The exchange rate pass-through, the internet and the cost of waiting.

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Abstract

'Pricing to market' is considered as the driving factor behind low exchange rate pass-through into import prices. We show that even in a world where firms cannot discriminate across markets, there is still room left for low exchange rate pass-through. In our model, trade takes time and consumers are thus facing 'waiting costs'. These costs directly affect the expenditure switching behavior of consumers. We use our framework to study internet markets where these 'waiting costs' are particularly important. Using a database on postal exchanges we estimate the impact of time into cross-border e-commerce trade and we quantify the effect of waiting one more day.

Keywords: Online trade, Shipping time, Exchange rates.

JEL Classification: F14, F31.

1. Introduction

Domestic prices react only mildly to exchange rate movements. This statement constitutes one of the six international economics puzzles in Obstfeld and Rogoff (2001). Low exchange rate pass-through is thought to be driven by firms' market power that translates into 'Pricing to Market' (PTM) (Campa and Goldberg, 2005; Corsetti and Dedola, 2005). In the traditional international trade framework firms are able to discriminate across markets. In contrast, firms selling through internet platforms set at a unique world price. Recent research by Anson et al. (2014) points out that we observe low exchange rate pass-through in online markets in spite of the absence of PTM.

In this paper we focus exclusively on firms selling on-line. In this framework, we provide theoretical and empirical evidence on imperfect exchange rate pass-through without PTM. We anchor our theoretical analysis on stylized facts of cross-border e-commerce trade, developing a simple and analytically tractable model. In our model we streamline short-run currency shocks, typical of the foreign exchange markets, to which producers cannot immediately adjust. Consumers however react to shocks by shifting their expenditure. The underlying assumption of our model is that e-commerce transactions for physical goods feature both a 'monetary cost' (the world price of the good) and a 'waiting cost' (goods are delivered after purchase). Consequently, our first finding is of theoretical nature. We predict that the higher the share of waiting costs in the net price of the good, the lower, in absolute value, the elasticity of demand with respect to the exchange rate. Logically and intuitively, the exchange rate pass-through in the short-run will be close to one for markets with low waiting costs and zero for those with high ones.

We test our prediction using a panel database on international postal exchanges. The database, collected by the Universal Postal Union (UPU), contains both information on the time parcels take to reach the final consumer and on the volume of parcels traded by a given country pair. Our coverage is comprehensive, with data on 133 exporters to 126 destinations.

In line with our theoretical model, we define the cost of waiting as an increasing function of shipping times. Eventually, we estimate the impact of an additional day on exchange rate elasticities. We find that an increase in the shipping time from one day to twelve days reduces the bilateral exchange effect by roughly 50 %. However, in some estimations we find the effect to be as little as four days.

In opposition to the traditional trade framework, where waiting costs are born by intermediates, e-commerce goods ship directly to final consumers who internalize delivery times. Firms selling through internet platforms, such as Google or Amazon, are well aware of these costs and many are seeking new and faster ways to deliver.[1] Our study is the first to test if these costs matter and to attempt to quantify them. Compared with off-line markets, on-line transactions are characterised by lower search costs and less frictions (Hortaçsu et al., 2009; Lendle et al., 2012). Hortaçsu et al. (2009) point out that consumers are able to compare prices and have complete listings conducting just a few computerized searches. It is clear that comparison to offline markets, search costs in the internet are greatly reduced. However, we argue that new costs arise such as 'waiting costs'. Olarreaga et al. (2013) provide a thoughtful comparison between online and offline exporting firms using Ebay data. They find that in spite of a few differences, offline and online firms share many similarities. Ellison and Ellison (2009) point out that in the absence of obfuscation mechanisms we should expect low price dispersion and high price elasticities. We expect consumers to arbitrate internationally and react to exchange rate movements as in Anson et al. (2014). So far, the only evidence for high exchange rate pass-through in internet markets is given by Gorodnichenko and Talavera (2014). The authors analyze internet price quotes in Canada and the United States. They find a high exchange rate pass-through that may be interpreted by our model as well. In fact as Canada and the United States are geographically close they exhibit low shipping times and higher exchange rate pass-through according to our model.

[1] The Economist publication of May 3rd 2014 covers this topic. See for instance: http://www.economist.com/news/business/21601556-online-firms-are-plunging-same-day-delivery-again-same-day-dreamers

We extend Gorodnichenko and Talavera's (2014) work by using frequency-type data on the effective amount of traded parcels. Our measure acts as a proxy of weekly demand changes.

