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José Anson, Mauro Boffa and Matthias Helble

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Abstract

In today's internet markets consumers can search for, find and compare prices worldwide. Online, information circulates faster than offline and arbitrage opportunities such as the ones arising from currency shocks are easily unveiled. In this paper, we estimate for the first time exchange rate elasticities for cross-border e-commerce transactions. Exploiting a new high-frequency database on international transactions of parcels, we find that a 1 % appreciation of the domestic currency increases e-commerce imports by 0.7 %. Comparing the result with traditional estimates in offline markets, this implies a 50 % exchange rate pass-through online.

Keywords

Online trade, Arbitrage, Exchange rate pass-through

JEL Classification numbers: F 14, F 31

1. Introduction*

The breakthrough of the internet and the propagation of new means of communication have substantially altered international trade patterns. Today's private consumers can interact directly and in real time with e-retailers around the world. In the quest for the best deal, they arbiter between the prices offered by businesses locally and those offered by online shops worldwide. As pointed out by Hortaçsu et al. (2009), the emergence of e-commerce has lowered search costs for consumers. If information on prices and products is getting easier to access, we need to ask whether consumers are taking advantage of international arbitrage opportunities and if yes to what extent.

The key determinant of price differences between home and abroad is the exchange rate. The paper investigates how favorable nominal exchange rate changes stimulate, in the short-run, e-commerce exports to a given destination. The hypothesis is put under scrutiny with the help of a dynamic specification of a demand equation using Pesaran et al.'s (1999) vector error correction (VEC) model for panel data. To abstract from supply shocks, we exploit a new high-frequency international postal parcel flows collected at dispatch by the Universal Postal Union (UPU) as a proxy and combine it with weekly exchange rate data. While international parcel postal flows are highly correlated to traditional trade flows, they originate mainly from e-commerce transactions. Therefore, they constitute the perfect measurement unit for cross-border e-commerce (physical) trade.[1]

Our analysis unveils two important facts. First, arbitrage is indeed happening in online markets. However, we find online exchange rate elasticities to be lower than the traditional offline estimates. While the average exchange rate elasticity (Head and Mayer, 2014) is of 1.4 %, we find an expenditure switching effect that is half as important (0.7 %). The direct consequence of this finding is an average bilateral exchange rate pass-through into import prices of about 50 %. The finding is similar to the one of Gorodnichenko and Talavera (2017), who already shown how exchange rate pass-through between Canada and the US is of about (60-75%) using price data

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[1] In the paper, the term e-commerce is used in the narrow sense of "goods purchased online which require physical delivery". The paper does not deal with services or intangible goods.

scrapped from online retailers. The paper confirms that phenomenon using actual quantities shipped for a variety of trading partners instead of listing prices.

The debate on exchange rate pass-through has mostly focused on the prevalence of producer currency pricing (PCP) versus local-currency pricing (LCP) (among others; Campa and Goldberg, 2005; Burstein and Gopinath, 2014; Devereux et al., 2017). Low exchange rate pass-through has often been attributed to the prevalence of local-currency pricing. This is in contrast with our second finding; low pass-through may be observed even when there is little LCP. This result is intrinsic to the nature of our database which primarily deals with flows deriving from international e-commerce transactions where PCP is more prevalent. This makes the overall contribution of our paper twofold. We test the hypothesis of international consumer arbitrage from demand data at an unprecedented high frequency and we provide evidence of low exchange rate pass-through even in the absence of LCP.[2]

We face two main challenges while testing the hypothesis of international arbitrage. First, we need to obtain reliable high-frequency data on e-commerce trade flows. As with arbitrage in financial markets, arbitrage in the goods market requires observing how consumers react to frequent price changes. We solve the issue by exploiting a new database on international parcel exchanges by the UPU. Second, monetary policy may well be endogenous to trade flows. Therefore, the empirical analysis focused only on highly integrated markets where exchange rate policy is considered exogenous to trade as of IMF exchange rate regimes de facto classifications.

