Import Switching and the Impact of a Large Devaluation*

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Abstract

In Colombia, from 1998 to 1999, during a large external shock the RER depreciated by 27% and import value dropped 32%. Using detailed firm level import transactions, we confirm that firms use less imported inputs varieties but we also document several facts contrary to our conventional economic intuition. We would expect increases in exit of firms from the import market as well as larger dropped varieties for continuing firms. We find the opposite. And we find that firms using less imported varieties are due to fewer adding of new imported varieties rather than larger dropping of varieties.

Regarding firms adjustment mechanisms, we find: 1) Most importers add and drop import varieties all the time. 2) Firms add and drop varieties with similar intensity. 3) Both the values of added and dropped products by continuing firms comove negatively with the exchange rate, as does entry and exit. Our findings suggest firms select their imported varieties, and reorganize their imported inputs and production over time. We introduce searching for imported inputs into a model with endogenous choice of import intermediate inputs. Firms search for imported inputs suppliers and reorganize their input usage over time. With an imported input cost shock, e.g., a devaluation, the benefit from searching new suppliers decreases, which leads to less adding and dropping in firms' imported inputs. Our model focuses on the dynamic aspects of import reorganization, and shows that a devaluation can slow down the import churning and lead to larger TFP declines beyond those previously found. The model predicts more productive firms use more imported inputs, and do more adding and dropping at the same time. During the devaluation, there are fewer firms add and drop import varieties, and if they do, the shares of adding and dropping among their total import decrease. In the data, firm level switching behavior are consistent with these predictions.

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1 Introduction

In Colombia, from 1998 to 1999, during a large external shock the real exchange rate depreciated by 27% [1] and import value dropped 32% [2]. Using detailed firm level import transactions, we confirm that the net import change as in (Gopinath and Neiman 2011): The extensive margin defined as the net exit of firms plays a small role in the import drop. Firms use less imported input varieties, i.e. the sub-extensive margin plays a sizeable role in aggregate import drop; and trade adjustment varies with importer size.

But when we further look at the churning of imported inputs, we find most of importers add and drop input varieties all the time. The gross churning in terms of added and dropped varieties is more than three times as the net. During this devaluation, one would expect major shifts towards drop and exit. But compared to normal times we find the value from dropped varieties and exit fall. Values from added varieties and entry also fall, which lead to a decline in net import value. In other words, firms dropped less imported varieties, and also added less imported varieties during the devaluation.

These two facts are puzzling and hard to be explained by models of endogenous choice of imported inputs ((Gopinath and Neiman 2011) and (Halpern, Koren, and Szeidl 2011)): Many firms are acting against our conventional economic intuition by adding import products and entering import market in a period of devaluation. And firms dropped less imported inputs during devaluation. These patterns convince us that we need to know more about how individual firms adjust their imported inputs over time and how they react to import real price shock.

To show the relevance of gross margins, we split changes in imports into 6 dimensions rather than 3: firm entry, and exit; for each continuing firm, the value of new added imported products, and the value of dropped products; the increased value of continuing products, and the decreased value for continuing products. We find that the gross adjustment patterns show the net obscuring much action, with the gross being at least three times the net. We also find that gross margins reveal large adjustments that move contrary to the net. In particular, entry of firms, added products of continuing firms and increasing value of continuing products all show values that are close to their corresponding negatively contributing margins.

To highlight the relevance of the RER, we plot it together with aggregate adjustment of the three pairs of margins. More precisely, we filter quarterly values for the six margins and the RER data to then focus on the trend. We find that the value of added and dropped products by continuing firms comoves negatively with the exchange rate; falls in aggregate

[1] The reported exchange rate is Colombian pesos to US dollars: US is Colombia‘s major trading partner and the change is from December 1998 to December 1999

[2] The equivalent import value drop for manufacturing firms is 23%.

volumes of adding and dropping are observed with a depreciation. A remarkably similar pattern appears for entry and exit. The same patterns appear if we use numbers of added and dropped products instead of values. The implication is that the fall in aggregate import observed in depreciation is caused by reductions in margins that contribute positively rather than increases in margins that contribute negatively to import value. We find these results have the flavor of (Shimer 2012), where he reports that unemployment increases are due to falling job finding rates rather than increases in job separation rates.

At the firm level, we also find that the number of firms that only drop are similar to those that only add, and that many more firms actually do both add and drop. Hence, for this last group, we plot the number of products added and dropped by each firm and find a very strong positive correlation, i.e., these firms add just as many products as they drop; so firms are substituting some imported products for others. Furthermore, at the firm level, this adding and dropping is not a small share at around 50% of their total import value. During the devaluation, there are less firms do both add and drop, and for firms do both, the shares of adding and dropping among their total import decreased.

Our findings suggest firms select their imported varieties and suppliers[3], and reorganize their imported inputs and production over time. During the devaluation, firms not only use less imported varieties, but also do less churning of imported inputs. The findings are consistent with a theory of endogenous input selection, where firms search for import inputs suppliers and reorganize their inputs usage over time.

Accordingly, we introduce searching for imported inputs into a model with endogenous choice of imported intermediate inputs ((Halpern, Koren, and Szeidl 2011)). Firms choose to import an endogenous range of inputs in response to inputs/suppliers productivity. Over time, importers decide if they want to pay a searching cost to be connected with a new bunch of foreign suppliers for inputs. After they pay the search cost, the productivity of new suppliers realize, firms decide the set of inputs they would like to import. The theory predicts that more productive firms use more imported inputs. Searching new input suppliers and reorganize inputs would increases profits, and the increased profits are larger for more productive firms (so more productive ones would like to pay the searching cost, and add and drop input varieties at the same time). As a consequence of a devaluation, imports became more expensive, firms use less imported inputs, and fewer firms would like to pay the search costs to look for new suppliers. These are supported by the evidence from matched manufacturing survey with firm level transaction data.

With an imported input cost shock, as would occur in a devaluation, the benefit from searching new suppliers decreases, which leads to fewer firms switch, and less adding and

[3]See additional results in the empirical part.

dropping in firms imported inputs. We show that this reduces manufacturing TFP, not only through firm using fewer varieties, but also through less reallocation within firms toward the most efficient use of inputs.

Our paper is related to the recent work on the relationship between firm imports and productivity. (Halpern, Koren, and Szeidl 2011) estimate the effects of imported inputs use on total factor productivity for Hungarian firms. (Goldberg, Khandelwal, Pavcnik, and Topalov 2010) find reducing input tariff induces new products. (Amiti and Konings 2007) show that reducing import tariff leads to large productivity gains. (Gopinath and Neiman 2011) study the effects of the Argentine trade collapse during the Argentine currency devaluation. (Bernard, Redding, and Schott 2010) find US manufacturing firms reassign resources by add and drop products, and product switching contributes to a reallocation of resources within firms toward their most efficient use. We find firms adjust their imported inputs, and inputs adding and dropping adds another margin of firms adjustment. Our model focuses on the dynamic aspects of input reorganization, and shows that devaluation can slow down the inputs churning and lead to larger TFP declines beyond those previously found.

The remainder of the paper is structured as follows. Section 2 describes our dataset and reports main empirical findings. Section 3 outlines the model. Section 4 shows further evidence on firms level switching that consistent with the model predictions. Section 5 concludes.

