Expected Exchange Rate Movement and Forward-Looking Importers *

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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. This finding 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 the 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 persists, 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; these responses are related to their access to credit and other firm-level characteristics. 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 the sunk costs in explaining firm-level decisions to participate in international trade. The presence of sunk costs suggests that firms would take into account their expectations of future conditions when making 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 disaggregated transaction level Customs data of Chinese imports from the United States between 2000 and 2006. Over this period, rapid growth in the aggregate import value was driven by a dramatic increase in the number of importers. During much of this period, the exchange rates between US dollars (USD) and Renminbi (RMB) were fixed. However, beginning in 2003, forward rates began observably appreciating in anticipation of future currency reform. Using the forward premium between USD and RMB as a proxy for the expectation of future exchange rate appreciation, we 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 was 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 type of crisis. In general, because China had a closed capital account during this period, the forward premium on exchange rates had little impact on domestic financial conditions relative to its impact 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 context

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 our empirical work, we 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 decisions. 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 domestic currency appreciates in the future. The sunk costs of importing can only be recovered for marginally productive firms if domestic currency value appreciates in the future. The expected appreciation induces more firms to start importing if the expected benefits surpass the sunk costs of importing. In such a way, the expectation of future exchange rate changes plays a role in current trade decisions, especially with substantial sunk costs of importing. However, import values for the existing importers depend largely on current exchange rates rather than future expectations. Thus, the "forward-looking" nature of the model influences importing primarily through the extensive margin rather than the 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 shrink as each additional firm enters, and the import response 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 a heterogeneous impact from expected exchange rate fluctuations on current entry probabilities depending on firm productivity, external credit accessibility and the size of sunk costs.

Empirically, to test model predictions, we 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. We 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 decisions. 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 using 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 values for existing importers. Additionally, following the approach of Bernard et al. (2007), we further decompose the total changes in import values into changes along the extensive and intensive margins respectively. The number of importers (i.e., extensive margin) responds significantly to forward exchange rate appreciation, 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. The interaction of forward premiums with firm productivity measurements shows 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 result 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 the 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 low sunk costs and adequate finances are more likely to react under exchange rate movements. However, financially constrained firms face larger barriers, especially those within the sectors depending heavily on external financing. By merging the import transaction data with firms' balance sheet data, we 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, the paper shows that productivity and location are the predominant factors determining the magnitude of the response. 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 that the results are not driven by the importance of the processing trade in China. To rule out noise from firms engaging in "two-way" trade,[2] We test the model predictions based on a pure ordinary trade sample after excluding all transactions related to "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.

Our study is related to five strands of the literature. First, it contributes to the vast literature in international trade that explains heterogeneous firm-level participation in international trade in the presence of sunk costs. The representative work is Melitz (2003) and the 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 the intensive and extensive margins (where the intensive margin infers trade volume per firm and the extensive margin refers to the 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,

[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 the assembling or processing trade with imported intermediate inputs.

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

Secondly, this paper is closely related to those studies exploring explanations for the "inelasticity" of trade responses (in term of both quantity and price) to exchange rates fluctuations, e.g., Dong (2012) and Devereux and Engel (2002). This paper is especially close to those seeking "micro-foundations" with heterogeneous firms to explain "inelasticity" patterns observed at an 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 "inelasticity" of prices (or volume) adjustments to exchange rates changes. By adding a forward-looking aspect to firms' import decisions, our study contributes a new element to the "micro-foundation" literature in that it helps to explain the "inelasticity" of trade response to current exchange rates at the disaggregate level.[3] Our 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, this paper relates to the literature in international macroeconomics that 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 the sales decision of the representative firm under future changes of currency value. Our study borrows this "forward-looking" nature, and introduces it into the new trade theory. It shows that a "backward and forward looking" nature also exists for firm's trade decisions under expected fluctuations, a previously unexplored topic. This study displays a different mechanism for future expectations on contemporaneous export decisions upon a heterogeneous-firm framework.

Fourth, our 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 to disaggregate level analysis using China's Customs data, e.g., Tang and Zhang (2012) and Li et al. (2012). However, few of these studies tackle the import side and our study fills in this gap with firm-level analysis.

Last, this paper is also related to models addressing firms' 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 find that aggregate-level variables, such as import (export) price or 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 rates to import prices is documented for major developed countries in Campa and Goldberg (2005) and Hooper, Johnson and Marquez (1998), and the pass-through coefficient has declined 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 the data and measurements and offers a short description of changes in imports. Section 5 presents the empirical tests and results for the extensive margin, the intensive margin response and the marginal response with firms' characteristics. Section 6 provides some robustness checks and Section 7 concludes.

2 Model

2.1 Production Side

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

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

Given 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 of 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 is as follows:

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

Let us consider exchange rates; the cost of the foreign intermediate input bundle is dominated by the domestic currency exchange rate e,[4] where e is the price of domestic currency in terms 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 are assumed to be less expensive than domestic inputs Z_i, the intermediate input bundle is always less than one if firm i imports.

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

[4]For simplicity, we use the representative foreign exchange rate e to denominate all foreign intermediate input, even if the firm imports multiple products.