The findings in the paper are important for at least three reasons. First, exchange rate movements have regained substantive attention during and in the aftermath of the Great Recession. As several countries have applied expansive monetary policies, macroeconomists have been repeatedly confronted with questions related to the role of monetary policy in restoring economic competitiveness, often questioning the impact of alleged currency manipulations. An important challenge for empirical research is the observation of short-run trade aggregates. In the paper, we present a new database that observes trade at an unprecedented high-frequency and allows for tracking those changes in almost real time.

[2] In the macroeconomic literature that deals with sticky prices and exchange rate movements different assumptions are made regarding the pricing by producers (e.g. Engel (2002) or Goldberg and Tille (2008)): First, several models assume producer currency pricing in which prices are set in the producer's currency. The second option is local currency pricing in which the producers set the price in the consumer's currency. Staiger and Sykes (2010) show that depending on the type of pricing applied the effects of currency movements cannot be easily translated into trade-policy equivalents as the effect hinges critically on the type of pricing applied. Adding to this literature Gopinath and Itskhoki (2010) find evidence for U.S. imports showing a large difference in the pass-through of the average good priced in dollars (25%) versus non-dollars (95 %).

Second, with online markets growing more and more important, it is necessary to assess if exchange rate changes have the same impact as they would have in the offline world. The two key elements affecting exchange rate elasticities offline are price stickiness and pricing to market (Corsetti and Dedola, 2005).[3] One may argue that tracking IP addresses may make discrimination easier in the online world. Ellison and Ellison (2009) report remarkably high elasticities for some goods, especially whenever a price search engine is present. The assumption of price stickiness in the context of exchange rate movements has been tested empirically in several studies. For example Alvarez et al. (2006) mainly focus on internet prices and show, for a subset of products in Germany, Italy, the United Kingdom, France and the United States that the median average price change spans from 25 to 68 days. The authors conjecture that the average time span seems large enough to allow for consumer arbitrage. The difference with respect to offline markets is remarkable. Price decreases seem to be more frequent in the internet than in the traditional brick-and-mortar businesses. In contrast to nominal exchange rates that are rather volatile, retail prices tend to move sluggishly. In their seminal contribution Gopinath and Rigobon (2008) use monthly data of import and export prices at-the-dock for the United States and show that the trade weighted average price duration in dollars is 12.26 months for imports and 13.77 months for exports. Our study shows the dynamics of the absorption of exchange rate changes.

Third, we contribute to the debate on the role of border price differentials, such as the Billion Prices Project (BPP) at the Massachusetts Institute of Technology. As pointed out by Fraumeni (2002) e-commerce flows are traditionally considered to be difficult to measure. While today several studies provide international comparisons of prices and assess their validity comparing them to offline prices (Boivin et al., 2012; Cavallo, 2017), none of them deal with true physical quantities that cross borders.[4]

The remainder of the paper is structured as follows. Section 2 describes the features of the Universal Postal Union Database. Section 3 presents the dynamic model for testing international arbitrage. Section 4 discusses the results and Section 5 concludes.

[3] In their theoretical work, they model prices in a way that they only respond mildly to nominal exchange rate changes and therefore significant cross-border price differentials between countries can be observed. In their model this is because firms tend to price to the market.

[4] Among others, Burstein and Gopinath (2013) find that nominal exchange rate movements do not impact domestic sale prices. In the short-run there seems to be low exchange rate pass-through. Despite these rich insights, the BBP lacks daily trade flows data to complete the picture. Our dataset adds for the first-time data on quantities effectively traded across borders.

2. Data

In our regression analysis, we use two main databases. The international postal database of the UPU and an exchange rate database constructed by Bloomberg. We start by explaining why the postal network is important for international trade and how postal flows are related to traditional trade. We then present the postal ow database sourced from data collected by the UPU as well as the exchange rates data. Finally, we describe the dataset used for estimation.

Postal and express delivery services form an integral part of world trade logistics and international supply chains. They are specialized in the delivery of relatively light weight goods and shipments. Compared to the bulk of international trade that is transported by container, international postal exchanges are typically airborne and therefore much faster in delivery. Another interesting feature of the postal and express delivery network (in the following called postal network) is the interconnections between operators. In most of international postal exchanges, postal items are handed over from one operator to another in a well-established and standardized procedure that defines the international postal supply chain.