2 Data and Empirical Evidence

The manufacturing survey is conducted by the national statistical office, DANE. The survey, called EAM (Encuesta Anual Manufacturera), is a panel and we have data for the period 1994-2009.

The import and export data comes from DIAN, the government tax authority. We have all import (export) transactions from 1994 to 2011 with data on value, quantity, HS code at 10 digits, country of origin (destination) and crucially with NIT, the tax identifier. Using the NIT we keep all manufacturing firms to avoid distributors[4].

In Colombia, from 1998 to 1999, during a large external shock the RER depreciated by 27% [5] causing an import value drop of 32% [6]. As we mention in the introduction, during this episode we observe lots of action against conventional economic intuition. We would expect increases in exit of firms from the import market as well as larger values for dropped varieties

[4]Before restricting our sample to manufacturing firms our dataset aggregates to virtually the same value as the DANE aggregate trade value statistics. Aggregate manufacturing trade closely tracks total Colombian trade and is around 50-60% of total value.

[5]The reported RER is Colombia to US, it's major trading partner and the change is from December 1998 to December 1999.

[6]The equivalent import value drop for manufacturing firms is 23%.

a) Net

		Total	Exit	Entry	Drop		Decrease	
ARG	HS6	-69%	0.11		0.18		0.71	
	HS10xCty	-69%	0.11		0.45		0.44	
COL	HS10	-23%	0.05		0.33		0.63	

b) Gross

		Total	Exit	Entry	Drop	Add	Decrease	Increase
COL	HS10	-23%	0.09	-0.04	0.59	-0.26	1.28	-.65

Table 1: Net And Gross Shares Of Adjustment Margins Of Aggregate Imports In 1998-1999.

for continuing firms. However, we do not see that. There are many firms entering the import market at all times and churning value goes down during the devaluation.

We highlight dimensions in which (Gopinath and Neiman 2011) did not focus. To show the relevance of gross margins, we first split changes in imports into 6 dimensions rather than 3: firm entry, and exit; for each continuing firm, the value of new added imported products, and the value of dropped products; the increased value of continuing products, and the decreased value for continuing products. We define dropped products as products that are never bought again, whereas added products as those that have never been bought before[7]; while results are qualitatively the same with a less conservative definition of add and drop, using this definition, we avoid an inventory explanation as in (Alessandria, Kaboski, and Midrigan 2010).

Table 1[8], shows net as well as gross adjustments of import change for the period 1998-1999 in Colombia and compares them to those reported for Argentina. While our import drop is around half of that in Argentina, the adjustment patterns for the net are very similar to the Argentina case. However, as the gross adjustment patterns show, the net obscures much action. First, notice how gross shares of the fall in aggregate imports reveal large adjustments that move contrary to the net. In particular, entry of firms, added products of continuing firms and increasing value of continuing products for stayers all show values that are close to their corresponding negatively contributing margins.

To analyze the impact of the devaluation, let's first look at how gross margins look in other episode. In figure 1 we report change values for our 3 pairs of adjustment modes during two different episodes: a period of import value increase, 1994/1995, and a period in which there is a fall, 1998/1999. In both episodes, value for entry of firms is close to the exit of firms,

[7]In case of HS code change, we use detailed documents of HS revisions to create a concordance which is available upon request.

[8] The data for Argentina is total trade whereas figure for Colombia represent trade for manufacturing firms.

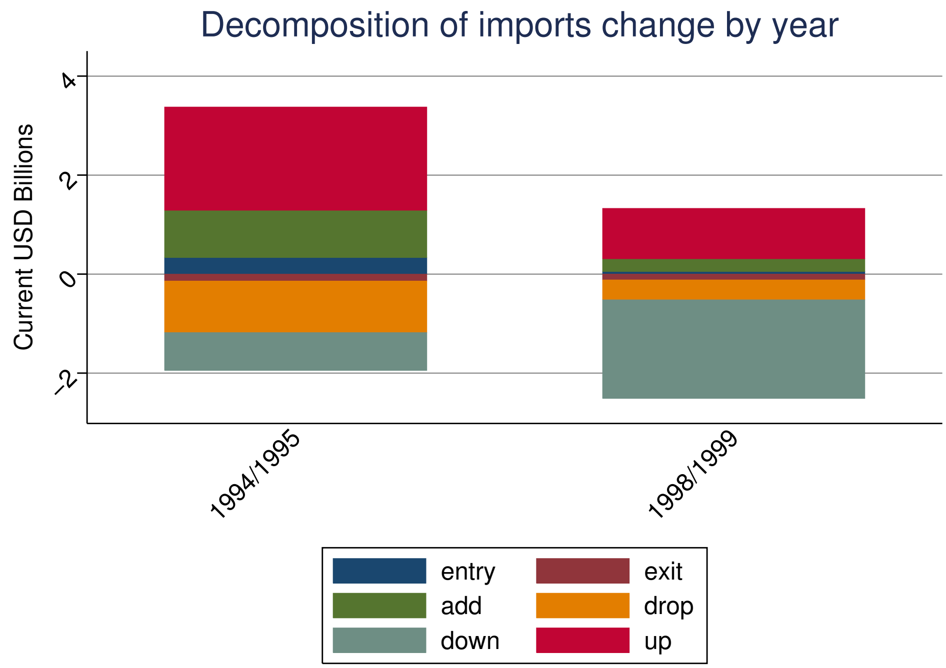

Figure 1: Decomposition of Imports Change.

value for added products of continuing firms is similar to dropped products, and the increasing value of continuing products is similar to the decreased value. During the depreciation period, 1999, net import value falls because entry, add and increasing value of continuing products all fall in value, not because firms dropped a larger value of imported inputs. In both cases, adjustment modes that go against conventional wisdom are not at all negligible in terms of value.

In figure 2 we show the number of firms that use a given adjustment mechanism between 1994/1995 and 1998/1999. It is surprising that the 1999 figure is so similar to 1995 since in the former the RER is increasing. During the devaluation one would expect major shifts towards drop and exit. However, we do not see that. We only observe minor differences in the number of firms that only add or enter. Many firms are acting against our conventional economic intuition by adding products and entering in a period of devaluation. The difference between the two episodes is there are fewer firms do both add and drop during devaluation.

Furthermore, we show that this adding and dropping is not a small value at the firm level. Figure 3 presents the average value that firms add(drop) as a fraction of their total