In this way, an appreciation of local currency represents a decrease in the cost of imported intermediate inputs, and hence a decrease in the cost of the intermediate inputs bundle given firm i decides to import. [5]

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

For simplicity, we assume that the imported varieties are homogeneous with a uniform price of P_{Mi}, and the quantity of each imported variety is consequently M_i. By minimization production cost, the 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. Because 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 the firm's import status. The production cost of firm i can be simplified as (7):

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

2.2 Market Demand and Production Profit

Firms engage in monopolistic competition in the market. The demand function for firm i is as 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, the 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, the profit of firm i depends on its productivity A_i as well as its importing status. Thus, under an domestic currency appreciation, for firms using imported intermediate inputs, there is

$$\frac{\partial \pi_i}{\partial e} > 0, \text{if firm } i \text{ imports}$$

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

2.3 Import Decision: A General Case

In the following section, we show that firm i makes its import decision depending on both the current exchange rate e and the future exchange rate $\bar{e}$. Firstly, we define two scenarios based on the firm's previous import status in $t-1$. One scenario is that firm i had already been an importer at $t-1$, and takes a value function with the form of $V_{imp}(e)$ at time t. The other scenario is defined as follows: if the firm had not imported at $t-1$, its value function takes the form of $V_{non}(e)$. If firm i under the second scenario decides to start importing at t, it pays for an initial sunk cost F_{imp} to start importing. For both scenarios, firm i can generate a profit of π_{imp} if it imports at t, while it generates a profit of π_{non} if it does not.

Following this 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 from choosing import or not at time t, and take the form of (11) and (12), respectively.

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

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

To generalize the change patterns of the future exchange rate, we assume that the expected future exchange rate fluctuation follows an 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 random white noise, and θ_t is the expected appreciation/depreciation speed at time t. Under this assumption, θ_t is a key parameter governing the expectation for future changes.

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

For convenience, we use the first regime as the setup for the model, i.e., $\theta > 0$ and $e_t > e_{t-1}$, which corresponds with an anticipated domestic currency appreciation. The model predictions under other regimes, e.g., depreciation and equilibrium fluctuations, could be derived following a similar approach. Combining equation (3) and (10), we can verify that $\frac{\partial[\pi_{imp}(e) - \pi_{non}]}{\partial e} > 0$, and the marginal profit of imports increases as domestic currency appreciates. Under a lasting one-way appreciation regime,

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

importing becomes more attractive for producers.

First, let us focus on the group of existing importers. Lemma 1 predicts the import decision for those who had already imported at $t-1$; the proof is attached in Appendix 1.

Lemma 1. *Under the expected appreciation regime, importing is always a dominant strategy at t for existing importers who had imported at* $t-1$.

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

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

According to Lemma 1, the 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 costs for importing, we can verify that $V_{non} = \pi_{non} + \beta EV_{non}$ always holds. [7] Combining these functions in 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 in value between importing and non-importing depends on the series of future marginal benefit from importing over non-importing, which is 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, the future marginal profit of importing is increasing with the 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 for the expected future exchange rate $\bar{e}_{t+n}$. Because under this assumption, the exchange rate evolves according to $\bar{e}_{t+1} = e_t + \theta_t(e_t - e_{t-1}) + \epsilon_t$, 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 the current import decision through the expected future marginal benefit of importing versus non-importing.

[7] To determine the value function of V_{non}, we 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 that $F_{imp} \leq \frac{\pi_{imp} - \pi_{non}}{1-\beta}$.

[8] Actually, the marginal benefit of importing 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 section, for simplicity, we use an identical θ_t to represent θ_{t+n}, the anticipated future exchange rates.

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

For non-importers in time $t-1$, by inserting the explicit profit function (10), the cut-off productivity A^* can be pined down for the non-importing group at $t-1$, which solves 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 the previous subsection, it follows that $EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e^*)$ is an increasing function of both the current exchange rate e and the expected future exchange rate $\bar{e}_{t+n}$. Hence, the left hand side of (16) is an increasing function of 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 productivity A_i on its import decision. Hence, under a 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 ($\theta > 0$), the anticipation of future exchange rate movement discourages firm from importing, i.e., through the adjustment of the extensive margin. Namely, e_t initially begins to decrease, i.e., $e_t < e_{t-1}$, and we obtain the following:

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

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

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

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

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

2.3.2 Long Run Effect: Finite Firms Exist Within A Sector

This section focuses on the long-run adjustment of the extensive margin when there are a finite number of firms within a sector. Based upon a similar setting in Atkeson and Burstein (2008), we assume that

there are a finite number of firms within sector s and each firm produces a variety of differentiated goods. Firms engage in monopolistic competition within 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 the elasticity of substitution across sectors is η; $\delta > 1$ and $\delta > \eta > 0$. Firm i faces the following demand function:

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

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 the form

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

where $S_{i,s}$ is the market share of firm i in 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 could be pined down by inserting P^* into $S_{i,s}$. By inserting P^* into the 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 the production cost defined in (6). To be specific, $C_i^{imp} = \phi\frac{P_{Xi}^{\mu}}{A_i}$ if a 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 us define $G(S_{i,s}) = \frac{1}{\sigma_{i,s}-1}(\frac{\sigma_{i,s}}{\sigma_{i,s}-1})^{-\delta}$. Depending on the 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 equations, the marginal profit of import follows $\pi^{imp} - \pi^{non} = [G^{imp}(S_{i,s})C_i^{imp} - G^{non}(S_{i,s})C_i^{non}]P_s^{\delta-\eta}$. Inserting this equation 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 which drives down the average cost of production as well as the 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 appreciation, the elasticity faced by importers $\sigma_{i,s}$ grows. The market share for importers decreases due to the 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 it is in the early stage with fewer entrants. Similarly, the expectation of future marginal profit from importing $EV_{imp}(\bar{e}|e^*) - EV_{non}$ gradually becomes smaller. Combining these results, the cut-off productivity in (24) is pushed even higher under one-way future currency appreciation in the long run. [9]

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

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

Proposition 4. *If the market expects a currency appreciation(depreciation) to last over the long run, the diminishing marginal profit(loss) of importing reduces the entry (exit) of potential importers (existing importers). Hence, there is declining response from the extensive margin to the 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 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 ($\frac{d\ln Intin}{d\ln \bar{e}}$).