Finally, traditional international trade in goods is predominantly made of transactions between producers (or B2B, especially in the case of global supply chains) or between producers and retailers (another type of B2B). In contrast, the postal network connects not only producers and retailers across borders, but also provides consumers with direct access to the international marketplace. The cross-border postal exchanges are thus between producers (B2B), producers and consumers (B2C) as well as between consumers (C2C). Overall, the postal network thus seems to be more inclusive and better connected than the network of traditional trade flows. It is therefore not surprising that when applying a gravity equation to international postal exchanges the distance coefficient is only half of the estimate for traditional trade flows (Anson and Helble, 2013).[5]

< Figure 1 about here >

The international postal network has gained significant importance over recent years for the delivery of physical goods for two main reasons. First, unbundled production spread across various countries requires fast and reliable exchanges of goods and information. The postal network might have lost part of its relevance in written communication (Figure 2), however, it has gained in the organization of the delivery of physical goods (Figure 2). Benefiting from its interconnections and

[5] For another discussion on new technologies and the weight of distance refer to Lendle et al. (2016).

capillarity, the postal network becomes crucial whenever certain products or components are needed urgently in a specific location. Second, the recent rise of cross border e-commerce was made possible through an intensive use of the logistics services offered by the postal network. The use of the traditional ways of exchanging goods, which rely on containers and consignment of goods, would introduce significant delays for retailers in the delivery of goods. E-commerce platforms offer consumers the possibility to receive goods within a short period of time and at their doorstep, which are two features that only postal networks can offer. Notice how the rise of internet usage has accompanied the decline of international letter-items and the increase of parcel deliveries (Figure 1).

< Figure 2 about here >

Beyond freight forwarding which is not covered by the nature of trade studied in this paper, two logistics systems compete internationally in the postal and express industry. One is an integrated model that supplies end-to-end services through the same network. The other, namely the postal one, is a model of interconnected networks with one network originating a shipment and another one located abroad ensuring the final delivery. Postal flows are the most universal of all trade flows in terms of geographical access by different populations to their services, including also rural areas and small and medium-sized towns. As these populations are being increasingly connected to mobile telephony and to internet platforms, postal platforms are likely to be increasingly used for their cross-border trade.

One might ask what types of goods are transported through postal and express networks. In a recent survey, a designated postal operator in a developed country recorded the content of all parcels sent in detail, mainly in order to facilitate and expedite the customs clearance processes. Table 1 is based on this data and contains the summary statistics of this sample of products transported by the international postal network. The 15 HS chapters listed represent about 80 % of all products dispatched internationally by this postal operator. The composition of the postal ows therefore reects the content of cross-border e-commerce. As one might expect, apparel and clothing as well as print products account for over 25 % of international postal ows. If one correlates the monthly volumes of the dispatches in these 15 HS chapters with the corresponding monthly value of trade in these chapters (as reported by national customs authorities), a strong statistical relationship (R2 of 68 % and 73 %) may be observed (see Table 2). Given this strong correlation, it is not surprising that the international postal exchanges are assumed to reflect the evolution of

global trade volumes. Postal and express delivery figures are often seen as a leading indicator of the evolution of international trade and closely monitored by participants in financial markets (such as the Dow Jones Transportation Average).[6]

< Table 1 about here >

< Table 2 about here >

The postal data used in this study is based on entries into the electronic data interchange (EDI) system of the UPU, which is a real-time messaging system used to organize cross-border postal operations at the international level. In the EDI system, every postal item that is dispatched internationally is scanned and tracked at several stages of the international postal process until it reaches its _nal destination. For a visual overview of the messaging system refer to Figure 3. The EDI system has been conceived to ensure traceability of every postal shipment from origin to destination, and to improve the quality of international postal services through greater operational efficiency along the postal supply chain. It is also meant to enhance the interconnection between postal operators according to agreed international standards.

< Figure 3 about here >

For our research question, we are interested in the daily volume of bilateral postal exchanges. Therefore, we have aggregated the detailed data for each message and constructed a database containing daily information of the volume of international bilateral dispatches. Our aggregation covers the three types of international postal items: First, international letter-post items including not only letters but also items weighing up to 2 kilograms each). Second, international parcel post items (up to 30 kilograms each). And third, international express mail service items belonging to what is called Express Mail Service (EMS), the fastest international postal service covering both documents and packages (up to 30 kilograms each). For each day from October 1st, 2010 to September 30th, 2014, we calculated the weight and the amount (in terms of number of items), by mail class that every postal operator sent to its partners. As specified in Table 3, our postal data of aggregated EDI messages covers entries from 171 exporters and 172 importers (postal operators) for a total of 12'832 country-pairs (corridors). In total, we count 8'848'313 non-zero entries.