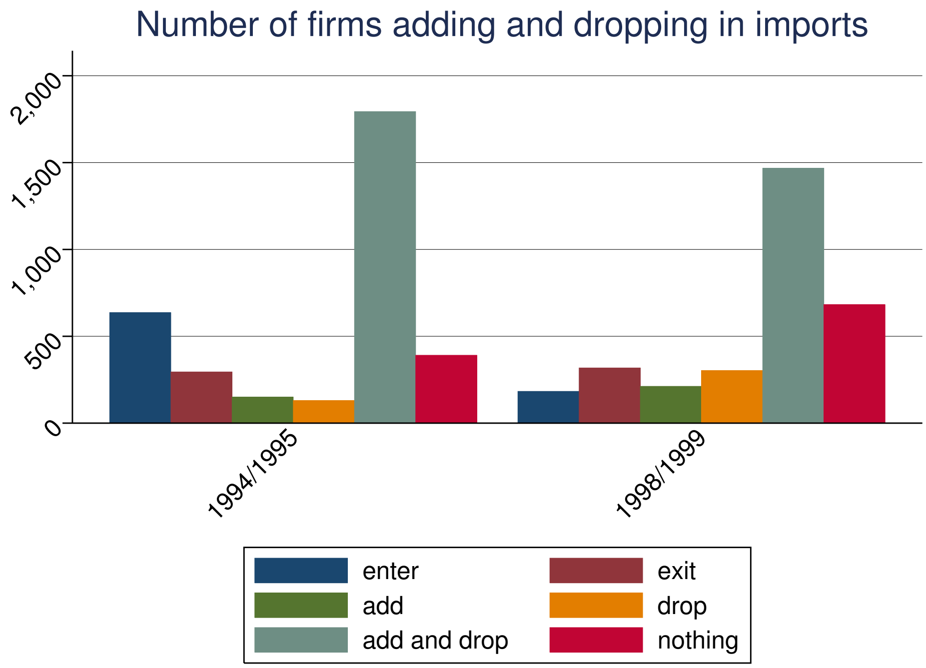

Figure 2: Number Of Firms By Adjustment Mechanism.

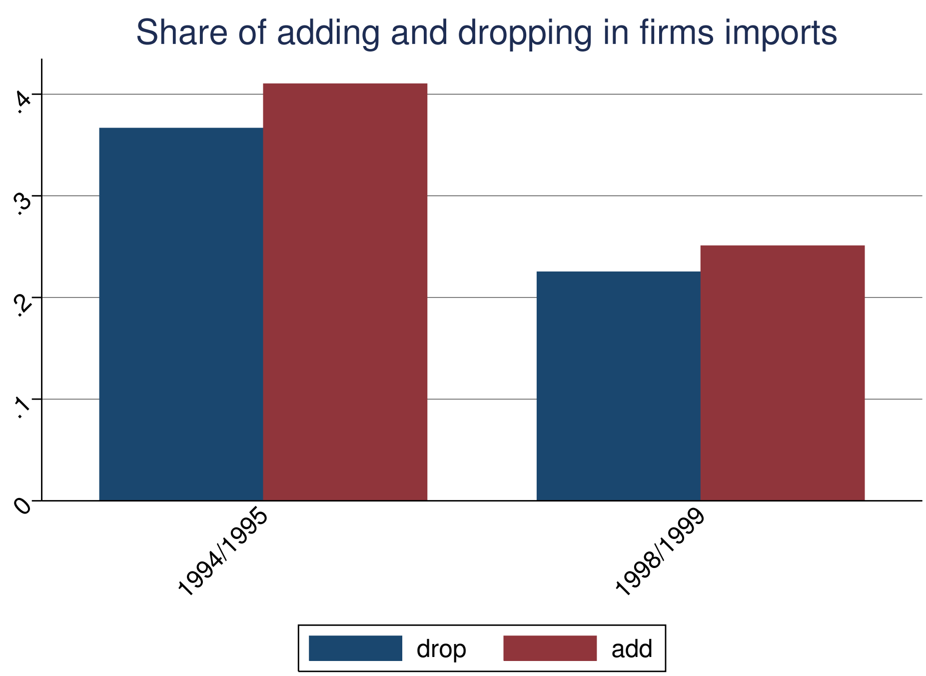

Figure 3: Firm Level Add And Drop Values As Fraction Of Total Import Value.

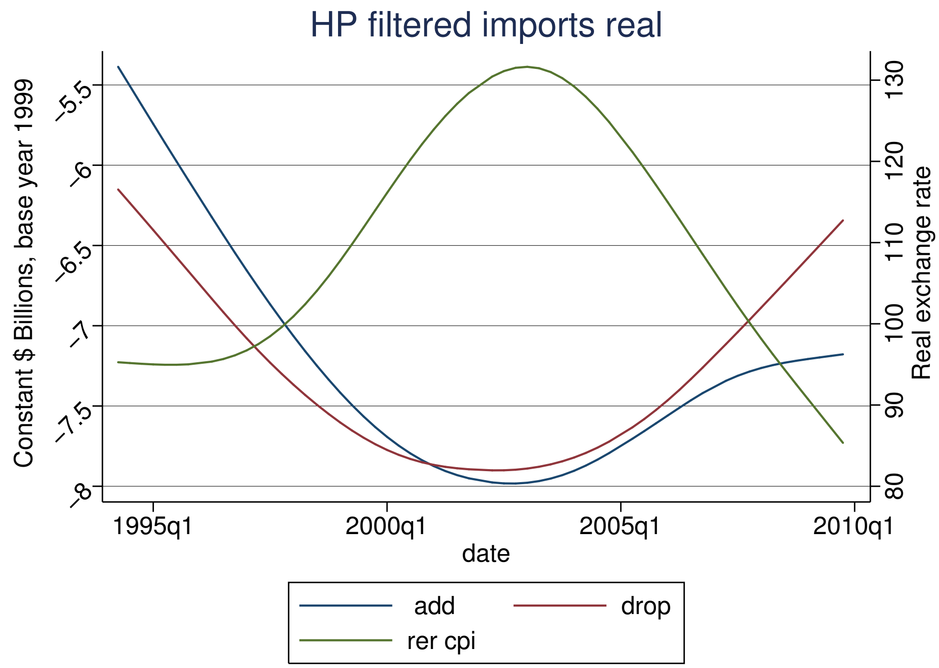

Figure 4: Aggregate Add And Drop Value Against The RER. HP Filtered Data.

imports. These shares are large at around 30% for both margins[9]. Also note that during the devaluation period, both shares fall but more intensely add which is consistent with the previous evidence.

To relate to the RER formally, we plot it together with aggregate adjustment volumes of the three pairs of margins. In order to study this connection, we filter quarterly values for the six margins and RER data to then focus on the trend[10]. We do this because our explanation of the aggregate patterns is going to be about slow moving factors, in particular, technology choice by firms. Figure 4 shows the value of added and dropped products by continuing firms[11] comoves negatively with the exchange rate; falls in aggregate volumes of adding and dropping are observed with a depreciation. This pattern is essentially the same when we conduct the same analysis using the average number of added and dropped products across firms. A remarkably similar pattern appears in figures 6 and 7 in the appendix. The implication is that the fall in aggregate import observed as a consequence of a depreciation

[9] This is the most conservative value, i.e., defining add(drop) as products never used before(anymore). Using the standard definition, the value is around 50%.

[10] More precisely, we take logs first and then apply the HP filter using the conventional value of 1600 for lambda.

[11] Only changes are meaningful in this figure. Levels are not.

