**} and e^*, I can verify that $e^{**} < e^*$.[18] For existing importers at $t-1$, there comes the following equation at the cut-off exchange rate e^{**}.

$$\pi_{imp}(e^{**}) + \beta EV_{imp}(\bar{e}|e^{**}) \geq \pi_{non} + \beta EV_{non}(\bar{e}|e^{**}) \tag{38}$$

Since $P_{xi} = (1 + P_{Mi}^{\frac{\rho}{\rho-1}})^{\frac{\rho-1}{\rho}} < 1$, the profit of production with imported intermediate inputs is strictly higher than the profit without import, i.e. $\pi_{imp} > \pi_{non}$. Also, since $e^{**} < e^*$ and the existence of fixed cost of import F_{imp}, non-importers at $t-1$ do not import under the exchange rate of e^{**}. So I can prove that $V_{imp}(e^{**}) \geq V_{non}(e^{**})$ and $EV_{imp}(\bar{e}|e^{**}) \geq EV_{non}(\bar{e}|e^{**})$. Hence, I get $\pi_{imp}(e^{**}) \geq \pi_{non}$ at cut-off exchange rate e^{**}.

Let's explore the first possibility, i.e. $\pi_{imp}(e^{**}) + \beta EV_{imp}(\bar{e}|e^{**}) = \pi_{non} + \beta EV_{non}(\bar{e}|e^{**})$. However this contradicts my assumption of $P_{Xi} < 1$. Without fixed cost F_{imp}, to import is always a dominate strategy over non-import for those who have already begun importing previously at $t-1$. Hence, the only possibility is that profit of importing is strictly larger than non-importing. In this case, for existing importers, the equation $\pi_{imp}(e_t) + \beta EV_{imp}(\bar{e}|e) > \pi_{non} + \beta EV_{non}(\bar{e}|e)$ always holds. It means that existing importer never drop out of importing as long as imported inputs is less expensive than domestic inputs.

[18] This can be obtained by comparing with two indifference conditions: $\pi_{imp}(e^{**}) + \beta EV_{imp}(\bar{e}|e^{**}) = \pi_{non} + \beta EV_{non}(\bar{e}|e^{**})$ and $\pi_{imp}(e^*) + \beta EV_{imp}(\bar{e}|e^*) - F_{imp} = \pi_{non} + \beta EV_{non}(\bar{e}|e^*)$.

APPENDIX2

Aggregate import value can be decomposed into extensive margin and intensive margin. The response to future exchange rate can also be decomposed into extensive margin and intensive margin as in equation of (A-1).

$$X = \int_{A^*}^{\infty} M_i dG(A_i)$$

$$\frac{d\ln X}{d\ln \bar{e}} = -\frac{\partial X}{\partial \bar{e}}\frac{\bar{e}}{X} = \frac{\bar{e}}{X}\int_{A^*}^{\infty} \frac{\partial M_i}{\partial \bar{e}} dG(A_i) - \frac{\bar{e}}{X} M_i G^{'}(A_i) \frac{\partial A_i^*}{\partial \bar{e}} \tag{A-1}$$

According to the right hand side of (A-1), the first item is intensive margin response and the second is extensive margin. I explore them respectively as below.

$$\frac{d\ln X}{d\ln \bar{e}} = \frac{dexts}{d\ln \bar{e}} + \frac{dints}{d\ln \bar{e}} \tag{A-2}$$

1) Extensive margin response to future exchange rate changes corresponds to the indifference condition in (16)

$$A_i^{*\rho-1}[(P(e)_x^{\mu})^{1-\rho} - (P_d^{\mu})^{1-\rho}] = F_{imp} - \beta[EV_{imp}(\bar{e}|e) - EV_{non}(\bar{e}|e)]$$

Let's define the elasticity of cut-off productivity to future exchange rate $\bar{e}$ to be ζ.

$$\frac{d\ln A_i^*}{d\ln \bar{e}} = \frac{\bar{e}}{A_i}\frac{\partial A_i^*}{\partial \bar{e}} \equiv \zeta, \text{ where } \zeta < 0$$

Also, I assume distribution of productivity follows Pareto distribution as below.

$$G(A_i) = 1 - A_i^{-\vartheta}$$

$$G^{'}(A_i) = \vartheta A_i^{-\vartheta-1}$$

Thus, the extensive margin becomes

$$-\frac{\bar{e}}{X} M_i G^{'}(A_i) \frac{\partial A_i^*}{\partial \bar{e}} = \frac{\bar{e}}{X} M_i \vartheta A_i^{-\vartheta-1} \zeta \frac{A_i}{\bar{e}} = \frac{\zeta}{X}\vartheta X = |\zeta\vartheta| \tag{A-3}$$

Thus the extensive margin (first item of A-2) is strictly positive.