< Table 3 about here >

[6] The "Dow Jones Transportation Average" records the economic performance of the 20 largest US logistics providers and is available at: http://www.djaverages.com/?go=transportation-overview.

The daily aggregated data of postal exchanges presents several statistical challenges. First, postal flows are not uniformly distributed during the week as reported in Table 4. In addition, few countries do not have daily postal flows and dispatches are only sporadic. This is mainly due to logistical reasons and market size. Secondly, there are many zero records (around 70% of the sample) as we illustrate in Table 3. The zeroes come from three different sources. First, postal flows are scarce during weekends accounting for 30% of the zeros. Second, in some country-pairs exchanges are very little or non-existent. Third, some countries have exchanges exclusively on some days of the week, because of logistics reasons. Therefore, many of the zeros are such because of the high frequency of the data.

< Table 4 about here >

We retrieved daily exchange rates from Bloomberg.[7] We collected 144 spot prices towards the US dollar in direct quote. The direct quote allows us to have homogeneous quotes in terms of US dollars. We computed the bilateral exchange rates by dividing, for a given country-pair, their respective spot prices. An increase of the newly computed exchange rates is considered as a depreciation in the exporting country. The spot prices are those at the closure of the London exchange market. We chose London to simplify the collection of the data and because of the importance of this stock exchange platform. As a corollary, we use the business calendar of the London stock exchange, which implies that we do not observe exchange rates during weekends. For the sake of simplicity, we assume the latter to be equal to the ones of the preceding Friday. The spot prices for the 14'148 corridors where computed by dividing each country relative spot price with respect to the US Dollar. The daily data spans from October 1st, 2010, to September 30th, 2014.

For our study, we have eliminated all countries with exchange rate regimes that are either pegged or managed. The reason for this is that in most managed or pegged exchange rate regimes, the consumer is unable to undertake international arbitrage, as small deviations from the targeted exchange rate are immediately corrected. Our study thus only includes countries with a floating exchange rate regime as of the de facto classification of the International Monetary Fund (IMF). In addition, in order for international consumer arbitrage to happen, countries need to be internationally well integrated and to have a high share of the population with internet access. In

[7] http://www.bloomberg.com/.

our sample we count 26 countries (most of them are countries with high per capita incomes) with de facto floating exchange rates according to the IMF classification in August 2012, see Table 6. After excluding all bilateral pairs which use the same currency (e.g. postal ows among Euro zone countries), we count a total number of 406 corridors with an average of 814 observations each. Another important feature of this sample restriction is that most of the remaining economies are developed countries.

< Table 5 about here >

< Table 6 about here >

3. A Dynamic Model for Testing International Arbitrage

The main objective of our econometric analysis is to test the hypothesis of international arbitrage. Our estimation sample consists of a large number of time series observations of international postal exchanges and exchange rates (four years on a weekly basis, an average of 180 time periods) and large number of groups (359 country pairs). The most straightforward approach would be to estimate a standard panel data dynamic model such as:

$$\ln c_{ijt} = \lambda \ln c_{ij,t-1} + \sum_{s=1}^{p} \delta_s \ln E_{ij,t-s} + u_{ijt} + \epsilon_{ijt}$$

$$ij = 1, \dots, 359 \; ; t = 1. \dots, 180$$

Notice that given the large time and cross-sectional dimension, equation (1) does not suffer from the typical endogeneity problem of dynamic panels. However, the problem with this specification is that it is overly restrictive. It assumes that all country pairs have the same dynamic coefficient and the same reaction to exchange rate shocks. Traditionally, such a problem would have been tackled using one of the two following procedures: run separate regressions for each group and analyze the distribution of the estimated coefficients across groups. The key result would then be the mean of the estimates, which is called the mean group estimator, and which yields a consistent estimate of the average of the parameters. However, the estimation does not consider that some parameters may be identical across groups. The second econometric approach would be to estimate pooled estimators, such as the fixed or random effects estimators. Using that approach, the intercepts are allowed to differ across groups while it is assumed that all other coefficients and error variances are identical. Pesaran et al. (1999) have developed an intermediate approach which we argue is the most appropriate for our problem, as it allows intercepts, short-run coefficients and