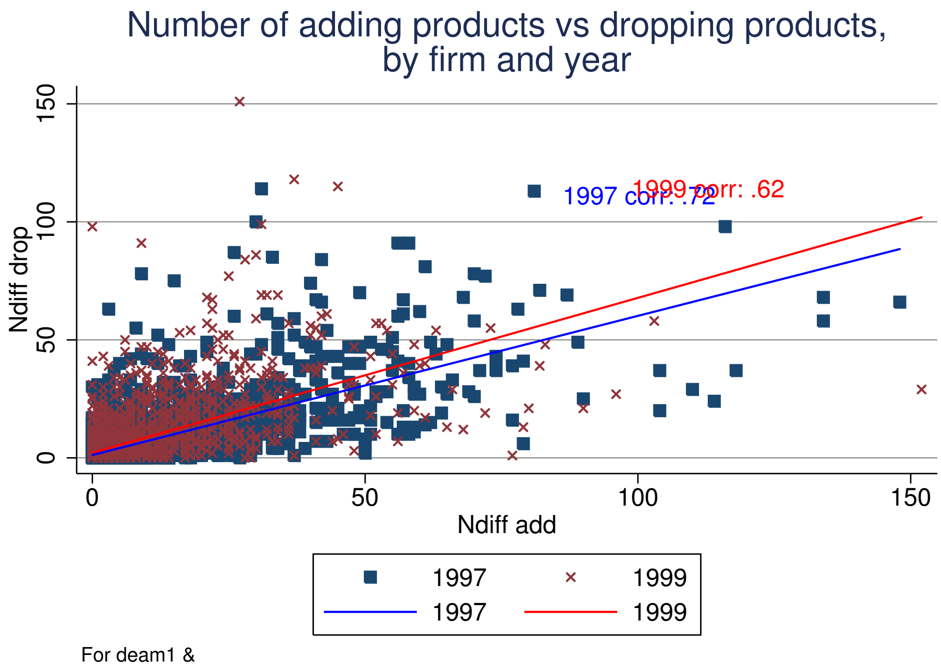

Figure 5: Number Of Products Added And Dropped.

is caused by reductions in margins that contribute positively rather than increases is margins that contribute negatively to import value.

Since a large pool of firms add and drop products simultaneously, on figure 5 we plot the number of products added and dropped by each firm[12]. The strong positive correlation found provides evidence that these firms add just as many products as they drop. In this way we rule out an explanation where our results are due to a composition effect, where firms suffer idiosyncratic shocks that make them either add or drop but not both. Contrary to such situation, what we find is that firms are substituting some imported products for others.

All of our results are robust to the exclusion of capital goods. We do that by using the HS codes classified by (Caselli and Wilson 2004) as capital goods.

These findings suggest firms select their imported varieties and suppliers, and reorganize their imported inputs and production over time. During the devaluation, firms not only use less imported varieties, but also do less churning of imported inputs. In the following section

[12] In table 6 in the Empirical Appendix, we shows how adding and dropping activities are related to firm size. Larger firms do more adding and also more dropping. See section 4 for a regression version of this results.

we present a theory of endogenous input selection, where firms search for import inputs suppliers and reorganize their inputs usage over time. We will show the theory predictions, empirical evidence on the relation between firms import switching behavior and their productivity, and the impact of a large devaluation.

TBA : Export Switching.

3 Baseline Model

To capture the features in the data, we introduce searching for imported inputs into a model with endogenous choice of import intermediate inputs ((Halpern, Koren, and Szeidl 2011)).

3.1 Production and Imported Inputs

The demand firm i face is:

$$q(i) = Dp(i)^{-\rho}.$$

Each firm i produces goods using labor and intermediate inputs,

$$Y_i = A_i L_i^{1-\alpha} X_i^{\alpha}.$$

Intermediate inputs consist of a bundle of intermediate goods indexed by $j \in [0,1]$ and aggregated according to a Cobb-Douglas technology:

$$X_i = \exp\left[\int_0^1 \ln X_{ij} dj\right].$$

For each type j of intermediate goods, there are two varieties: home, H, and foreign, M,

$$X_{ij} = \left[H_{ij}^{\frac{\sigma-1}{\sigma}} + (b_{ij} M_{ij})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

where σ is the elasticity of substitution between the home and foreign varieties in the production function. $b_{ij} > 1$ measure the productivity advantage of the foreign varieties j in producing i.

We focus on the imports variety decision and ignore firms entry and exit for now. Firms know their productivity A. Furthermore, to import n varieties firms need to pay a fixed cost of $n^{\eta}F$ units of labor. We assume $\eta > 1$ so the cost function is convex on the number of varieties as in (Gopinath and Neiman 2011). Each input productivity has a distribution $f(b)$, with support over $(1, \infty)$. After the imported inputs productivity are realized, firms decide their imported input bundles. Given this setup, firm i would use all the home inputs, and some foreign inputs which depend on the trade off between productivity advantage and fixed cost of importing. Assume home varieties have price p_H and foreign varieties have the same price εp_F.

3.2 Firms Problem

For a firm with productivity A, after the imported input productivity realized, he decides which foreign inputs to use:

$$\min_{L,\Omega,\{H_j,F_j\}} \left\{ wL + \int_0^1 p_H H_j dj + \int_\Omega \varepsilon p_F M_j dj + |\Omega|^\eta wF \right\}$$

such that:

$$Y = AL^{1-\alpha} X^\alpha$$

$$X = \exp\left[\int_0^1 \ln X_j dj\right] \tag{1}$$

$$X_j = \left[H_j^{\frac{\sigma-1}{\sigma}} + (b_j M_j)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

Guess the solution is that firm use imported inputs that have productivity larger than b^*. By law of large numbers, there are $f(b)$ fraction of inputs draw productivity equal b.

$$\int_0^1 \left(\ln \left[1 + I(im) \left(b_j \frac{p_H}{\varepsilon p_F} \right)^{\sigma-1} \right]^{\frac{1}{1-\sigma}} \right) dj = \int_{b^*}^\infty \ln \left[1 + \left(b \frac{p_H}{\varepsilon p_F} \right)^{\sigma-1} \right]^{\frac{1}{1-\sigma}} f(b)\, db.$$

And the measure of inputs firm would use is $\int_{b^*}^\infty f(b)\, db$.

Solving the firm problem[13], we can express his unit cost, λ, as

$$\lambda = \frac{C}{A} G(b^*)^{-\alpha}.$$

where $C = \left(\frac{w}{1-\alpha}\right)^{1-\alpha} \left(\frac{p_H}{\alpha}\right)^\alpha$, $G(b^*) = \exp\left[\alpha \int_{b^*} (\ln B) f(b)\, db\right]$ and $B = \left[1 + \left(b\frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}$. So the unit cost depends on firm's productivity A, the home countries factor costs C, and the benefit from using more productivity foreign inputs $G(b^*)$.

If the firm uses imported inputs in Ω, and produce output Y, his total cost is,

$$\lambda Y + |\Omega|^\eta wF,$$

[13] See Theoretical Appendix for a detailed derivation of the model.

and he maximizes net profits:

$$\max_{Y,b^*} \left(\frac{Y}{D}\right)^{-\frac{1}{\rho}} Y - \lambda Y - m(b^*)^{\eta} wF$$

where defining $m(b^*) = \int_{b^*} f(b)\, db$.

The two first order conditions are for optimal output and the cutoff b^*. Plugging the former into the latter, we have that the marginal input[14] satisfies,

$$\alpha D \left(\frac{\rho - 1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^*)^{\alpha(\rho-1)} \ln B^* = \eta m(b^*)^{\eta-1} wF. \tag{3}$$

Adding more imports, i.e., b^* is smaller, increases the benefit from using more productivity foreign inputs $G(b^*) = \exp\left[\alpha \int_{b^*} (\ln B)\, f(b)\, db\right]$, hence the unit cost is lower. And the firm faces higher demand. On the other hand, using more imports incurs an increasing fixed cost.