2) Intensive margin response to future exchange rate could be obtained by solving the firm i's optimal chose of imported intermediate input M_i. There are two cases: i) If output of production is fixed per period due to contract or fixed production capacity, the optimal choice of M_i is obtained by solving cost minimization problem. Firm i chooses between the optimal composition of domestic

input Z_i and imported input M_i to produce one unit of output.

$$\underset{Z,M}{m}in[P_{zi}Z_i + P_{Mi}M_i]$$

$$s.t.[Z_i^\rho + M_i^\rho]^{\frac{1}{\rho}} = 1$$

Solving the cost minimizing problem yields the optimal input of imported intermediate input M_i^* as in (A-4).

$$M_i^* = (1 + P_{Mi}(e)^{\frac{-\rho}{\rho-1}})^{\frac{-1}{\rho}} \tag{A-4}$$

If I define the expenditure on imported intermediate input as x_i, i.e. intensive margin, and it follows

$$x_i(e) = (1 + P_{Mi}^{\frac{-\rho}{\rho-1}})^{-\frac{1}{\rho}} P_{Mi}(e) \tag{A-5}$$

Thus intensive margin only depends on current exchange rate e, but does not respond to future exchange rate $\bar{e}$, that is $\frac{\partial M^*}{\partial \bar{e}} = 0$

(ii) When firm can choose production output flexibly between periods, it can adjust output quantity according to production cost between periods. Firms choose the optimal optimal input of Y_i (that is M_i)by allocation output for each period depending on cost fluctuations over the all periods. Firm i chooses output to maximize lifetime profit subject to expenditure constraint.

$$\max_{Y} \pi_t + \beta\pi_{t+1} + \beta^2\pi_{t+2} + ... + \beta^k\pi_{t+k} \tag{A-6}$$

The ratio between domestic and imported input always follows the equation of

$$\frac{Z}{M} = (\frac{p_Z}{p_M})^{\frac{1}{\rho-1}} \tag{A-7}$$

Firm subjects to a expenditure constraint: the expenditure on total intermediate inputs should not exceed income M.

$$\sum_{k=0}^{k} P_{M,t+k}M_{t+k} + Z_{t+k} = W \tag{A-8}$$

By inserting equation A-7, the constraint becomes

$$\sum_{k=0}^{k} M_{t+k}(P_{M,t+k} + P_{M,t+k}^{\frac{-1}{\rho-1}}) = W \tag{A-9}$$

Let's write profit function of output Y, which is a production function of inputs.

$$\pi = \frac{1}{\delta}[(A_iK_i^\alpha L_i^{1-\alpha})^{1-\mu}X_i^\mu]^{\frac{\delta-1}{\delta}} \tag{A-10}$$

Also, intermediate input bundle follows the equation

$$X_i = [Z^\rho + M^\rho]^{\frac{1}{\rho}} = M[1 + P_M^{\frac{-\rho}{\rho-1}}]^{\frac{1}{\rho}} \tag{A-11}$$

If we ignore capital input K and labor input L for convenience, profit function becomes function of imported intermediate input M.

$$\pi = S(A_i)M^{\tau}h(P_M) \tag{A-12}$$

$$where\ h(P_M) = (1 + P_M^{\frac{-\rho}{\rho-1}})^{\frac{\mu}{\rho}\frac{\delta-1}{\delta}} \tag{A-13}$$

$$\tau = \mu\frac{\delta-1}{\delta}s(A_i) = A_i^{\tau\frac{1-\mu}{\mu}} \tag{A-14}$$

Hence, it becomes to maximize profit flow over the whole periods by choosing optimal imported intermediate input M, that is

$$\max_M S(A_i)M_t^{\tau}h(P_{M,t}) + \beta S(A_i)M_{t+1}^{\tau}h(P_{M,t+1}) + \beta^2 S(A_i)M_{t+2}^{\tau}h(P_{M,t+2}) + ... + \beta^k S(A_i)M_{t+k}^{\tau}h(P_{M,t+k}) \tag{A-15}$$

$$s.t. \sum_{k=0}^{k} M_{t+k}(P_{M,t+k} + P_{M,t+k}^{\frac{-1}{\rho-1}}) = W \tag{A-16}$$