error variances to differ across groups, but the long-run coefficients are assumed to be the same. Pesaran's (1999) vector error correction (VEC) is specifically designed for dealing with panels with large time and group dimensions, where one needs to distinguish short-run effects from equilibrium effects. In addition, the model yields consistent estimates even if the time series are non-stationary. We therefore specify the model in a way that identifies the impact of transitory short-run shocks and of permanent equilibrium shocks. Stacking up the time series for a given country-pair, *ij*, the Pesaran's PMG estimator focuses on the equation:

$$\Delta \ln c_{ijt} = \phi_{ij}\, \xi(\theta)_{ijt} + \sum_{s=1}^{p} \lambda_{ijs} \Delta \ln c_{ij,t-s} + \sum_{s=1}^{p} \delta_{ijs}\ \ln E_{ij,t-s} + u_{ij} + \epsilon_{ijt}$$

$$\xi(\theta)_{ijt} = \ln c_{ij,t-1} + \theta \ln E_{ij,t-1}\ ;\ \ ij = 1, \dots, 359\ ;\ t = 1, \dots, 180$$

Our dependent variable, taken as a proxy for consumption, is the seasonally adjusted consumption of international parcel flows. As we discuss in section (2) postal dispatches show seasonal patterns specific to each corridor. This is mainly due to logistics of the network and purely seasonal effects. The seasonal adjustment is done by taking the residual for each country-pair, between parcel flows and a regression of first-differenced (detrended) postal flows with week dummies. As a result, the adjusted dependent variable does not contain seasonal components.[8] We choose the dummy variable technique because of the deterministic type of seasonality exhibited in postal networks. Therefore $\Delta \ln c_{ij}$ is the percentage change of seasonally adjusted parcels dispatched from country *i* to country *j*.[9] $\ln E_{ij}$ is the exchange rate and $\Delta \ln c_{ij,-p}$ and $\Delta \ln E_{ij,-p}$ are the *p* lags of the percentage change in parcels and in exchange rates. ϵ_{ij} is the error term assumed to be Gaussian for every time series.

The interpretation of model (2) is very appealing. On one hand, it assumes that there is an underlying equilibrium relationship $\xi(\theta)_{ij}$ with the same parameter θ for every panel. The equilibrium relationship refers to how parcel flows change following a permanent nominal depreciation. θ is seen as the elasticity of dispatched parcels from country *i* to country *j* following a permanent one percent depreciation of country j currency. On the other hand, the speed of

[8] When not seasonally adjusted, the relationship with the exchange rates seems stronger. However, this might be mainly due to confounding deterministic effects. Our approach is more conservative.

[9] For clarity of exposition, we drop the time index in the discussion.

returning to the equilibrium, or error correction term ϕ_{ij} is country-pair specific. This allows for more flexibility. Following a temporary shock of the system, the average of ϕ_{ij} is the percentage time that it takes to return to the equilibrium. A significant and negative average ϕ_{ij} is a necessary condition for the existence of the equilibrium relationship. The short-run parameters, $\lambda_{ijp}, \delta_{ijp}$, are specific to each corridor. This controls for the fact that for some country-pairs' short-run movements can be more important because of stronger economic ties. The short-run parameters are response to a temporary shock.[10] The specification allows for a time invariant (ι_T being a vector of ones of dimension 180) corridor fixed effects. We discuss the estimation of equation (2) in section (4).

4. Estimation Results

We estimated models (1) and (2) for a sample of countries classified by the IMF as having a free-floating exchange rate regime. This way we may consider the determination of the exchange rate to be exogenous to monetary policy. The estimation sample contains mostly well integrated economies with a large percentage of the population having internet access. This suits well the purpose of our study, however the inference we make relates only countries with similar characteristics.