The profits is $\frac{1}{\rho-1}\lambda Y - m(b^*)^{\eta} wF$. Using the FOC for b^*, profits can be written as

$$\pi = m(b^*)^{\eta-1} wF \left(\frac{1}{\rho - 1} \frac{\eta}{\alpha \ln B^*} - m(b^*)\right). \tag{4}$$

3.3 Switching

At period 2, importers decide if they want to pay a searching cost F_s to be connected with a new bunch of foreign supplier for the varieties. If they pay the sunk cost, they get a new draw for each input. For each input, they can choose importing from the more productive suppliers. Suppose the optimal inputs set for a firm is Ω_1 at time 1 and Ω_2 at time 2. Firm may add a variety if $b_{j1} \notin \Omega_1$ and $b_{j1} \in \Omega_2$(won't be the case) or $b_{j2} \in \Omega_2$. The firm may also keep a variety if $b_{j1} \in \Omega_1$ and b_{j1} or $b_{j2} \in \Omega_2$, he may drop a variety if $b_{j1} \in \Omega_1$ and $b_{j1} \notin \Omega_2, b_{j2} \notin \Omega_2$.

We assume $f(b)$, the productivity distribution for each supplier is a Frechet distribution, which will give us close form solutions[15]

$$F(b) = \exp\left(-T(b-1)^{-\theta}\right)$$

The maximum of two draws for a variety has the distribution with parameter $2T$. Letting small a denote age, the distribution would be $f_a(b)$ with parameter aT (if firms always choose to pay F_s). The total profit change if they search for new suppliers is $\frac{d\pi}{da}$, and the firm will pay to search for new draws if it is larger than wF_s. We next turn to summarize the solution.

[14] There is a unique b^* if the second order condition is negative. See Theoretical Appendix for parameter restriction.

[15] The model can be simulated for more general distributional assumptions.

3.4 Solution

To summarize, at age a, firm with productivity A, uses inputs that have productivity larger than a cutoff b_a^* that satisfies,

$$\alpha D\left(\frac{\rho-1}{\rho}\right)^{\rho}\left(\frac{C}{A}\right)^{1-\rho}G(b_a^*)^{\alpha(\rho-1)}\ln B_a^* = \eta m(b_a^*)^{\eta-1}wF, \tag{5}$$

and search for new draws if

$$\frac{d\left(m(b^*)^{\eta-1}\left(\frac{1}{\rho-1}\frac{\eta}{\alpha\ln B^*}-m(b^*)\right)wF\right)}{da} \geq wF_s \tag{6}$$

Note that given parameters $\left(\alpha, C, \rho, \sigma, \eta, w, F, F_s, \frac{p_H}{\varepsilon p_F}, T, \theta\right)$, for each firm A, we can solve the optimal imports cutoff b_a^*, $a = 1, 2, 3...$

3.5 Propositions

Our first proposition addresses the well known fact, also present in our data, that more productive firms use more imported inputs.

Proposition 1 *More productive firms use more imports.*

Proof. See Theoretical Appendix in section 6.2.

$$\frac{db_a^*}{dA} < 0,$$

so when firm productivity increases, the input cutoff decreases and the firm uses more inputs[16].
■

One of the key features we find is that firms are simultaneously adding and dropping imported varieties. Our model generates such behavior by combining search of better inputs with the possibility of dropping those that are less productive. The next proposition shows this feature of the model analytically.

Proposition 2 *If firms pay the search costs to find new suppliers, they will add and drop varieties simultaneously .*

Proof. See Theoretical Appendix in section 6.3. $\frac{db^*}{da} > 0$, searching new suppliers raises cutoff. Some original inputs should be dropped, but the measure of imported inputs increases. So if firms paid the search cost, they add and drop imported inputs simultaneously. ■

[16] Note the distribution of the productivity of imports input the firm use also shift to the right.

Proposition 3 *Searching new input suppliers increases profits. And the increased profits are larger for more productive firms. Hence, larger firms are more likely to do add and drop.*

Proof. See Theoretical Appendix in section 6.4. $\frac{d\frac{d\pi}{da}}{dA} > 0$, so more productive firms are more likely to pay the search cost. When firms want to find better imported inputs they pay a fixed cost to reorganize production and search. Once paid that fixed cost, their variable cost function improves which allows them to sell more. The benefit is larger for more productive firms, they are more likely to pay the search cost, and more likely to add and drop varieties. ■

Our evidence uses RER variation to document that adding and dropping is reduced during a devaluation in Colombia. And the net imports fall. In our model firms do adding and dropping, and during devaluation, they use less imported inputs.

Proposition 4 *In a devaluation firms use less imported inputs.*

Proof. See Theoretical Appendix in section 6.5. $\frac{db^*}{d\varepsilon} > 0$, then when ε increases, the productivity cutoff increases, firms use less imported inputs. ■

The last proposition shows that the number of firms that add and drop decreases with a RER devaluation.

Proposition 5 *When the currency devaluates, less firms would like to pay the search costs to find new suppliers. Moreover, conditional on paying the cost there firms do less dropping.*

Proof. See Theoretical Appendix in section 6.6. Because $\frac{d\left(\frac{d\pi}{da}\right)}{d\varepsilon} < 0$,the change of profit from searching is lower when the currency devaluates as imports have become more expensive. Accordingly, fewer firms would pay these searching cost. Therefore, fewer firms would add and drop simultaneously. Furthermore, $\frac{\left(\frac{db^*}{da}\right)}{d\varepsilon} < 0$ which implies the number of dropping varieties falls in a devaluation. ■

4 Evidence On Firms Import Switching Behavior

In this section we provide further evidence on firms imported input switching behavior is that consistent with model predictions. We run 4 regressions, each of which is associated with a proposition in the section 3:

In Proposition 1 we show that more productive firms use more imported inputs. Accordingly we run,

$$M_{it} = \alpha_t + \gamma_i + \beta productivity_{t-1} + \varepsilon_{it}$$

where M_{it} is import value or number of different variety of firm i in time t. α_t and γ_i are time and firm fixed effects.

	(1)	(2)
	log_v_imports	log_ndiff
L.log_productivity	0.0380^{***}	0.0176^{***}
	(6.60)	(7.99)
N	38785	38785

t statistics in parentheses

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

Table 2: Import Level And Productivity At The Firm Level.

In table 2, we run import value or the number of different imported varieties on lagged firm size[17]. We proxy firm productivity with sales[18], and do so throughout this section. Consistent with the model and the literature, we find that more productive firms import more.

We next turn to Proposition 3 which states that larger firms gain more through more intense reorganizing. That is, larger firms will do more intense switching so there will be more adding and dropping[19]. We run,

$$\triangle\ M_{it} = \alpha_t + \gamma_i + \beta productivity_{t-1} + \varepsilon_{it}$$

where $\triangle\ M_{it}$ is the gross change: value(number) of added inputs and value(number) of dropped inputs.

[17] All variables are in logs in this section.

[18] Other measures available soon.

[19] The model also predicts that larger firms are more likely to do switching. This prediction is the extensive margin version of the result in table 3. To confirm that, we run a linear probability model and we get a positive slope on productivity no matter how we define the switching dummy; we use 3 different definitions: add vs do nothing, drop vs do nothing, and either add or drop vs do nothing. We also control for firm and year fixed effects.