In Appendix 2, the first component, i.e., the extensive margin $\frac{d\ln Extin}{d\ln \bar{e}}$, equals the product of the

[9] This conclusion holds in the simplest case with homogeneous firms, when $P_s = N^{\frac{1}{1-\delta}} P_i$ and $S_i = \frac{1}{N}$. More firms imported intermediate inputs, which reduced production costs and led to more less productive firms entering in the market initially. However, in the long run, as the average price index within sector s declines, the market share of importers drops. The profit of importing also drops, and the threshold for surviving firms within sector s is driven up, which leads to a smaller N. Then $\sigma = \delta + \frac{1}{N}(\eta - \delta)$ is driven up, inducing to a smaller value for $G^{imp} - G^{non}$.

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 one hand, the cost minimizing import value of existing importers does not depend on future exchange rate fluctuations $\bar{e}$ if the outputs for each period are fixed. Therefore, there is no marginal effect of $\bar{e}$ on the intensive margin, $\frac{d\ln Intin}{d\ln \bar{e}} = 0$. On the other hand, if the firm is free to choose its output between periods, it allocates less to the current period when facing a future reduction of input costs. Thus, in this case, the 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 from the 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 the intensive margin barely 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 the expected exchange rate changes primarily comes through an adjustment along the extensive margin rather than the intensive margin.*

3 Extension: Heterogeneous Marginal Response

As predicted in the model, the expected appreciation or depreciation of domestic currency induces an increase or decrease in the marginal benefit of importing. Due to the presence of a sunk cost of importing, the cut-offs productivity shift for importing, creating adjustment along the extensive margin.

In this sense, firm-level heterogeneity for sunk costs and the ability to finance payments may lead to a different levels of response to future exchange rate fluctuations. Firm-level factors, e.g., the 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 that firm i incurs a substantial fixed cost of F_{imp} to import, which is denoted in domestic currency. A fraction d of F_{imp} could be covered by external financing, and the rest of $(1-d)$ is paid from the firm's 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} is claimed by an external creditor. The probability of a successful operation is λ, and $0 < \lambda < 1$. Then, the firm chooses to optimize its profit subject to incentive compatible and individual rationality conditions.

$$\max_{Y_i} P_iY_i - C_iY_i - (1-d)F_{imp} - \lambda z(A) - (1-\lambda)rF_{imp} \tag{25}$$

$$\text{s.t. } P_iY_i - C_iY_i - (1-d)F_{imp} \geq z(A)$$

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

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 obtain $z(a) = \frac{d-(1-\lambda)r}{\lambda}F_{imp}$. After inserting $z(A)$ into the profit function of 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 the profits of importing firms π_{imp} with non-importing firms π_{non} (where $\pi_{non} = (\frac{1}{A_i})^{1-\delta}$),

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

As seen earlier, the "cut-off" import condition in (16) is $\pi_{imp}(e) - \pi_{non} + \beta[EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e)] = F_{imp}$. Combining conditions (15) and (28), there are offsetting effects between e, $\bar{e}$ and d, F_{imp}, which are summarized as follows: $\frac{\partial A^*}{\partial e} < 0, \frac{\partial A^*}{\partial \bar{e}} < 0, \frac{\partial A^*}{\partial d} > 0, \frac{\partial A^*}{\partial F_{imp}} > 0$. 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, because $EV_{imp}(\bar{e}|e^*) - EV_{non}(\bar{e}|e^*)$ 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 expected appreciation, the marginal response (entry) of the extensive margin is smaller for those firms with larger sunk costs or who largely depend on external finance; while under expected depreciation, the marginal response (exit) along the extensive margin is smaller for those with larger sunk costs or who are financially constrained. Thus, we offer 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 leads to an adjust-*

ment in the 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 costs for importing. These characteristics are all potential factors affecting the import response toward future fluctuations. We list the following hypothesis without a proof, but in the empirical section, we test the hypothesis.

Hypothesis 1. *An expected appreciation/depreciation of domestic currency encourages firm's entry/exit; the marginal effect is associated with the 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 a monthly frequency. The monthly census data cover all import transactions by Chinese firms. The data include the 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, we 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 an annual survey data of Chinese manufacturing firms collected by the National Bureau of Statistics of China. The data cover manufacturing firms of various ownership types with revenue above 5 million yuan (about US$ 600,000) during the sample period. They records firm's identification, location, ownership type and balance sheet data. The firm's balance sheet include information about production and financial condition.

We merge the transactional-level Customs data with the firm survey data to form a sample with rich information. Firms are merged by firm identification number, name, address (zip code) and telephone number, which all appear on both data sets. After merging the two sets, approximately 46 percent of the total US-China bilateral import value is covered by the sample. Many of the dropped observations are conducted by trade intermediaries and not by manufacturing firms. Thus, our sample primarily captures the imports of large manufacturing firms for production purposes.