< Table 7 about here >

Table (7) shows the estimation results of model (1) with country pair fixed effects for different lag values of the exchange rate. The coefficient that matters the most is the one on the one-week lagged exchange rate, δ_1. The preferred specification is the one in column (6) as it has country-pair fixed effects and time fixed effects. The magnitude of the 0.4 % exchange rate elasticity can be interpreted as follows. Suppose that $\ln E_{ij,t-1}$ goes up temporary by 1 % (origin's currency appreciates) and the next period goes back to its previous value; then parcel flows (origin's exports) decrease by 0.4 %. This is the result of a temporary increase. In contrast if $\ln E_{ij,t-1}$rises permanently and the initial system was at the steady state ($\ln c_{ijt} = \ln c_{ij,t-1}$) then the permanent effect on parcels is:

$$\Delta \ln c^{Long\ Run} = \frac{\hat{\delta}_1}{1-\hat{\lambda}} = -\frac{0.41}{1-0.43} \approx -0.72$$

[10] For example if the exchange rate changes by 1 % and returns back to its precedent value after one period.

In Table 8 we show the result for the PMG estimation of model (2). We present four models with different lag structures. The number of lags represents the order of the underlying VAR model. We estimate model (2) by profiled maximum likelihood with a custom modified version of Pesaran`s Stata command xtpmg. The custom command is available upon request.[11] The short-run and error correction coefficients displayed are the average of the corridor specific coefficients. For the 4 specifications the system exhibits very few short-run dynamics. In fact, the short-run coefficients for the exchange rate are mostly statistically zero. Absence of such dynamics might be due to the fact that exchange rate depreciations are transmitted very quickly into the internet market or that only permanent depreciations have an effect. Thus, temporary shocks have little impact on exports. The error correction coefficient is negative and close to 0.4. Given a temporary shock, consumption returns to half its original value in 5 days. The equilibrium relationship suggests that a 1 % permanent appreciation will decrease bilateral parcel exports of about 0.62 to 0.7 %. The finding is robust with the long-run parameter of model (1).

< Table 8 about here >

5. Discussion and Conclusion

For the first time, we use a high-frequency international exchange database to assess the question of international consumer arbitrage on the online market. Postal flows form an integral part of international trade and the scale economies of its network allows consumers to face low transport costs. This, coupled with price rigidity and low search costs allows for international arbitrage. Combining weekly postal flows with weekly exchange rate movements, we find that exchange rate fluctuations do indeed matter for bilateral trade flows. A permanent currency appreciation triggers an increase of postal inflows by the magnitude of 0.6-0.7 %. However, this value goes against the traditional estimates of the elasticity of substitution. Traditionally, the empirical literature surveyed by Anderson and van Wincoop (2004) has found the elasticity of substitution, σ, to be between 5 and 10 for most goods when estimated through tariff changes. Recent work by Simonovska and Waugh (2014) extending the methodology of Eaton and Kortum (2002) suggests a value of 4, that is closer to the lower bound of the typical estimates. Head and Mayer (2014) point out that

[11] It is mainly based on Pesaran's command, but with a few improvements in the likelihood part of the algorithm. In particular, the command supports a much larger number of groups and it takes advantage of the Mata language to speed up the last passages.

elasticities are much lower when estimated with exchange rate changes. In particular the average value is around 1.4 for most studies. Still, our estimate is only half of this magnitude.

The model presented in section (3) assumed implicitly that import prices move one to one with exchange rates. If we relax this assumption and we assume an imperfect exchange rate pass-through of _, we would obtain that the total price change following an exchange rate appreciation is the product between the exchange rate pass-though and our elasticity parameter:

$$\frac{d \ln c^{longrun}}{d \ln E_{ij}} = \sigma \quad \times \underbrace{\alpha}_{pass-through} = \theta = 0.7 \Leftrightarrow \alpha = 0.5$$

Our estimated parameter would then be interpreted as the product of two structural parameters. The exchange rate pass-through, α, and the elasticity of substitution between varieties, σ. An elasticity of substitution of 1.4 combined with our estimates of 0.7, yields a pass-through of about 50 %. Arbitrage opportunities will therefore be reduced because of low exchange rate pass-through. Our finding is surprising since most economic models suggest that low pass-through comes mostly from LCP; a pricing behavior incompatible with the nature of our data.