By f.o.c., we have

$$(\frac{M_t}{M_{t+k}})^{\tau-1} = (\frac{P_{M,t}}{P_{M,t+k}})[\frac{P_{M,t+k}^{\frac{\rho}{\rho-1}} + (\frac{P_{M,t}}{P_{M,t+k}})^{\frac{-\rho}{\rho-1}}}{1 + P_{M,t+k}^{\frac{\rho}{\rho-1}}}]^{\frac{\tau}{\rho}+1},\ \text{where } 0 < \tau < 1 \tag{A-17}$$

It states the ratio between current imported intermediate input and future input $\frac{M_t}{M_{t+k}}$ negatively depends on ratio of current price to future price $\frac{P_t}{P_{t+k}}$. When future price P_{t+k} reduces due to future appreciation, the rising ration of $\frac{P_t}{P_{t+k}}$ affects the weight allocates to current output (imported intermediate input), i.e. M. Thus current imported intermediate input M_t reduces, it offers a channel for future exchange rate fluctuation to affect current import value of input, that is

$$\frac{dM_t}{d\bar{e}} \le 0 \tag{A-18}$$

Thus the intensive margin (second item of A-2) is zero or negative.

Over all, by combining 1) and 2) together, aggregate import value elasticity to forward expected exchange rate becomes $\frac{d\ln X}{d\ln\bar{e}} \le \frac{dexts}{d\ln\bar{e}}$. If marginal effect of aggregate import value to future exchange rate is positive, it must mainly comes through effect of extensive margin,i.e. $\frac{dexts}{d\ln\bar{e}}$, rather than intensive margin,i.e. $\frac{dints}{d\ln\bar{e}}$.

APPENDIX3

Let's start from a simplest case with identical firms within the sector, each firm sets a uniform price level of p_i, the following equation hold.

$$P_s = N^{\frac{1}{1-\delta}} p_i \tag{A-19}$$

$$p_i = \frac{\sigma}{\sigma - 1} C_i \tag{A-20}$$

$$S_i = \frac{1}{N} \tag{A-21}$$

$$\sigma_i = \delta + \frac{1}{N}(\eta - \delta) \tag{A-22}$$

Since profit of production for importers follows 21

$$\pi = \frac{1}{\sigma - 1}(\frac{\sigma}{\sigma - 1})^{-\delta} C_i^{1-\delta} P_s^{\delta-\eta}$$

Combining all the above equations of (A-19), (A-20) and (A-21) into profit function (A-22), I have

$$\pi^{imp} = [\delta + \frac{1}{N_{imp}}(\eta - \delta)]^{-\eta}[\delta + \frac{1}{N_{imp}}(\eta - \delta) - 1]^{\eta-1} N_{imp}^{\frac{\delta-\eta}{1-\delta}} C_{i,imp}^{1-\eta} \tag{A-23}$$

Comparing it with non-import state

$$\pi^{non} = [\delta + \frac{1}{N_{non}}(\eta - \delta)]^{-\eta}[\delta + \frac{1}{N_{non}}(\eta - \delta) - 1]^{\eta-1} N_{non}^{\frac{\delta-\eta}{1-\delta}} C_{i,non}^{1-\eta} \tag{A-24}$$

The marginal profit through import, which is the difference of profit between import and non-import(difference of equation (A-23) and (A-24)), depends only on the number of firms N. Also, the marginal profit of import, i.e. $\pi_{imp} - \pi_{non}$, decreases with N, i.e. the number of firms within the sector.

Since the number of firms within sector s, N, is a decreasing function of cut-off productivity A^*. Initially, during domestic currency appreciation, the cut-off productivity level A^* reduces, more firms with lower productivity enter the sector, leading N increases. However, in the long run, profit generating from importing (π_{imp}) decreases with the rising number of incumbent firms N in the market. Due to less profitable to start import (smaller of $\pi_{imp} - \pi_{non}$), less productive importers can not survive in the market any further, which drives down the number of new entries. Hence, the number of importers within the sector approaches an equilibrium state in the long run.

In a more general case with heterogeneous firms within one sector, production profit becomes

$$\pi = [\delta + S_i(\eta - \delta)]^{-\delta}[\delta + S_i(\eta - \delta) - 1]^{\delta-1} C_i^{1-\delta} P_S^{\delta-\eta} \tag{A-25}$$

I can prove under the sufficient condition that $\delta >> \eta$, profit is decreasing when S_i and sector

Table A-1: Entry Decision and Time Horizons of the Shock

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry
	3-month forward			6-month forward			9-month forward		
$\triangle$ Fwd	0.847***	0.837***		0.568***	0.558***		0.400***	0.392***	
	(0.1102)	(0.1103)		(0.0946)	(0.0947)		(0.0857)	(0.0858)	
Firm#		-0.0484***			-0.0484***			-0.0485***	
		(0.0021)			(0.0021)			(0.0021)	
$\triangle \widehat{Firm}\#$			-1.955***			-2.650***			-3.713***
			(0.1964)			(0.2931)			(0.4775)
Firm fixed	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	190402	190402	153734	190402	190402	153734	190402	190402	153734