The forward premiums are calculated based on the forward exchange rate between USD and RMB, which is released by BOC, HK (Bank of China, HK). [10] These data include forward rates at various

[10] These data represent non-deliverable forward data in a off-shore exchange rate market outside Mainland China.

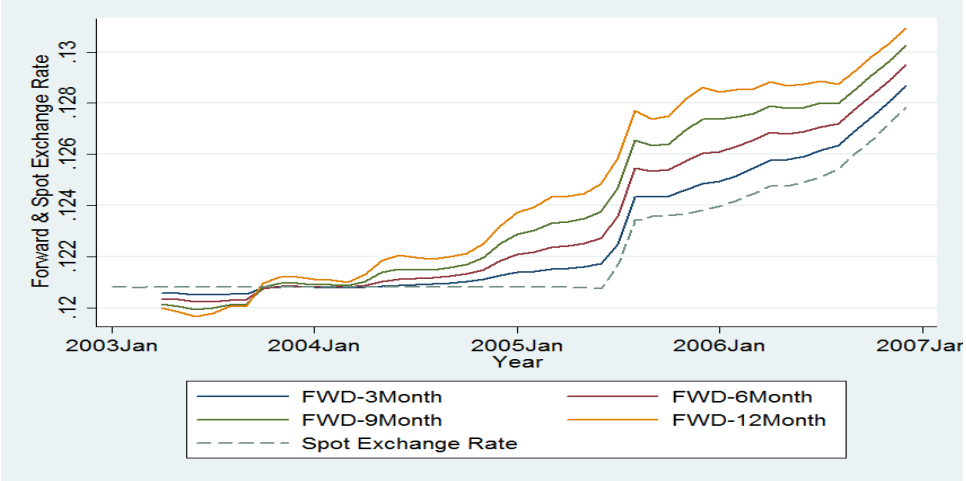


Figure 1: Forward & Spot Exchange Rate Fluctuations Between RMB and USD

horizons, e.g., one-month, three-month, six-month, nine-month and one-year forward. We use forward exchange rates as proxies for the market's expectation of future exchange rate fluctuations.

As we know, before July 2005, China had a fixed exchange rate policy with the RMB exchange rate pegged to the 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 July 2005, when the government officially announced the new policy. However, the market had anticipated this appreciation much earlier than the actual change, and forward exchange rates between USD and RMB increased as early as 2003.

In early February 2003, Japan proposed a reform regarding China's exchange rate regime at the G7 meeting. Since then, there has been widespread debate and discussions about the necessity and feasibility of exchange rate reform, and the Chinese government has faced increasing pressure to reform its foreign currency policy. Western countries believe that the RMB had been severely undervalued, 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 its foreign exchange rate policy.

Graph 1 captures the changes in 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 for RMB (including three-, six-, nine- and twelve-month forward) appreciated as early as late 2003, especially for the nine-month and twelve-month forward exchange rate. In this test, we focus on the period from 2003 to 2006, when the market began forecasting an appreciation of the RMB.

4.1 Measurements

In the test, we use the forward exchange rate between the USD and the RMB as a proxy for the market expectations of future exchange rates. We define a series of K-month forward premiums between USD

and RMB as $Fwd = ln[FXR_{T+k}/EXR_T]$, where FXR_{T+k} is the K-month forward rate and EXR_T is the current spot exchange rate.[11] For comparison, we 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 responses 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 direct trade of foreign exchange rate derivatives. Thus, it is unlikely that firms avoid future exchange rate risks by 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 source of future exchange rate forecasts is the reported forward rates in an off-shore foreign exchange market, such as the Hong Kong or Singapore exchange market.

For other variables in our empirical test, a firm's import value is calculated as the 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 the 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).

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

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

4.2 A First Glance at the Data

Using only Chinese Customs data, we 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 China's imports. We firstly focus on entry/exit and the net increase in the number of importers. In Graph 2, the number of importers from the U.S. is fewer than 20000; this number began to rise significantly after 2002, and approached 50000 in 2006. We record the change of numbers using entry and exit. In the year 2000, the exit rate is as high as the entry rate, thus the net