Even though literature on trade and time is sizable, there are no applications to e-commerce 'waiting costs'. A very important contribution by Hummels and Schaur (2013) investigates the consumers' valuation of time and the willingness-to-pay of firms engaged in trade to avoid lengthy shipping times. The authors focus their research mostly on modal transportation choices showing that consumers value the quality of faster delivery times. Hence firms need to engage in air transport to meet demand of time sensitive goods. Our approach is different. We acknowledge that consumers value time by internalizing a disutility equivalent in the net price of the good. Nevertheless, we point out that in the context of e-commerce, consumers internalize these costs entirely since firms do not use freight companies but the postal network. Our empirical angle differs as well. While their database consists of imports of the United States and cargo shipping data, our empirical analysis covers most of the world. Instead of imports we have parcel flows and detailed estimates of shipping time between all nodes in the postal network. Our higher country coverage comes at a price, we do not have detailed HS classifications but only parcel flows aggregated by country. In contrast to Djankov et al. (2010) who use a gravity difference equation approach to evaluate the trade reducing effects of time, we concentrate our efforts on relating time to price sensitivity and exchange rate pass-through. Berman et al. (2012) categorize the *time-to-ship* as a financial friction. The authors show that during financial crises exporting firms worry more about importers defaulting. Firms adjust their exports to 'closer' markets to compensate for the risk of defaulting of partners that are far away. Therefore the bilateral reduction of trade of a financial crises is increasing in the *time-to-ship*. *Time-to-ship* becomes more than just a trade cost. It directly affects the elasticity of trade to financial risk. Our study, centered on the microeconomics of internet markets, also points out that time plays a role in trade elasticities. One key difference is that consumers pay e-commerce goods in advance which puts the friction on the demand side instead of the supply.

We face three main challenges in estimating the effect of time costs. First, we need reliable daily trade data to properly identify the effect of day to day changes of exchange rates and adequate estimates of delivery times. In fact, our identification approach lies on the consumer expenditure switching effect of exchange rates so we need high frequency data to estimate the arbitrage equation. Second, we need a model where the exchange rate pass-through interacts with delivery times. To the best of our knowledge, this channel has not been explored in the literature. Third, we need a proper identification strategy dealing with the possible endogeneity of delivery times and parcel flows.

We tackle the first challenge using the postal exchanges database of the UPU. The database allows us to observe daily merchandise trade generated by on-line markets all over the world for UPU members. Then, we use a differentiated varieties model with a pricing equation similar to Hummels et al. (2009) that integrates the cost of time. The model yields a sharp prediction claiming that exchange rate pass-through is negatively related to 'waiting costs'. Our identification strategy faces the possible endogeneity of trade and time instrumenting by the time of shipping documents. Since both parcels and letters use the same distribution network, the delivery schedules are highly correlated. We exploit this fact to construct an instrumental variables estimator.

2. Model

The demand side of our model is closely related to Hummels et al. (2009) demand setup. In their work the authors examine the market power of ocean cargo carriers. They find that cargo companies can effectively discriminate across products and thus charge different shipping prices. Our setup differs in two aspects. First, shipping prices in the postal network are negotiated multilaterally. Second, shipping prices do not depend on the type of good transported.

We consider a world with $j = 1, \ldots, J$ symmetric countries populated by a representative consumer. We define preferences of the representative consumer in country j to be quasi-linear over a domestically produced *numéraire* good and a continuum of varieties, $i \in [0, N]$, of a good differentiated by origin in the spirit of Armington (1969). For simplicity we consider that each country produces one and only one variety.

$$U_j = A_j + \int_0^N q_j(i)^{(\sigma-1)/\sigma} di \tag{1}$$

Where A_j is a domestically produced *numeraire* good and $q_j(i)$ is the quantity of variety i coming from country i. As shown in Hummels et al. (2009), demand for variety i in country j takes the form

$$q_j(i) = \left[\frac{\sigma}{\sigma-1} p_j(i)\right]^{-\sigma} \tag{2}$$

$p_j(i)$ is the price of variety i in country j. When sourcing from country i the consumers face two types of costs. First, the monetary price defined as the world price in producer's currency, $p^w(i)$ converted by the nominal exchange rate $E_j(i)$. Second, the 'cost of waiting' $F_j(i)$ seen as a function of the time to reach country j from country i. Thus the *net consumer price* of variety i is:

$$p_j(i) = \underbrace{E_j(i)p^w(i)}_{\text{Monetary Cost}} + \underbrace{F_j(i)}_{\text{Cost of waiting}} \tag{3}$$

The key element of equation (3) is that the 'cost of waiting' is valued in domestic currency. An alternative approach would be to introduce the valuation of time directly into the utility function, as Hummels and Schaur (2013), and then to calculate a monetary equivalent of the disutility of time. Such an approach would not alter our results but would be more tedious. Now, assuming that $p^w(i)$ does not change, i.e. firms do not adjust, we have imperfect exchange rate pass-through for all $F_j(i) \neq 0$

$$ERPT_j(i) = \frac{\partial \ln p_j(i)}{\partial \ln E_j(i)} = \frac{E_j(i)p^w(i)}{E_j(i)p^w(i) + F_j(i)} = 1 - \frac{F_j(i)}{E_j(i)p^w(i) + F_j(i)} \tag{4}$$

From equations (2) and (3) we derive the demand function for variety j.

$$q_j(i) = \left[\frac{\sigma}{\sigma-1}(E_j(i)p^w(i) + F_j(i))\right]^{-\sigma} \tag{5}$$

As opposed to Hummels et al. (2009), where $F_j(i)$ was a fee for freight companies, consumers internalize the 'cost of waiting'. The price of variety j may be very low but if the waiting time is sizable, consumers may prefer to source the good from a closer destination. This reflects the fact that most consumers tend to shop nationally or from bordering countries unless the price differences are too big. In the short-run, we assume that firms cannot change their output so it is the demand side which is determining the equilibrium. A positive shock to the exchange rate generates a currency depreciation as depicted in equation (6).

$$\frac{\partial q_j(i)}{\partial E_j(i)} = -\sigma \left(1 - \frac{F_j(i)}{E_j(i)p^w(i) + F_j(i)}\right) = -\sigma(1 - s_j(i)) \tag{6}$$

Where $s_j(i)$ can be seen as the share of the 'cost of waiting' in the net price of the good. We assume the world price $p^w(i)$ to be set in advance. We make the assumption with no apology since firms react little to bilateral exchange rate movements for at least two reasons. The first being they can set only one world price so, assuming all markets to have similar weight, revenues from one partner will have weight $1/N$. The second reason is that firms often face 'menu costs' and only prefer to adapt the prices in the long-run. This is the usual assumption leading to price stickiness. The hypothesis is also in line with the findings of Boivin et al. (2012) who show that even if firms react to domestic competition, they do not do so for foreign relative price changes due to exchange rate movements. Nevertheless, we do not attribute this phenomenon to market segmentation but rather to the little weight of a given market.