Future extensions of this research are to investigate the rationale behind low exchange rate pass-through in the absence of LCP or why we observe so little international arbitrage. A possible explanation could be that while it is easy to compare prices of domestic retailers on the internet, it is hard to do so for foreign retailers. Thus, consumers may face lower search costs domestically than internationally. In the near future, systematic information on customs declarations, including value, quantity and good category for each international postal shipment, will be collected across countries.

Forthcoming access to this customs declaration data will enable the analysis of consumer arbitrage at the most disaggregated HS-6 level and estimate exchange rate elasticities for each individual good. This could lead to a new classification of goods between the ones that are subject to international arbitrage and others with relatively inelastic reactions to exchange rate variations, namely 'proximity goods', a new category of implicitly non-tradable goods. These goods would benefit from some sort of preference for proximity consumption due to specific characteristics, such as high transportation costs or the availability of local after-sale service.

To conclude, international e-commerce is reshaping consumers and producers' behavior worldwide. As for goods ordered online, it is time for economic science to start tracking and analyzing today's and tomorrow's consumption and production patterns. International e-commerce

constitutes an important fast-growing part of international trade in the 21st century. We hope that our research sheds new light on today's international e-commerce and that in the future, the database presented in this paper can be used in various ways to further our understanding of today's trade patterns.

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Tables

Table 1: Products transported by international postal networks

HS2	Description	Sample Frequency
61	Art. of apparel & clothing access	0.136
49	Printed books, newspapers, pictures	0.123
85	Electrical machinery, equipment and parts therof	0.108
95	Toys, games & sports requisites	0.095
64	Footwear, gaiters and the like	0.054
21	Miscellaneous edible preparations	0.049
70	Glass and glassware	0.038
33	Essential oils & resinoids	0.026
90	Optical, photographic, cinematographic, measuring, etc.	0.026
84	Boilers, machinery & computers	0.026
62	Art. of apparel & clothing access, n.e.s.	0.025
87	Vehicles o/t railway/tramway roll-stock	0.023
71	Natural/cultured pearls, prec. stones	0.023
92	Musical instruments; parts & accessories	0.022
42	Articles of leather; saddlery/harness, hand bags, etc.	0.020

Outward statistics from a customs declaration sample
Source: UPU Statistics Division.

Table 2: Correlation between parcel dispatches and export COMTRADE data

Dep. Variable	Exports top 50% HS2	Exports top 50% HS2	Exports top 50% HS2	Exports top 75% HS2	Exports top 75% HS2	Exports top 75% HS2
log parcels dispatched	0.887***	0.032***	0.710***	0.898***	0.024***	0.655***
	(0.013)	(0.007)	(0.020)	(0.011)	(0.005)	(0.018)
R^2	0.345	0.345	0.675	0.395	0.395	0.725
Importer-time FE	NO	NO	YES	NO	NO	YES
Exporter-time FE	NO	NO	YES	NO	NO	YES
Importer-Exporter FE	NO	YES	NO	NO	YES	NO
Number of observations	110628	110628	110433	118882	118882	118670

Here we present regressions of the log-value of monthly trade, as reported in COMTRADE, with our log-parcel dispatches. The correlation stays significant even when controlling by Fixed Effects. We correlated only trade flows corresponding with the top 50% and 75% HS2 codes present in our parcel data. Since COMTRADE data is only available at monthly frequency we aggregate our database at the same frequency. Standard error clustered by country-pairs in parenthesis.

Table 3: Postal Raw Data Overview

Number of exporters	171
Number of importers	172
Number of currencies	144
Number of corridors	12'832
Time span	01oct2010-30sep2014
Number of records	27'934'184
Number of zero observations	19'085'871
Percentage of Letters	29.55 %
Percentage of Parcels	36.46 %
Percentage of Express mail	33.99 %

Source: authors' calculations based on UPU parcel database.

Table 4: Daily percentage deviations in international parcel dispatches

Day	Average deviation	Sd. deviation	Minimum deviation	Maximum deviation
Tuesday	0.363	0.350	−0.782	1.998
Wednesday	0.458	0.398	−0.633	2.351
Thursday	0.449	0.407	−0.678	2.315
Friday	0.437	0.479	−0.647	3.550
Saturday	−0.035	0.372	−0.931	2.996
Sunday	−0.640	0.115	−0.962	−0.303

Percentage deviations considering Monday dispatches as a benchmark.