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

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

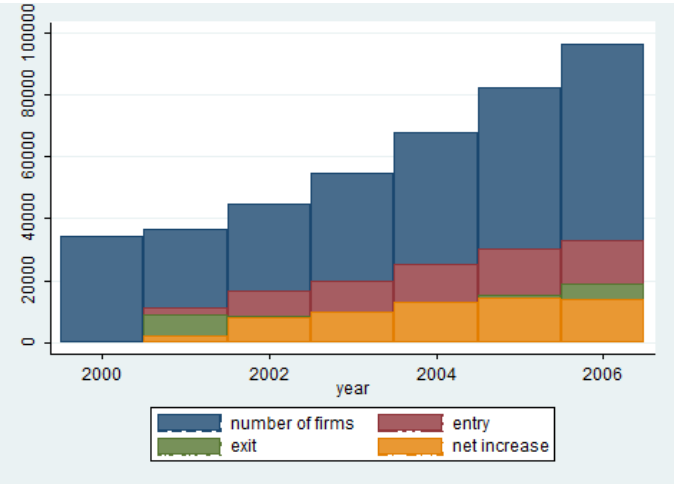
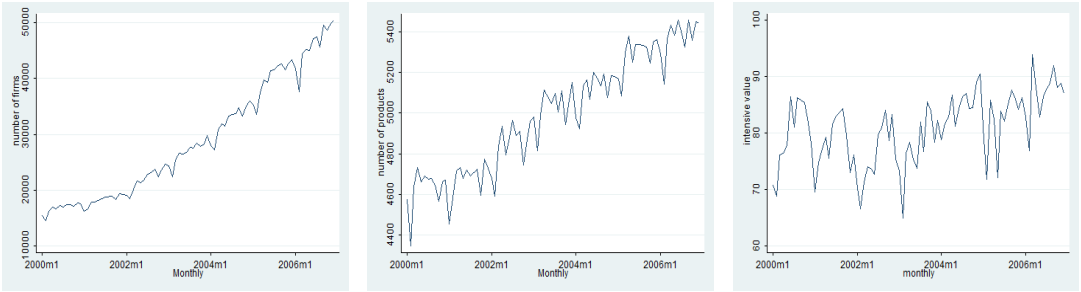


Figure 2: Number of Importers from U.S.



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

Figure 3: Decompose Import Change

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 slightly declines from 2005 to 2006. The change in the net number of importers is mainly attributable to increased entry of importers.

Aside from the number of firms, we further decompose the change in aggregate import value into changes in the number of firms and products (extensive margin), and changes in the 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 despite monthly fluctuations. The number of firms 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 magnitude of the increase is less than 20 percent. On average, each firm imports approximately 4 to 5 varieties of products from the US. Figure 3(c) 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 indicates that entry of importers represents the 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 of the components of import growth between China and the US during 2002 to 2006, after China's entry into the WTO. The annual entry rate of new importers is more than 35 percent of the existing number of firms, and is also much larger than the exit rate, thereby it is associated with a large net increase in importers. Focusing on the HS-6 varieties of imported products, we find that there is no obvious rise in terms of imported varieties. The declining rate of existing product variety is almost as great as the increasing rate of new variety. Further, by decomposing the growth rates of import values into three different margins, the extensive margin at firm level alone contributes 74 percent on average, the intensive margin contributes 24 percent and the extensive margin at the product level contributes only 2 percent. Thus, a large proportion of import growth comes from the entry of new firms or the increase of import values rather than the import of 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.

Table 2 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 we focus on the 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 represents one

year. This finding suggests that most importers import at a very high frequency level. Once a firm starts importing, it will continue importing in the future. This pattern indicates two facts: (1) once a firm starts importing, it is less likely to drop out, which supports the prediction in Lemma 1; (2) a sunk cost exists for initializing imports, which induces firms to continue importing.

5 Empirical Tests

5.1 Tests of Extensive Margin Response

In this section, we test to see how entry probability changes with forward exchange rate fluctuations. Our dependent variable $Entry$ is defined as a dummy variable for import status: $Entry = 1$ if the firm imports at time t but didn't import at time $t-1$; otherwise, $Entry = 0$. $\triangle fwd_{t,t+k}$ is an annualized forward premium between USD and RMB, and covers one-, three-, six-, nine- and twelve-month forward premiums ($k = 1, 3, 6, 9, 12$). We also construct an annual average forward premium ($Av\triangle fwd$), which is defined as $\sum_{k=3,6,9,12} 1/4\triangle fwd_{t,t+k}$. 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 $\triangle fwd$, we include an exchange rate growth rate ($gexr$) over the past six-months to control for the realized change in exchange rates. x_{it} is a vector of firm level control variables. X_{it} includes size and a two-way trade dummy. The former is the logarithm of the 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 helps to control for the effects brought by changes of import policies;[13] it also controls the shifts in inflation rates in both China and US. In the test, to make the monthly-based series variables stationary, we de-trended $\triangle fwd$ and $gexr$, prior to the regression.

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

[13] e.g.,the Chinese government announced the release of import licenses for private firms during the sample period; we control for these effects by adding annual dummies into the 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

those firms that engage in both export and import at the same time. By comparing the coefficients among the various forward premiums, we find that the magnitudes tend to be larger for the one- and three-month forward premiums. However, the coefficients become smaller as the time interval becomes longer, especially as the time interval exceeds six months. For example, in the Probit regressions in column 1-4, the three-month forward premium has the largest coefficient of 0.848; the coefficient reduces to 0.399 for a twelve-month forward premium.

In the right-hand side panel of column 5-8, we find a similar pattern in the linear probability regression. This pattern suggests that the 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 three-month forward.

5.1.1 Alternative Tests: Dynamic Panel Regression

Let us focus on the relationship between the forward premiums and the changes in the number of firms importing the same product. Because the adjustment in the total number of importers is a gradual process, and tends to reach an equilibrium in the long run, we use a dynamic GMM model as an alternative test for the extensive margin. Further, this econometric model controls for possible simultaneity and endogeneity problems. By following the method of Arellano and Bond (1991), we assume the regressors are 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 the past exchange rate growth rate $gexr_t$.