Implicitly, we are making two additional assumptions. First, we suppose that elasticity of substitution between foreign and domestic goods is the same. As Tille (2001) shows, this assumption has important consequences for Welfare analysis. We state this assumption because of data constraints as we do not observe domestic consumption. Second, we do not consider the possibility that firms ship intermediate goods through the postal network. Seminal work by Obstfeld (1980) illustrates the importance of the elasticity of intermediates' demand in determining changes on the current account. De Melo and Tarr (1992) and Bacchetta and Wincoop (2003) are examples of how different elasticities play a role in calibrating general equilibrium models and their Welfare effects. We acknowledge the weakness of our approach and we state that abstracting from intermediate goods tends to bias our results downwards generating lower exchange rate elasticities.

3. Empirical strategy

According to the predictions of our model, the bilateral effect of a home-currency depreciation on domestic consumption depends on the 'cost of waiting'. The higher the cost, the lower the expenditure switching effect. This hypothesis implies that exchange rate pass-through decreases with shipping times. Unfortunately, a structural estimation of our model is unfeasible because we do not have price data for our parcels. Nonetheless, it is possible to test our predictions in reduced form. Following equation (6), we know that quantities adjust bilaterally as a function of the exchange rate and the 'cost of waiting'. A first attempt to represent the relationship is to estimate a specification of the type

$$\begin{gathered} \ln c_{ijt} = \beta \ln E_{itj} + \gamma \ln E_{itj} F_{ij} + \epsilon_{ijt} \quad F_{ij} = f(t_{ij}) \\ i = 1, \ldots, N \quad j = 1, \ldots, i-1, i+1, \ldots, N \quad t = 1, \ldots, T \end{gathered} \tag{7}$$

where i is the country exporting the parcel, j the destination country and t the week of the year. $\ln c_{ijt}$ is the logarithm of exported parcels and $\ln E_{ijt}$ is the logarithm of the weekly average of bilateral exchange rate. Focusing on the destination country, j, and increase in the exchange rate E_{ijt} is a currency depreciation of the destination country. $f(t_{ij})$ is a function of time, the 'cost of waiting' and ϵ_{ijt} is an idiosyncratic effect. We expect to have correlation within pairs, ij, so we structure the error term to be independent by country pair.

$$\epsilon_{ij} \sim IID(0, \Sigma_{ij}) \tag{8}$$

The estimation of equation (7) by Ordinary Least Squares (OLS) invariably suffers from an omitted variables bias. It is well known that in the context of panel data, the fixed effects estimator of β is consistent for large N. Thus, we introduce a common intercept per country pair ij taking into account all unobserved bilateral factors such as distance, common language, trade agreements and customs unions. We control for country time factors too, such as a multilateral devaluations or aggregate demand shocks by imposing jt fixed effects.

Since the setup is symmetric, we also include exporter-time fixed effects, jt. Accounting for all possible sets of fixed effects, our estimating equation takes the form

$$\ln c_{ijt} = \beta \ln E_{itj} + \gamma \ln E_{itj} f(t_{ij}) + \underbrace{\alpha_{ij} + \lambda_{jt} + \nu_{it}}_{\text{fixed}} + \underbrace{\epsilon_{ijt}}_{\text{random}} \tag{9}$$

Model (9) fits the category of three dimensional panels discussed in Balázsi et al. (2014). As the authors point out, the optimal within transformation that is necessary to wipe out the fixed effects yields biased estimates in the absence of self-flows. The bias is decreasing with the number of importers and exporters. Given our large panel dimensions we do not expect to have that problem.

Now, we highlight some important facts about model (9) and its econometric identification. First of all we need to give a form to $f(t_{ij})$ which could be estimated parametrically or non-parametrically. Since we have sets of high-dimensional fixed effects, non-parametric techniques are cumbersome. Economic intuition tells us that $f(t_{ij})$ is more likely to be an increasing function. For simplicity we assume the time disutility to be a logarithmic function. We acknowledge the limitations of this approach but the results hold too for other strictly increasing functions. Notice that $f(t_{ij})$ may also be interpreted as the effect modifier of a varying coefficient model.