	(1)	(2)	(3)	(4)
	log_v_add_imp	log_v_drop_imp	log_ndiff_add	log_ndiff_drop
L.log_productivity	0.0210**	0.0310***	0.0120***	0.0191***
	(3.10)	(4.02)	(4.29)	(6.46)
N	26943	27050	26943	27050

t statistics in parentheses

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

Table 3: Adding And Dropping Imported Inputs And Firm Productivity

Results are reported in table 3. We find positive coefficients so more productive firms add and drop more, both in terms of value and number of varieties.

In Proposition 3 we show that the gross change of inputs matters for firms productivity growth. In particular, a key prediction of the model is that firms that pay the fixed cost of switching engage in adding and dropping which in turn improves their productivity and sales. Accordingly, we run,

$$\triangle Y_{it} = \alpha_t + \gamma_i + \beta_1 Change of inputs_{it} + \varepsilon_{it}$$

where Y_{it} is sales and $Change of inputs_{it}$ can be either value or numbers.

	(1)	(2)	(3)	(4)
	change_log_prod	change_log_prod	change_log_prod	change_log_prod
L.log_productivity	-0.671***	-0.670***	-0.671***	-0.670***
	(-8.57)	(-8.56)	(-8.56)	(-8.55)
log_gross_margin_val	0.0500***			
	(3.52)			
log_net_margin_val		0.0167		
		(1.86)		
log_gross_margin_ndiff			0.129***	
			(3.80)	
log_net_margin_ndiff				0.00116
				(0.91)
N	23355	23355	23355	23355

t statistics in parentheses

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

Table 4: Productivity Growth And Gross Vs Net Import Change

In table 4 we obtain results consistent with the prediction. Notice how gross changes for both value and number of varieties are positively associated with changes in sales; also, note how the net has lower economic significance than the equivalent gross variable. Furthermore, unlike the gross, the net is statistically insignificant.

The last prediction we test is Proposition 5, which shows that, during the devaluation, less firms were doing add and drop, and each firm was doing less add and drop. Our specification for the later prediction[20] is,

$$\triangle\ M_{it} = \gamma_i + \beta_1 productivity_{t-1} + \beta_2 RER_t + \varepsilon_{it}$$

where $\triangle\ M_{it}$ is the gross change: value(number) of added inputs and value(number) of dropped inputs. Results in table 5 show that adding and dropping falls when the RER[21] goes up, ie, during the devaluation. We interpret this as firms reducing their reorganizing activities as a consequence of input prices going up.

[20] The former prediction is the extensive margin: fewer firms do switching during a devaluation. To confirm that, we run a linear probability model and we get a negative slope on the RER no matter how we define the switching dummy; we use 3 different definitions: add vs do nothing, drop vs do nothing, and either add or drop vs do nothing.

[21] RER_t is the US-Colombia, RER with base year 1992.

	(1)	(2)	(3)	(4)
	log_v_add_imp	log_v_drop_imp	log_ndiff_add	log_ndiff_drop
L.log_productivity	0.0211**	0.0509***	0.00951***	0.0273***
	(3.09)	(5.75)	(3.39)	(7.81)
rer	-2.287***	-3.556***	-0.606***	-1.361***
	(-20.90)	(-32.54)	(-12.64)	(-29.17)
N	26943	27050	26943	27050

t statistics in parentheses

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

Table 5: Import Switching and RER

5 Conclusion

To analyze the impact of devaluation on firms imports, we look at the change of firms import varieties during the devaluation in Colombia. We observe that many firms exited from imports market and many firms dropped some imported varieties, but we also observe many firms entered, and those who dropped imports varieties added new varieties at the same time. This leads us to compare firms import switching behavior during devaluation with other normal episode. We find most of firms add and drop import varieties all the time. During the devaluation, they actually dropped fewer varieties than the normal time, but the new varieties they added are even less, which caused the fall in their imports varieties.

We introduce searching for imported inputs into a model with endogenous choice of imported intermediate inputs. Firms search for imported inputs suppliers and reorganize their input usage over time. With an imported input cost shock, e.g., a devaluation, the benefit from searching new suppliers decreases, which leads to less adding and dropping in firms imported inputs. The model predicts that more productive firms use more imports, they benefit more from searching new imports suppliers, and do add and drop simultaneously. In a devaluation, fewer firms add and drop varieties, and for firms do add and drop, the value of adding and dropping decrease. We find the relations between import switching and firms size are consistent with the model predictions. (To be continued.)

6 Theoretical Appendix

6.1 Firms' Problem

The Lagrangian for the firm problem in the main text is:

$$\begin{aligned} L &= wL + \int_0^1 p_H H_j dj + \int_\Omega \varepsilon p_F M_j dj + |\Omega|^\eta wF + \lambda \left(Y - AL^{1-\alpha} X^\alpha\right) + \psi \left[X - \exp\left[\int_0^1 \ln X_j dj\right]\right] \\ &\quad + \int_\Omega \chi_j \left[X_j - \left[H_j^{\frac{\sigma-1}{\sigma}} + (b_j M_j)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right] dj \end{aligned}$$

Guess that the solution is that firms use imported inputs that have productivity larger than b^*. By the law of large numbers, because there are $f(b)$ fraction of inputs draw productivity equal b. $\int_0^1 \left(\ln\left[1 + I(im)\left(b_j \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{1-\sigma}}\right) dj = \int_{b^*}^\infty \ln\left[1 + \left(b \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{1-\sigma}} f(b)\, db$. And the measure of inputs the firm would use is $\int_{b^*}^\infty f(b)\, db$.

Solving this problem, we get for intermediate good j:

$$X_j = \frac{\lambda \alpha Y}{p_H \left[1 + \left(b_j \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{1-\sigma}}} \text{ if } M_j > 0,$$

and firm unit cost is

$$\lambda = \frac{1}{A}\left(\frac{w}{1-\alpha}\right)^{1-\alpha} \left(\frac{\exp\left[\int_0^1 \ln p_H dj\right]}{\alpha \exp\left[\int_{b^*}^\infty \ln\left[1 + \left(b \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}} f(b)\, db\right]}\right)^\alpha.$$

Define $C = \left(\frac{w}{1-\alpha}\right)^{1-\alpha} \left(\frac{p_H}{\alpha}\right)^\alpha$, $G(b^*) = \exp\left[\alpha \int_{b^*}^\infty (\ln B) f(b)\, db\right]$, and $B = \left[1 + \left(b \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}$ to obtain unit cost as

$$\lambda = \frac{1}{A} C G(b^*)^{-\alpha}.$$

Firm's total cost is then:

$$\lambda Y + |\Omega|^\eta wF,$$

and firm maximizes net profits:

$$\begin{aligned} & \max_{Y,b} \left(\frac{Y}{D}\right)^{-\frac{1}{\rho}} Y - \lambda Y - |\Omega|^{\eta} wF \\ = & \max_{Y,b} \left(\frac{Y}{D}\right)^{-\frac{1}{\rho}} Y - \lambda Y - m(b^*)^{\eta} wF, \end{aligned}$$

where $m(b^*) = \int_{b^*}^{\infty} f(b)\, db$.