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

5.2 Entry Response of Import with Time Horizon

To see the time pattern of entry response, we used a rolling window regression to capture the different magnitude of response under various durations of anticipated appreciation. Starting from the first

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

Table 4: Alternative Dynamic Regression for Extensive Margin

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm#	Firm#	Firm#	Firm#	Firm#	Firm#
	Av Fwd	1-month	3-month	6-month	9-month	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

signal of appreciation in early 2003, we regress the entry response on a 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 the market has anticipated the appreciation. The vertical axis is the entry response coefficient at different times; it shows that the entry response jumps dramatically around the fourth or fifth quarter of the expected shock. Then the response drops quickly and moves towards stable status in the long run.[15]

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

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

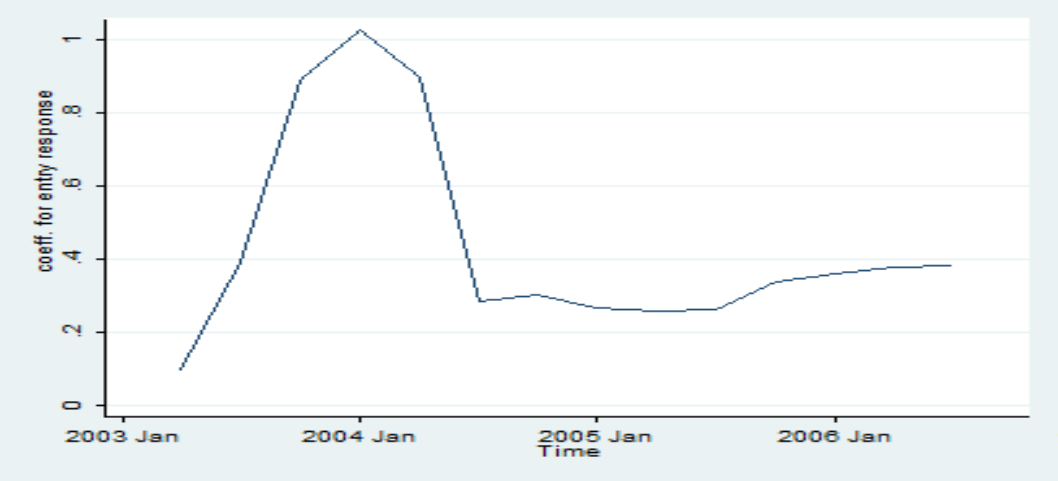


Figure 4: Number of Importers from U.S.

times. If the firm's response really weakens as time goes by, we expect to see a negative coefficient for variable $\triangle fwd * duration$. Both the annual forward premium $\triangle Avfwd$, and the six-month and twelfth-month forward premium ($\triangle fwd-6month$ and $\triangle fwd-12month$) are employed as independent variables for forward premiums. The results are listed in Table 5. Columns 1 ,3 and 5 in Table 5 apply Probit estimations, and columns 2, 4 and 6 employ linear probability regressions. Aside from forward premiums and exchange rate growth rates, both of the estimations include the interaction item $\triangle fwd * duration$. As a robustness check corresponding to the dynamic GMM test in section 5.1.1, which is listed in columns 7,8 and 9, we regress the number of importers importing a specific HS-6 product variety on the 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 columns 7,8 and 9. In the tests, the effect of forward premiums on firm entry becomes less significant than the previous results. The negative coefficients of $\triangle fwd * duration$ suggest that the prediction is confirmed; the effect of the forward premium on import disappears as appreciation (depreciation) persists over the long run.

Table A-1 of Appendix documents the mechanism for the above changes among different durations. Columns 1 and 2 show 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, because the forward premium induces more firms to import, the marginal benefit of importing becomes smaller due to reduced market share. The extensive margin adjustment is diminishing as expected appreciation lasts for a long time, which suggests that the stimulating effect of domestic currency appreciation vanishes as more new entrants start importing.

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

5.3 Heterogeneous Response of Extensive Margin

5.3.1 Entry Response of Import with Firm's Productivity

In proposition 3, we predict that the adjustment in the extensive margin tends to be larger for firms with lower productivity. We 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 uses an entry dummy as the dependent variable. The iteration item $\triangle fwd_t * tfp_{it}$ is the key variable in the test. If the prediction that firms with lower productivity are more likely to start importing is valid, the iteration item $\triangle fwd_t * tfp_{it}$ will have 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, we employ two types of TFP measurements(using both OLS and OP methods receptively) to represent firm's productivity, denoted by tfp_{ols} and tfp_{op} respectively. Both Probit and linear probability regressions are used in the test. The results are displayed in Table 6. We find that the coefficients of the interaction items $\triangle fwd * tfp$ are significantly negative for most of the tests. The results using tfp_{op} as productivity are stronger than those tests with tfp_{op}. The results are also robust for both the six-month and twelve-month forward premiums. This result suggests that less productive firms respond to 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, we explore the relationship between the marginal effect of the forward premium on import and firm characteristics. As in Propositions 6 and 7 and Hypothesis 1, firms' responses to expected future exchange rate fluctuations vary with the fixed cost of import, external finance accessibility, ownership and location. In the specification of (35), we use z_{it} to denote all firm characteristics associated with financial status or external credit accessibility and interact them with the forward premium, i.e., $\triangle fwd * Z_{it}$. To be specific, the heterogeneous variable Z_{it} includes bank loan supply ($Loan_{it}$), and the liability to asset ratio($Debt_{it}$).