Our main parameter of interest is γ and we interpret it with the following thought experiment. Assume $f(t_{ij})$ to be negligible (low t_{ij}). The expenditure switching effect of a currency depreciation is β. As t_{ij} rises, $f(t_{ij})$ as well rises to reach $\beta + \gamma f(t_{ij})$. *Ceteris paribus* a change on $\ln E_{ijt}$ is

$$\frac{\ln c_{ijt}}{\ln E_{ijt}} = \beta \underbrace{+\gamma f(t_{ij})}_{\text{time cost}} \tag{10}$$

3.1. Causal Effects and Identification

Our first implicit identification assumption is that the exchange rate influences parcel flows. In principle, we may argue that parcel flows are negligible, both in value and mass, compared to the bulk of international trade. Therefore, we do not expect that big commercial imbalances, in parcel terms, actually affect the exchange rate. We think that given the relative small size of international e-commerce, we do not suffer the problem of reverse causality. We consider $\ln E_{itj}$ to be predetermined. However, there might be the issue of endogeneity with respect to delivery times. The mechanism we have in mind is that larger parcel flows push for better infrastructures as well as improved logistics. For example, large flows may produce bottleneck effects in the sorting centers, so postal operators invest in better infrastructure that allows higher parcel flows to move faster. The consequence is that growing volumes affect delivery times. The potential endogenous variable in model (9) is our interaction term, $\ln E_{itj} f(t_{ij})$.

Fortunately, our database provides two possible instruments for tackling this. In addition to the time of shipping parcels, we are also able to calculate the time to send letters and express mail. Thus, we instrument our interaction term by the time of shipping letters interacted with the exchange rate.[2] We have at least two reasons to think that the time of shipping letters is a good instrument. First, it is uncorrelated with parcel volumes as they are different kinds of flows. Letters weigh up to 2 kg while parcels can be up to 30 kg. Second, it is directly linked to the time to ship parcels. For a given dyad they share the same distances and postal operators. We also have a second instrument in the time to ship express mail. Following Anson et al. (2014), express shipments are inelastic to exchange rate movements. However the time to ship express mail is correlated with the time of shipping parcels even if express mail gets shipped much faster. Having two instruments allows us to compute overidentification tests for our two stages regressions so we include them both for completeness.

Another challenge we take into account is the timing of shipping goods. Even though exchange rate movements trigger e-commerce transactions, packaging and shipping goods

[2]We cannot just instrument by the time of shipping letters because we would end up sacrificing the time variation.

takes time. The timing is between four to six working days before export so we consider lags of the exchange rate of a week.

Lastly, when identifying the trade elasticity we are making some assumptions and omissions. We consider all the traded goods as final goods. Some firms may use the postal network to ship intermediate goods but since the majority of goods are for final consumption we abstract from this. Moreover, we do not observe domestic consumption, c_{iit}, so we cannot directly infer the elasticity between domestic and foreign goods.

In spite of these drawbacks, our approach has the benefit of exploiting data from a unifying source, the UPU, allowing for international comparisons. All the data points are the product of tracking number scans and dispatch bags so the accuracy is very high. Furthermore, we can take advantage of the high frequency nature of our data to look for arbitrage movements which would not be possible with traditional trade data.

4. Data Description

Our empirical strategy requires the use of high frequency data in order to be able to observe the smallest of arbitrage movements. With lower frequency data it would be much more difficult to capture the impact of exchange rates as other effects may pollute the analysis. Since international trade data is unavailable on a daily basis, we proxy these flows with international parcel data. By exploiting higher frequencies, our approach allows us to deal with the aggregation bias. For a discussion on what type of goods are shipped through the postal network refer to Anson et al. (2014). The authors find that the goods are typically light weight and the result of e-commerce sales, see the sample survey in Table 1.

Table 1: Products transported by international postal networks

HS2	Description	Freq.
61	Art of apparel & clothing access,	0.136
49	Printed books, newspapers, pictures	0.123
85	Electrical mchy equip parts therof	0.108
95	Toys, games & sports requisites; pa	0.095
64	Footwear, gaiters and the like; par	0.054
21	Miscellaneous edible preparations.	0.049
70	Glass and glassware.	0.038
33	Essential oils & resinoids; perf,	0.026
90	Optical, photo, cine, meas, checkin	0.026
84	Boilers, mchy & computers	0.026
62	Art of apparel & clothing access, n	0.025
87	Vehicles o/t railw/tramw roll-stock	0.023
71	Natural/cultured pearls, prec stone	0.023
92	Musical instruments; parts and acce	0.022
42	Articles of leather; saddlery/harne	0.020

Outward statistics from a customs declaration sample representative of parcel flows.

Source: Anson et al. (2014).

We construct our estimation database using information from two postal databases of the UPU: the Electronic Data Interchange (EDI) messaging system and the PREDES standard. Each international parcel sent by a postal operator member of the UPU has a particular code-bar with a *track-and-trace* number. When dispatching parcels to their partners around the world, postal operators scan *track-and-trace* numbers and send customized messages indicating that time and location of the parcel. These messages are called EDI messages and they are collected and treated by the Portal Technological Center under the EMSEVT standard. From postal collection to final delivery there are several messages exchanged between postal operators. The type of messages collected are described in Table 2.