The two first order conditions are

$$Y = \left(\frac{\rho - 1}{\rho}\right)^{\rho} D\lambda^{-\rho}$$

and

$$-\frac{d\lambda}{db} Y - \eta m^{\eta-1} m' wF = 0$$

This last condition can be written as

$$-\frac{d\lambda}{db} Y - \eta m^{\eta-1} f(b^*) wF = -Y\frac{C}{A}(-\alpha) G(b^*)^{-\alpha-1} G'(b^*) + \eta m^{\eta-1} f(b^*) wF$$

$$\alpha Y \frac{C}{A} G(b^*)^{-\alpha-1} \left(G(b^*)(-1) \ln \left[1 + \left(b^* \frac{p_H}{\varepsilon p_F} \right)^{\sigma-1} \right]^{\frac{1}{\sigma-1}} f(b^*) \right) + \eta m^{\eta-1} f(b^*) wF = 0,$$

Using a more compact form, the marginal input satisfies:

$$\alpha Y \frac{C}{A} G(b^*)^{-\alpha} \ln B^* = \eta m(b^*)^{\eta-1} wF$$

and using the FOC for Y becomes 3 in the main text:

$$\alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^*)^{\alpha(\rho-1)} \ln B^* = \eta m(b^*)^{\eta-1} wF \tag{7}$$

By rewriting the above equation, we obtain the next equation which will be the basis of our proofs:

$$\alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^*)^{\alpha(\rho-1)} \ln B^* - \eta m(b^*)^{\eta-1} wF \tag{8}$$

To check the property of the optimal b^* we differentiate 8. The second order condition is negative as long as

$$\alpha D\left(\frac{\rho-1}{\rho}\right)^{\rho}\left(\frac{C}{A}\right)^{1-\rho}G(b^*)^{\alpha(\rho-1)}f(b^*)\left(\alpha\left(\rho-1\right)\left(\ln B\right)^2 f\left(b^*\right)-\frac{\left(\frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}b^{*\sigma-2}}{\left[1+\left(b^*\frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]}\right)\cdots$$
$$-\eta(\eta-1)m^{\eta-2}(f(b^*))^2wF<0$$

which occurs if η is large enough. In that case the optimal b^* is unique.

The profit is

$$\pi=\frac{1}{\rho-1}\lambda Y-m(b^*)^{\eta}wF,$$

and $Y=\left(\frac{\rho-1}{\rho}\right)^{\rho}DP^{\rho-1}\lambda^{-\rho}$, so

$$\pi=\frac{1}{\rho-1}D\left(\frac{\rho-1}{\rho}\right)^{\rho}\left(\frac{C}{A}\right)^{1-\rho}G(b^*)^{\alpha(\rho-1)}-m(b^*)^{\eta}wF,$$

which using 7 can be written as

$$\pi=\frac{1}{\rho-1}\frac{\eta m(b^*)^{\eta-1}wF}{\alpha\ln B^*}-m(b^*)^{\eta}wF=m(b^*)^{\eta-1}wF\left(\frac{1}{\rho-1}\frac{\eta}{\alpha\ln B^*}-m(b^*)\right). \tag{9}$$

This is another key equation in our proofs. The total profit change if they search for new suppliers is $\frac{d\pi}{da}$, and the firm will pay to search for new draws if it is larger than wF_s, i.e.,

$$m(b^*_{a+1})^{\eta-1}wF\left(\frac{1}{\rho-1}\frac{\eta}{\alpha\ln B^*}-m(b^*_{a+1})\right)-m(b^*_a)^{\eta-1}wF\left(\frac{1}{\rho-1}\frac{\eta}{\alpha\ln B^*}-m(b^*_a)\right)>wF_s \tag{10}$$

6.2 Proof of proposition 1

Proof. From equation 8, $\frac{d(8)}{db^*}>0$ and $\frac{d(8)}{dA}>0$. So $\frac{db^*}{dA}=-\frac{\frac{d(8)}{dA}}{\frac{d(8)}{db^*}}<0$.

$$\frac{db^*_a}{dA}<0,$$

so when firm productivity increases, the input cutoff decreases and the firm uses more inputs. ■

6.3 Proof of proposition 2

Proof. From equation 8, $\frac{d(8)}{db^*}>0$, because $SOC=-\frac{d(8)f(b)}{db}=-\frac{d(8)}{db}f(b)$ and

$$
\begin{aligned}
\frac{d(8)}{da} = \alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} \ln B^{*} \alpha(\rho-1) G(b^{*})^{\alpha(\rho-1)-1} \frac{dG(b^{*})}{da} - \\
\cdots \eta(\eta-1) m(b^{*})^{\eta-2} w F \frac{dm(b^{*})}{da} = \\
\alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} \ln B^{*} \alpha(\rho-1) G(b^{*})^{\alpha(\rho-1)} \alpha \int_{b^{*}} \ln B \frac{df(b)}{da} db - \\
\cdots \eta(\eta-1) m(b^{*})^{\eta-2} w F \int_{b^{*}} \frac{df(b)}{da} db
\end{aligned}
\tag{11}
$$

Looking at the second term we notice that using more inputs, improves productivity but increases marginal costs as well. $\frac{d(8)}{da}$ can be positive or negative. If η big enough, it is negative. Since $\frac{db^{*}}{da} = -\frac{\frac{d(8)}{da}}{\frac{d(8)}{db^{*}}} > 0$, searching new suppliers increases cutoff. Some original inputs should be dropped, but the measure of imported inputs increases. So if firm paid the search cost, they add and drop imported inputs simultaneously. ■

6.4 Proof of proposition 3

1. Searching new input suppliers increases profits.

   Proof.

$$
\begin{aligned}
\frac{d\pi}{da} = \frac{\partial \pi}{\partial b^{*}} \frac{\partial b^{*}}{\partial a} + \frac{\partial \pi}{\partial a} = \left.\frac{\partial \pi}{\partial a}\right|_{b_a^{*}} = \\
\alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^{*})^{\alpha(\rho-1)-1} \frac{dG(b^{*})}{da} - \eta m(b^{*})^{\eta-1} w F \frac{dm(b^{*})}{da} = \\
\alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^{*})^{\alpha(\rho-1)} \int_{b^{*}} \ln B \frac{df(b)}{da} db - \eta m(b^{*})^{\eta-1} w F \int_{b^{*}} \frac{df(b)}{da} db = \\
\frac{\eta m(b^{*})^{\eta-1} w F}{\ln B^{*}} \int_{b^{*}} \ln B \frac{df(b)}{da} db - \eta m(b^{*})^{\eta-1} w F \int_{b^{*}} \frac{df(b)}{da} db = \\
\eta m(b^{*})^{\eta-1} w F \int_{b^{*}} \left(\frac{\ln B}{\ln B^{*}} - 1\right) \frac{df(b)}{da} db > 0
\end{aligned}
$$

   where the 3rd equality uses equation 9, and the 5th equation 7.