* p<0.10, ** p<0.05, *** p<0.01
Constants are included in all regressions
Forward premiums are annualized for all regressions

price level P_s become smaller. The market share of importers, $S_{i,s} = (\frac{P_{i,s}}{P_s})^{1-\delta}$, reduces as more firms start to import in the long run. Also, sector price level p_s also decreases due to decrease of average production cost using imported intermediate inputs.

Insert S_i into the equation, the profit equation π (including both π^{imp} and π^{non}) is function of p_s and p_i.

$$\pi = P_s^{1-\eta}[\delta P_s^{1-\delta} + (\eta - \delta)P_i^{1-\delta}]^{-\delta}[(\delta - 1)P_s^{1-\delta} + (\eta - \delta)P_i^{1-\delta}]^{\delta-1}C^{1-\delta} \tag{A-26}$$

When the individual firm's price P_i is close to sector price level P_s, the profit equation becomes

$$\pi = \eta(\eta - 1)P_s^{\delta-\eta}C^{1-\delta} \tag{A-27}$$

$$\pi^{imp} - \pi^{non} = \eta(\eta - 1)P_{s,imp}^{\delta-\eta}C_{imp}^{1-\delta} - \eta(\eta - 1)P_{s,non}^{\delta-\eta}C_{non}^{1-\delta} \tag{A-28}$$

With the same logic, as more entrants with imported goods during domestic currency appreciation, the market share of importer becomes smaller, and the marginal profit of import $\pi_{imp} - \pi_{non}$ decreases in the long run. It is less attractive to import when the appreciation lasts in the long run than in the beginning. Thus there is less firms start importing under an expected currency appreciation in the long run than in the short run.

Table A-2: Forward Premium and Firm's Productivity for Intensive Margin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue	ΔFirmvalue
△ AvFwd	0.179*	0.0349								
	(0.1049)	(0.1091)								
△ Fwd3M			0.126	-0.0179						
			(0.1012)	(0.1052)						
△ Fwd6M					0.191*	0.0373				
					(0.1126)	(0.1150)				
△ Fwd9M							-0.00391	-0.150*		
							(0.0854)	(0.0853)		
△ Fwd12M									0.0313	-0.165
									(0.1268)	(0.1283)
Exgrowth	0.0273	0.0495	0.0282	0.0518	0.0307	0.0515	0.0501	0.0710**	0.0440	0.0664*
	(0.0354)	(0.0351)	(0.0357)	(0.0354)	(0.0345)	(0.0348)	(0.0325)	(0.0328)	(0.0340)	(0.0342)
Export dummy	-0.0398	-0.0630	-0.0448	-0.0587	-0.0482	-0.0633	-0.0397	-0.0409	-0.0397	-0.0404
	(0.0607)	(0.0681)	(0.0606)	(0.0677)	(0.0602)	(0.0672)	(0.0583)	(0.0639)	(0.0583)	(0.0639)
Fwd×TFPop	-0.0146		-0.0117		-0.00990		0.00341		0.00172	
	(0.0092)		(0.0088)		(0.0099)		(0.0076)		(0.0113)	
Bwd×TFPop	-0.00233		-0.00232		-0.00275		-0.00443		-0.00394	
	(0.0031)		(0.0032)		(0.0031)		(0.0029)		(0.0030)	
Fwd×TFPlp		-0.000192		0.00245		0.00456		0.0167**		0.0201*
		(0.0095)		(0.0091)		(0.0100)		(0.0075)		(0.0113)
Bwd×TFPlp		-0.00497		-0.00508*		-0.00525*		-0.00685**		-0.00652**
		(0.0030)		(0.0031)		(0.0030)		(0.0029)		(0.0030)
TFPop	0.126		0.178***		0.209***		0.272***		0.264***	
	(0.0787)		(0.0674)		(0.0683)		(0.0555)		(0.0665)	
TFPlp		0.176**		0.203***		0.217***		0.250***		0.266***
		(0.0835)		(0.0718)		(0.0714)		(0.0579)		(0.0690)
N	43574	35045	45145	36323	45803	36859	48343	38882	48343	38882
Adj. R-sq	0.582	0.575	0.580	0.573	0.578	0.571	0.575	0.568	0.575	0.567
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS product Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust Standard errors in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.01$