Table 2: Description of the UPU EMSEVT events

Message ID	Event Information
Exporting Events	
EMA	Posting/Collection
EMB	Arrival at outward office of exchange
EMC	Departure from outward office of exchange
Importing Events	
EMD	Arrival at inward office of exchange
EME	Held by import Customs
EMF	Departure from inward office of exchange
EMG	Arrival at Delivery office
EMH	Attempted/Unsuccessful delivery
EMI	Final delivery
Transit Events	
EMJ	Arrival at transit office of exchange
EMK	Departure from transit office of exchange

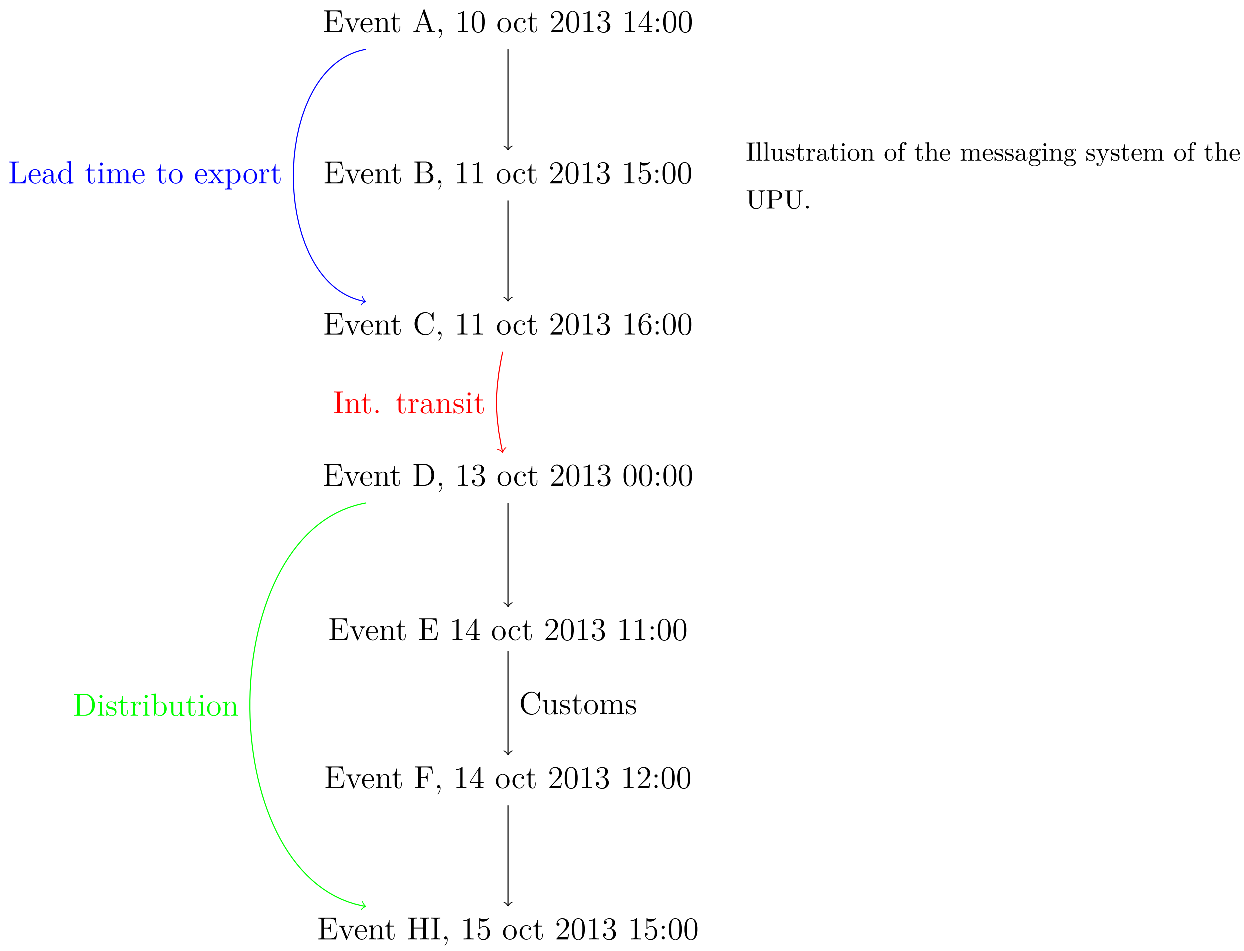
Source: Universal Postal Union, EMSEVT v1 standard.

They provide, among others, the information about the date and location of postal items. Figure 1 illustrates the data collection process from dispatching to final delivery. We use this database to calculate bilateral transport durations for country dyads using a sample of 250 million track-and-trace messages between 2013 and 2014.[3] We proxy the waiting time for consumers in days by taking the difference between event A, posting, and event H or I, attempted delivery or final delivery. For each country pair we observe several items in traffic. We estimate the expected waiting time by the sample mean of all these items at

[3]250 million taking into account parcels, letters and express mail.

the country pair level. The PREDES messaging system records, at the exporter level, the

Figure 1: Illustration of UPU distribution tracking system



quantity and weight of postal items dispatched bilaterally for a given date. This is our proxy of consumption. The last variable that we need to add is the nominal exchange rate. We take daily rates at the London closing time from the Thomson Reuters Datastream. The exchange rate database contains spot rates in direct rate with respect to the United States Dollar (USD). We compute the bilateral exchange rates by cross currency triangulation.

As Anson et al. (2014) show, postal flows exhibit seasonal patterns by day of the week.

We solve the problem by aggregating at the weekly level. This aggregation reduces greatly the variability by smoothing out postal exchanges and dealing with the number of zeros resulting from holiday days. Our panel data structure is summarized in Table 3.

Table 3: Sample Summary, International Parcels

Time frame	2010, 40th week - 2014, 39th week
Exporters	133
Importers	126
Country Pairs	8'680

Source: author's calculations.