2. The increased profit from searching new suppliers is larger for more productive firms. For this part of the proof start using the intermediate step derived above,

$$
\frac{d\pi}{da} = \alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^{*})^{\alpha(\rho-1)} \int_{b^{*}} \ln B \frac{df(b)}{da} db - \eta m(b^{*})^{\eta-1} w F \int_{b^{*}} \frac{df(b)}{da} db
$$

Now, take derivatives wrt A,

$$\frac{d\frac{d\pi}{da}}{dA} = \alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} (\rho-1) A^{\rho-2} C^{1-\rho} G(b^*)^{\alpha(\rho-1)} \int_{b^*} \ln B \frac{df\,(b)}{da} db > 0$$

■

6.5 Proof of proposition 4

Proof. From equation 8, $\frac{d(8)}{db^*} > 0$,. We also have

$$\frac{d(8)}{\varepsilon} = \alpha D \left(\frac{\rho-1}{\rho}\right)^{\rho} \left(\frac{C}{A}\right)^{1-\rho} G(b^*)^{\alpha(\rho-1)} \cdots$$

$$\left(\frac{-\left(b^* \frac{p_H}{p_F}\right)^{\sigma-1} \varepsilon^{-\sigma}}{1+\left(b^* \frac{p_H}{p_F}\right)^{\sigma-1}} + \ln B_a^* \alpha(\rho-1) \int_{b^*} \frac{-\left(b \frac{p_H}{p_F}\right)^{\sigma-1} \varepsilon^{-\sigma}}{1+\left(b \frac{p_H}{p_F}\right)^{\sigma-1}} f\,(b)\, db \right) < 0$$

Since $\frac{db^*}{d\varepsilon} = -\frac{\frac{d(8)}{d\varepsilon}}{\frac{d(8)}{db^*}} > 0$, then when ε increases, the productivity cutoff increases, firms use less imported inputs. ■

6.6 Proof of proposition 5

Proof. Equation 10 states the condition under which firms search for new draws. Taking a as continuous,

$$\frac{d\left(\frac{d\pi}{da}\right)}{d\varepsilon} = \frac{d\left(\eta m(b^*)^{\eta-1} wF \int_{b^*} \left(\frac{\ln B}{\ln B^*}-1\right) \frac{df(b)}{da} db\right)}{d\varepsilon} = \frac{d\eta m(b^*)^{\eta-1} wF \int_{b^*} \left(\frac{\ln B}{\ln B^*}-1\right) \frac{df(b)}{da} db}{db^*} \frac{db^*}{d\varepsilon} =$$
$$\left(\eta(\eta-1) m^{\eta-2} m'^{\eta-1} wF \left(\int_{b_a^*} \ln B \frac{df_a\,(b)}{da} db\right) \frac{\left(\frac{p_H}{\varepsilon p_F}\right)^{\sigma-1} b_a^{*\sigma-2}}{(\ln B_a^*)^2 \left[1+\left(b_a^* \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]} \right) \frac{db_a^*}{d\varepsilon} =$$
$$\left(-\eta(\eta-1) m^{\eta-2} f(b_a^*) wF - \eta m^{\eta-1} wF \left(\int_{b_a^*} \ln B \frac{df_a\,(b)}{da} db\right) \frac{\left(\frac{p_H}{\varepsilon p_F}\right)^{\sigma-1} b_a^{*\sigma-2}}{(\ln B_a^*)^2 \left[1+\left(b_a^* \frac{p_H}{\varepsilon p_F}\right)^{\sigma-1}\right]} \right) \frac{db_a^*}{d\varepsilon} < 0 \tag{12}$$

because $\frac{db_a^*}{d\varepsilon} > 0$. The change of profit from searching is lower when the currency devaluates as imports have become more expensive. Accordingly, fewer firms would pay the searching cost. ■

6.7 Empirical Appendix

Quantile	Total	Add	Drop	Net	Add share	Drop share
1	6.04	2.19	2.17	0.57	0.63	0.36
2	7.55	2.85	2.67	0.82	0.65	0.36
3	12.67	4.8	4.25	1.49	0.62	0.35
4	52.25	15.28	14.49	8.11	0.47	0.33
Total	20.98	6.67	6.26	2.97	0.58	0.34

Table 6: Number Of Different Products By Quantile. Average Over 1994-2009.

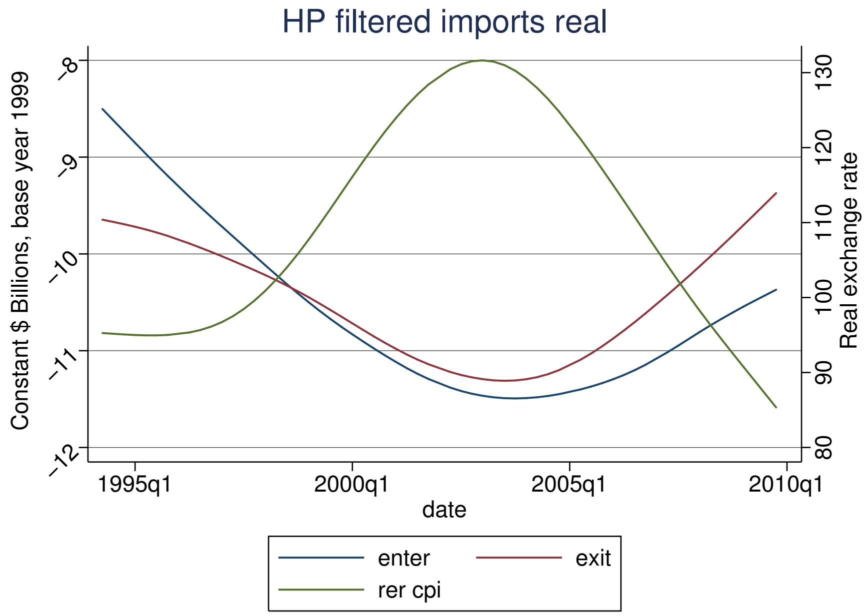

Figure 6: Aggregate Entry And Exit Value Against The RER. HP Filtered Data.

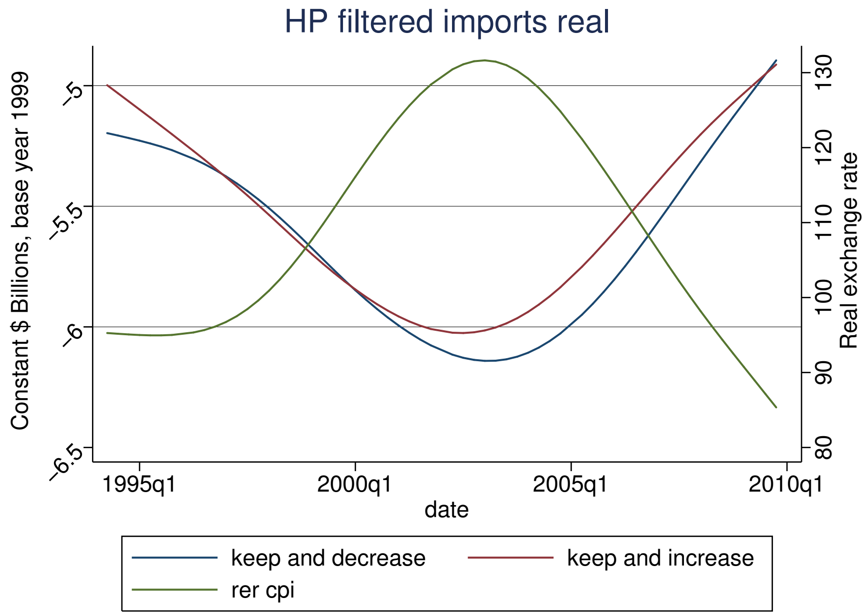

Figure 7: Aggregate Continuing Products Value Against The RER. HP Filtered Data.

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