Further, to capture the heterogeneity of sunk costs, we employ both the index of external finance dependence EFD_{pt} from Manova (2011) and a ratio of physical capital to total assets $Capital_{pt}$ as proxies for the sunk cost of importing. Sectors with a higher capital-labor ratio or that depend more on external financing are more likely to incur greater sunk costs from importing and thus are expected to see a weaker response in terms of entry under 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 panel shows the result of the Probit regression and the right hand shows the linear probability regression. In columns (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 also less likely to respond.

In columns (3) and (4), the interaction term with bank loan supply $\triangle fwd * Loan$ is not significant, suggesting that external credit access plays a negligible role in determining firms' responses. However, the negative coefficient for the debt ratio interaction $\triangle fwd * Debt$ shows that firms with larger debt ratio has little response to future exchange rate fluctuations. This result indicates that a firm's financial status also influences its import response. Firms with adequate cash flows or with smaller liability ratio tend to respond strongly to anticipated movements of the exchange rate.

Hypothesis 1 indicates that firms' location and ownership structures may affect their responses as well. In the above tests, we include location and ownership dummies to explore their effects on the 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

of whether the firm is located in coastal cities or not. The coastal dummy *Coastal* equals one if it is located 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 for those located in coastal areas.

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

In column (5) and (10), we include all heterogeneous characteristics, including location and ownership, into a single regression. The negative coefficient of $\triangle fwd * Coastal$ suggests that the expected exchange rate appreciation has larger effects for non-coastal firms than coastal ones. Compared to 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 greater response to forward exchange rate fluctuations than those in the "privileged group". One possible reason for this result lies in the fact that private firms are more flexible in making trade decisions and thus respond more efficiently than privileged ones.

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

5.4 Intensive Margin Regressions

In Proposition 6, we predict that the intensive margin does not respond significantly to anticipated exchange rate fluctuations. In this section, we test the changes in import value for the existing "importer-product" bundles, i.e., the intensive margin, as a result of forward exchange rate fluctuations according to 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, and $\triangle fwd$ is the k-month forward premium between RMB and USD at time t. We also control the

past exchange rate growth rate $gexr$. x_{it} is a vector of firm level control variables, including firm size and a two-way trade dummy. We 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. We regress the import value y_{itp} on various horizons for the forward premium(including one-, three-, six-, nine- and twelve-month forward premiums and an 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. We find that the forward premiums $\triangle Fwd$ become insignificant for most of the forward premiums, regardless of whether the single k-month forward premium or the annual average forward premium. This result suggests that the future appreciation of domestic currency does not significantly influence the import value of existing importers, for there is no obvious evidence showing the adjustment of the current "firm-product" bundle.

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

We also test the interaction item between the forward premiums and firm productivity following an approach similar to that in Section 5.1.3., and find that the productive interaction item is insignificantly negative as well (See Table A-2 in the Appendix). This result indicates that there is no significant response pattern with respect to productivity. No type of firm, regardless of low or high productivity, adjusts the import value significantly based on the anticipation of future exchange rate changes.

[16]For robustness, we also use a dynamic panel regression, similar to those tested 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 to that above.

5.5 Decomposition of Intensive and Extensive Margins

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

According to the following equation (37), the aggregate change in import value $\triangle import$ is decomposed into 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 the extensive margin and the intensive margin, and only offers a rough calculation of the share for each margin.

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

The last three columns in Table 1 list the decomposition results for different margin's contributions to aggregate value changes. The sample period ranges from year 2002 to year 2006. The firm-level extensive margin (firm's entry) alone contributes approximately 70 % of the total increase in value. There is little effect from products adding to aggregate value growth, which has a share of less than 5 %. The average import values per firm-product bundle are also increasing, but not as significantly as the increase in firm level entry. Focusing on the average share listed at the bottom of the Table 1, we record the percentage changes for each item in equation (37) respectively. It demonstrates that within the total growth rate of 29%, increase of entry $\triangle Num_{it}$ (extensive margin at firm) accounts for 74%, import value for existing firm $\triangle Fimp_{ipt}$ (intensive margin) accounts for 24 %, and the remaining 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 in 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, we 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, we define the dependent variable as the "number of firms importing each HS-6 product" to identify changes from the extensive margin at firm level. We also calculate the average import value per firm importing each HS-6 product category and treat it as an approximate estimate in the intensive margin. Then we regress these separately on future appreciation to check their impact on two different margins. Table 9 displays the results. After controlling for the 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 the expected future exchange rate significantly. This result servers as empirical evidence that changes in aggregate imports primarily comes through the extensive rather than the intensive margin.

6 Robustness Check

6.1 Subsample: With Only Expected Future Fluctuations

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

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

Table 10: Robustness: With Only Future Exchange Rate Fluctuations

	(1)	(2)	(3)	(4)	(5)	(6)
	entry	entry	entry	entry	entry	entry
	Av Fwd	1-month	3-month	6-month	9-month	12-month
△ FWD	1.328***	0.977***	1.208***	1.277***	1.289***	1.268***
	(0.0986)	(0.0938)	(0.1073)	(0.097)	(0.091)	(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 imports is that a large portion of imports contributing to the 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, firms receive foreign inputs from a trade partner without payment, and they send final products back to the partner after assembling; under the latter regime, Chinese exporters pay to purchase imported intermediate inputs, and sell the final products.

Because the processing trade represents a large portion of China's total import value, especially during the sample period. If importers engage in export at the same time, their response to an expected currency fluctuation may be offset by an opposite effect on exporting. It is likely that importers engaging in the processing trade (or assembly trade) may respond in a way different from that predicted in the model. To rule out this concern, we have conducted a robustness check by excluding processing trade observations and focusing on the pure ordinary trade sample.