On average we observe 100 time periods per country pair. The weekly average percentage change is very low and we observe about 7'000 variations where the change, in absolute value, is greater than 5%. The sample is heterogeneous and the country coverage is very large. Although we expect the model to hold better for highly integrated economies. By integrated economies, we intend countries that have a good postal corridor and where most of the population has access to the internet. We report a summary of our dependent and independent variables in Table 4.

Table 4: Whole sample

Mail Class	c_{ijt}	t_{ij}
	mean and standard deviation	
Parcels	144.36	25.65
	1719.99	39.12

Source: author's calculations, exchange rates taken from Bloomberg

When focusing exclusively on international parcels and estimating the model with all sets of fixed effects, we end up with 133 importing countries and 126 exporting. Our coverage is higher than in other e-commerce studies (Hortaçsu et al., 2009; Lendle et al., 2012) but at the price of missing the product dimension.

5. Estimation Results

We estimate equation (9) using Guimarães and Portugal's 2009 techniques for high-dimensional fixed effects. As previously discussed we assume a logarithmic form of the 'cost of waiting', $f(t_{ij}) = \ln(t_{ij})$. For robustness purposes we try different specifications for the fixed effects in model (9). Thanks to the granularity of our data, we can account for unobserved country pair effects, origin-time and destination-time. All these sort of fixed effects are compatible with our model predictions. We acknowledge that the estimation with all sets of fixed effects is very demanding but it nonetheless serves as a robustness check. We cluster all standard errors by country pair. We expect a negative coefficient for $\widehat{\beta}$ and the opposite sign for $\widehat{\gamma}$, because the exchange rates are in direct quotation. Increasing the 'cost of waiting' should progressively stall the currency effects.

Table 5: Estimation on Parcels Sub-sample

	(1)	(2)	(3)	(4)	(5)	(6)
	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$
	b/se	b/se	b/se	b/se	b/se	b/se
$\ln E_{ij,t-1}$	-0.297***	-0.638***	-0.608***	-0.563***	-0.571***	-0.499*
	(0.033)	(0.118)	(0.118)	(0.037)	(0.036)	(0.260)
$\ln E_{ij,t-1} \times \ln t_{ij}$		0.122***	0.110***	0.097***	0.100***	0.091***
		(0.041)	(0.041)	(0.012)	(0.013)	(0.014)
Constant	2.775***	2.773***	2.568***	2.778***	2.777***	2.767***
	(0.008)	(0.015)	(0.018)	(0.004)	(0.005)	(0.068)
Pair FE	YES	YES	YES	YES	YES	YES
Month FE	NO	NO	YES	NO	NO	NO
Year FE	NO	NO	YES	NO	NO	NO
Destination-Time FE	NO	NO	NO	YES	NO	YES
Origin-Time FE	NO	NO	NO	NO	YES	YES
N	690378	659663	659663	659663	659663	659663
R^2	0.002	0.002	0.026	0.909	0.902	0.917

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 uses the weekly sample of all international parcels dispatched from October 2010 to December 2014. The coefficients are very consistent and stable through the specifications. For the exchange rate effect, we have an estimate between -0.5 and -0.6. The interaction term is stable and always close to 0.1. The overall effect of the exchange rate is a function of time. As of the logarithmic specification the maximum effect of a currency depreciation is when $t_{ij} = 1$. This effect gets dampened by the 'cost of waiting'. Increasing the 'cost of waiting' reduces the currency effects. If we take column (6) of Table 5 as the baseline, our estimated effect is

$$\frac{\ln c_{ijt}}{\ln E_{ijt}} = -0.5 + 0.1 \ln(t_{ij}) \tag{11}$$

a function of t_{ij}. From the baseline coefficient of -0.5 it takes 12 days to halve the effect of the exchange rate. Another important fact is that the average time in our sample is of 25 days. The corresponding average effect is even lower at -0.18. The economic interpretation of the result is that consumers are less reactive to arbitrage opportunities if the delivery network is not fast enough. In the e-commerce market, it would mean that firms may not take as much advantage as expected from favorable currency swindles.

Table 6: Instrumental Variables Estimation in Parcels sub-sample

	(1)	(2)	(3)	(4)
	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$	$\ln c_{ijt}$
	b/se	b/se	b/se	b/se
$\ln E_{ij,t-1}$	-0.541***	-1.255***	-0.291***	-1.097**
	(0.080)	(0.104)	(0.098)	(0.519)
$\ln E_{ij,t-1} \times \ln t_{ij}$	0.062**	0.289***	0.010	0.375***
	(0.030)	(0.037)	(0.038)	(0.056)
Constant	3.214***	3.137***	3.242***	3.161***
	(0.009)	(0.011)	(0.010)	(0.064)
Pair FE	YES	YES	YES	YES
Destination-Time FE	NO	YES	NO	YES
Origin-Time FE	NO	NO	YES	YES
R^2	0.913	0.937	0.933	0.950
Sargan test	11.055	5.567	27.045	9.911

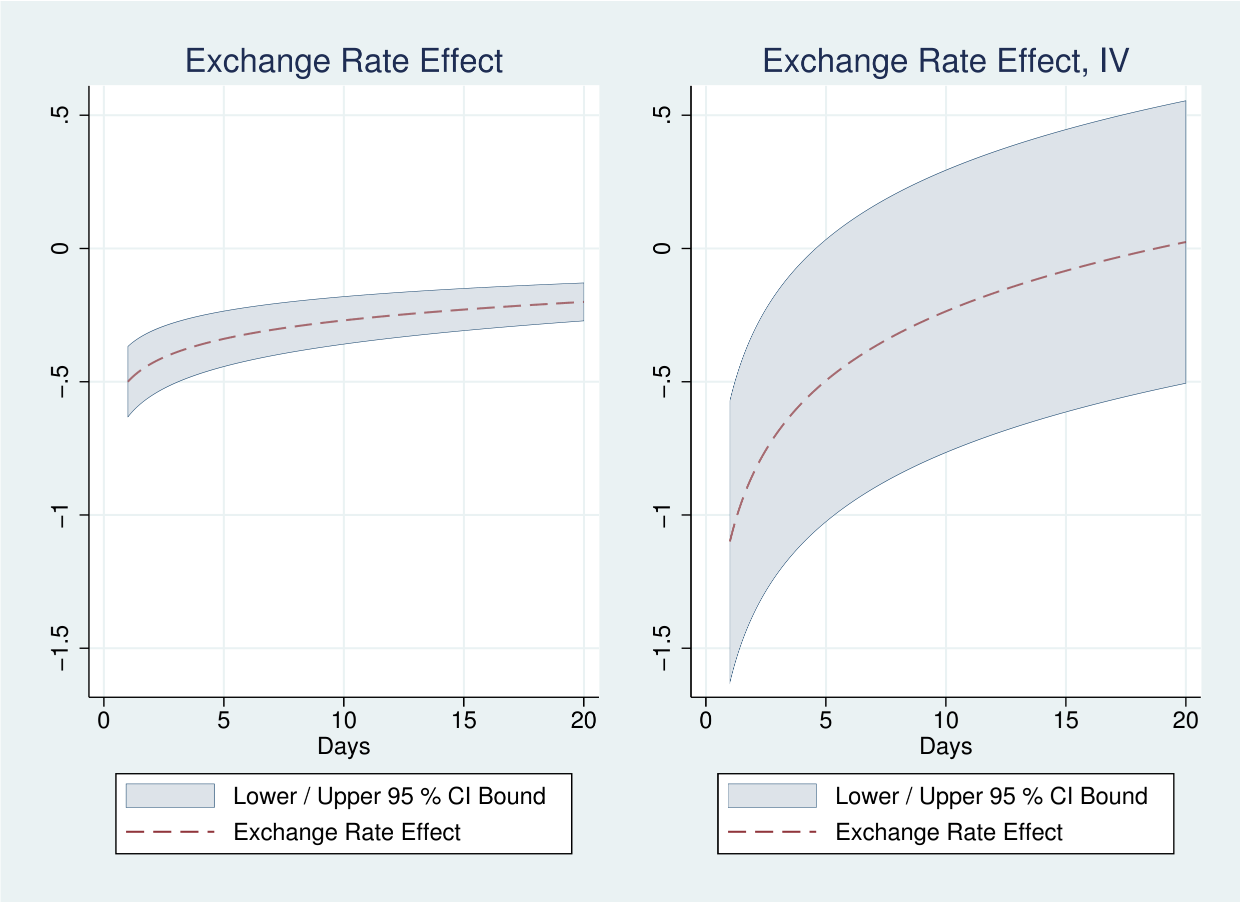
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 provides the results of the instrumental variables estimator. We use two instruments, one based on the time to ship letters and the other based on the time to ship express mail. The coefficients are less stable than our previous estimates but the baseline, column (4) of

Table 6, qualitatively corroborates our first findings. Using that specification the overall effect halves when passing from one to four days, as the exchange rate effect is a lot higher, and the total effect at the mean is almost half of the previous estimation, -0.1. Comparing this to the previous estimation, we observe that the coefficient on the exchange rate has a much larger variance. Hence the difference in the size of the effect. Eventually, we reject the Sargan test for over-identifying restrictions so we keep both instruments.

We compute the standard error of (11) based on the asymptotic distribution of $\widehat{\beta}$ and $\widehat{\gamma}$. Figure 2 shows the asympotic confidence intervals for specification 6 in Table 5 and specification 4 in Table 6. As it is often the case the variance of the instrumental variables is a lot bigger than the fixed effects estimator. Both models suggest qualitatively similar results.

Figure 2: Overall Exchange rate effect



Source: Author's calculation, standard errors based on the asymptotic distribution of the joint distribution of $\widehat{\gamma}, \widehat{\beta}$.

6. Conclusion

Internet markets are denoted as increasingly flexible. Some papers have shown price elasticities to be very high in domestic markets (Ellison and Ellison (2009)). This does not seem to be the case in international e-commerce markets. Domestic e-commerce markets are more developed than international ones. According to UPU official statistics, for an average postal operator the international parcels are only 1-2% of the amount of domestic parcels. We conclude our study arguing that international e-commerce might be facing a 'cross-border challenge' because of 'waiting costs'.