The categorizing of ordinary trade and processing trade is conducted at the transactional level. By dropping translations that belong to processing (including the assembling trade), the sample shrinks to 60 percent of its original size. Using an ordinary trade sample, response in the extensive margin is robust, which confirms the predictions that the extensive margin responds to expectations of exchange rate fluctuations.

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

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

7 Conclusion

Our study provides a channel for the influence of expectations of exchange rate fluctuations on firms' decisions to import. Using China's Customs data which covers the transit period with exchange rate reform, we provide the investigation that how firms respond to changes in market expectations for exchange rates. A "forward looking" dynamic exists when firms make import decisions, and the "forward looking" effect is as important as the realized or past exchange rate fluctuations. We find that imports change along the extensive margin, i.e., the 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. We also find firm debt ratio, access to finance, ownership and location affect firm response to future exchange rate fluctuations.

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

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

Furthermore, this paper offers implications to evaluate the consequences of exchange rate reform. Not only do 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 expectations as well as the duration of the expected shock, the actual adjustment of trade under a policy change varies from the original prediction.

Finally, according to our results, the most significant response comes from the extensive margin at firm level rather than the 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 left for future research.

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APPENDIX1

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

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

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

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 it:

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

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

Let us explore the two cut-off exchange rates e^{**} and e^*, we 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 for production with imported intermediate inputs is strictly higher than the profit without imports, i.e., $\pi_{imp} > \pi_{non}$. Also, because $e^{**} < e^*$ and fixed cost F_{imp} exist for importing, non-importers at $t-1$ do not import under the exchange rate of e^{**}. So we can prove that $V_{imp}(e^{**}) \geq V_{non}(e^{**})$ and $EV_{imp}(\bar{e}|e^{**}) \geq EV_{non}(\bar{e}|e^{**})$. Hence, we obtain $\pi_{imp}(e^{**}) \geq \pi_{non}$ at the cut-off exchange rate e^{**}.

Let's explore the first possibility, i.e., $\pi_{imp}(e^{**}) + \beta EV_{imp}(\bar{e}|e^{**}) = \pi_{non} + \beta EV_{non}(\bar{e}|e^{**})$. This possibility contradicts the assumption of $P_{Xi} < 1$. Without fixed cost F_{imp}, importing is always a dominate strategy over non-importing for those who have already begun importing previously at $t-1$. Hence, the only possibility is that the profit of importing is strictly larger than that of 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 and the existing importers never stop importing as long as imported inputs are less expensive than domestic inputs.

[18] This verification can be obtained by comparing 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

The aggregate import value can be decomposed into the extensive margin and the intensive margin. The response to the future exchange rate can also be decomposed into the extensive margin and the 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 the intensive margin response and the second is the extensive margin response. We explore them respectively 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 us 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, we assume that the distribution of productivity follows a 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) The Intensive margin response to future exchange rate could be obtained by solving firm i's optimal choice of imported intermediate input M_i. There are two cases: i) if the output of production is fixed per period due to a contract or fixed production capacity, the optimal choice of M_i is obtained by solving the 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 for 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 we define the expenditure on imported intermediate input as x_i, i.e., intensive margin, it follows that

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

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

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

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

Firms are subject to an 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 the profit function of output Y, which is a production function of inputs.

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

Also, the intermediate input bundle follows 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, the profit function becomes a function of the 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, firm i maximize the profit flow over the entire periods by choosing the 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

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

This equation states that the ratio between current imported intermediate input and future input $\frac{M_t}{M_{t+k}}$ negatively depends on the 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 ratio of $\frac{P_t}{P_{t+k}}$ affects the weight allocated to current output (imported intermediate input), i.e., M. Thus, the current imported intermediate input M_t reduces, and offers a channel through which future exchange rate fluctuation affects the current import value of input, that is,

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

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

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

APPENDIX3

Let us start with the simplest case of identical firms within the sector. If each firm sets a uniform price level of p_i, the following equations hold:

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

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

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

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

Because the profit from 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 of the above equations (A-19), (A-20) and (A-21) into profit function (A-22), that is,

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

Comparing the above equation with the 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 in profit between import and non-import(difference between 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.

The number of firms within sector s, N, is a decreasing function of cut-off productivity A^*. Therefore, initially, during domestic currency appreciation, the cut-off productivity level A^* reduces, and more firms with lower productivity enter the sector, leading N to increase. However, in the long run, the profit generated from importing (π_{imp}) decreases with the rising number of incumbent firms N in the market. Because it is less profitable to start importing (smaller of $\pi_{imp} - \pi_{non}$), less productive importers cannot survive in the market any longer, 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, the production profit becomes

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

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		
△ 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

We can prove under the sufficient condition $\delta >> \eta$, that profit is decreasing as S_i and sector 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, the sector price level p_s also decreases due to a decrease in the average production cost using imported intermediate inputs.

If S_i is inserted into the equation, the profit equation π (including both π^{imp} and π^{non}) becomes a 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 the 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 import goods during domestic currency appreciation, the market share of the importers becomes smaller, and the marginal profit of import $\pi_{imp} - \pi_{non}$ decreases in the long run. It is less attractive to import as appreciation lasts over the long run than it is in the beginning. Thus, fewer 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