By lowering search costs, international e-commerce allows consumers to easily access and compare retailers worldwide. While this opens the door to international arbitrage, it also transfers some transaction costs to final consumers. With no middlemen left, consumers bear the ‘cost of waiting’ and by doing so they are less sensitive to price changes than to an immediate transaction. In this context, we show that exchange rate elasticities depend negatively on shipping times. Bilateral shipping times impact expenditure switching effects and lower consumer demand elasticities. Our main empirical finding is that an immediate transaction would have an exchange rate elasticity twice the one with four days shipping time. A direct consequence is that exchange rate pass-through is lower for goods with higher delivery times. Shipping times mostly depend on postal operators.

Political economy conclusions from the analysis should be taken with extreme care. Nonetheless we must make an important point. In the transport process there is one segment that cannot be directly controlled by postal operators. In Figure 1 we see that parcels must pass through the customs before domestic delivery. In a setup *à la* Hummels et al. (2009), instead of companies choosing shipping rates, we may have countries choosing the optimal customs inspection time based on a realistic Welfare function. We hope to lead future research in that field.

Our research has not taken into account the selling of immaterial goods that is an important part of cross-border e-commerce trade. Our model suggests that because of the immediateness of the transaction those goods should exhibit a higher elasticity. Nevertheless, we cannot test this prediction. Another caveat of our analysis is the absence of the sectoral dimension. We consider parcel flows as trade differentiated by origin, an assumption that does not hold in reality. To tackle this issue the UPU is working on the establishment of the scanning of custom declaration forms. In the future we might be able to analyze daily flows by value and good type. This would enable us to test for heterogeneous time effects across sectors.

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7. Appendix

Figure 3: Origin Countries in the Parcel Sample

Albania	Costa Rica	Jamaica	Netherlands	Swaziland
Algeria	Croatia	Japan	New Zealand	Sweden
Antigua and Barbuda	Cyprus	Jordan	Nigeria	Switzerland
Argentina	Czech Republic	Kenya	Norway	Tanzania
Australia	Denmark	Korea, Rep.	Pakistan	Thailand
Austria	Dominican Republic	Kuwait	Panama	Tonga
Azerbaijan	Ecuador	Kyrgyz Republic	Paraguay	Trinidad and Tobago
Bahamas, The	Egypt, Arab Rep.	Latvia	Peru	Tunisia
Bahrain	El Salvador	Lebanon	Philippines	Turkey
Bangladesh	Estonia	Lesotho	Poland	Uganda
Barbados	Ethiopia	Lithuania	Portugal	Ukraine
Belarus	Fiji	Luxembourg	Russian Federation	United Arab Emirates
Belgium	Finland	Macao SAR, China	Rwanda	United Kingdom
Belize	France	Macedonia, FYR	Samoa	United States
Bhutan	Gambia, The	Malawi	Saudi Arabia	Uruguay
Bolivia	Germany	Malaysia	Serbia	Uzbekistan
Bosnia and Herzegovina	Ghana	Maldives	Seychelles	Vanuatu
Botswana	Greece	Malta	Sierra Leone	Venezuela, RB
Brazil	Hong Kong SAR, China	Mauritania	Singapore	Vietnam
Brunei Darussalam	Hungary	Mauritius	Slovak Republic	Yemen, Rep.
Bulgaria	Iceland	Mexico	Slovenia	Zambia
Canada	India	Moldova	Solomon Islands	Zimbabwe
Chile	Indonesia	Mongolia	South Africa	
China	Ireland	Morocco	Spain	
Colombia	Israel	Mozambique	Sri Lanka	
Comoros	Italy	Nepal	Suriname	

Figure 4: Destination Countries in the Parcel Sample

Albania	Comoros	Ireland	Morocco	Spain
Algeria	Congo, Rep.	Israel	Mozambique	Sri Lanka
Angola	Costa Rica	Italy	Nepal	Suriname
Antigua and Barbuda	Croatia	Jamaica	Netherlands	Swaziland
Argentina	Cuba	Japan	New Zealand	Sweden
Australia	Cyprus	Jordan	Nigeria	Switzerland
Austria	Czech Republic	Kenya	Norway	Tanzania
Azerbaijan	Denmark	Korea, Rep.	Oman	Thailand
Bahamas, The	Dominican Republic	Kuwait	Pakistan	Tonga
Bahrain	Ecuador	Kyrgyz Republic	Panama	Trinidad and Tobago
Bangladesh	Egypt, Arab Rep.	Latvia	Paraguay	Tunisia
Barbados	El Salvador	Lebanon	Peru	Turkey
Belarus	Estonia	Lesotho	Philippines	Uganda
Belgium	Ethiopia	Lithuania	Poland	Ukraine
Belize	Fiji	Luxembourg	Portugal	United Arab Emirates
Benin	Finland	Macao SAR, China	Russian Federation	United Kingdom
Bhutan	France	Macedonia, FYR	Rwanda	United States
Bolivia	Gambia, The	Madagascar	Samoa	Uruguay
Bosnia and Herzegovina	Germany	Malawi	Saudi Arabia	Uzbekistan
Botswana	Ghana	Malaysia	Serbia	Vanuatu
Brazil	Greece	Maldives	Seychelles	Venezuela, RB
Brunei Darussalam	Honduras	Malta	Sierra Leone	Vietnam
Bulgaria	Hong Kong SAR, China	Mauritania	Singapore	Yemen, Rep.
Canada	Hungary	Mauritius	Slovak Republic	Zambia
Chile	Iceland	Mexico	Slovenia	Zimbabwe
China	India	Moldova	Solomon Islands	
Colombia	Indonesia	Mongolia	South Africa	