Table 5: Floating sample overview

Number of countries	26
Number of corridors	359
Time span	01oct2010-30sep2014
Average number of observations per corridor	182

Source: authors' calculations using UPU parcel database.

Table 6: Free-floating countries

Country	iso2	Currency
Austria	AT	EUR
Australia	AU	AUD
Canada	CA	CAD
Chile	CL	CLP
Cyprus	CY	EUR
Czech Republic	CZ	CZK
Germany	DE	EUR
Estonia	EE	EUR
Spain	ES	EUR
Finland	FI	EUR
France	FR	EUR
United Kingdom	GB	GBP
Greece	GR	EUR
Ireland	IE	EUR
Israel	IL	ILS
Italy	IT	EUR
Japan	JP	JPY
Malta	MT	EUR
Netherlands	NL	EUR
New Zealand	NZ	NZD
Poland	PL	PLN
Portugal	PT	EUR
Sweden	SE	SEK
Slovenia	SI	EUR
Slovakia	SK	EUR
United States	US	USD

Source: IMF, www.imf.org

Table 7: Dynamic Panel Data Model

Dependent variable						
$\ln c_{ijt}$	(1)	(2)	(3)	(4)	(5)	(6)
$\ln E_{ij,t}$	−0.697***	−0.294	−0.251	−0.097		
	(0.116)	(0.244)	(0.234)	(0.197)		
$\ln E_{ij,t-1}$		−0.413*	−0.495*	−0.503*	−0.394***	−0.406***
		(0.241)	(0.255)	(0.299)	(0.067)	(0.069)
$\ln E_{ij,t-2}$			0.031	0.204		
			(0.225)	(0.195)		
$\ln c_{ij,t-1}$				0.455***	0.446***	0.432***
				(0.040)	(0.040)	(0.046)
Constant	3.940***	4.023***	4.077***	2.230***	2.228***	2.361***
	(0.003)	(0.003)	(0.002)	(0.166)	(0.162)	(0.182)
Pair-FE	YES	YES	YES	YES	YES	
Week-FE	NO	NO	NO	NO	YES	
Number of observations	64584	62608	61198	60785	62344	62344

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

Standard errors clustered by coutry pair.

Dependent variable is the number of parcels sent in a week.

Table 8: Dynamic model for exchange rates and parcel dispatches, weekly frequency

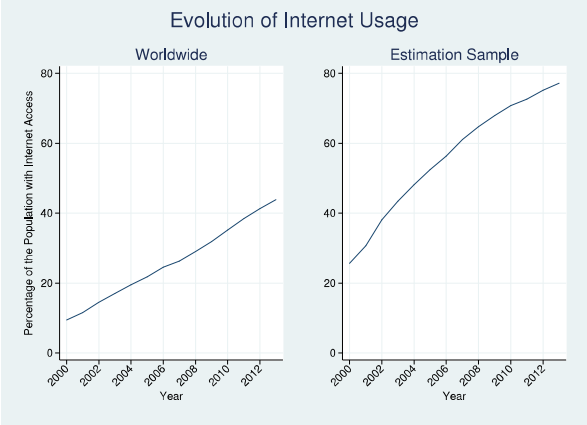
Dependent variable	PMG	PMG	PMG	PMG
$\Delta \ln c_{ijt}$	(1)	(2)	(3)	(4)
Equilibrium relationship				
$\ln E_{ij,t-1}$	−0.734***	−0.703***	−0.686***	−0.618***
	(0.061)	(0.063)	(0.063)	(0.063)
Short-run dynamics (averaged)				
$\Delta \ln E_{ij,t-1}$	−2.238	−2.693	−3.499	−10.258
	(2.341)	(2.823)	(2.643)	(8.975)
$\Delta \ln E_{ij,t-2}$		−2.010	−4.571*	−4.403
		(1.285)	(2.599)	(3.879)
$\Delta \ln E_{ij,t-3}$			−3.092	7.878
			(3.681)	(7.374)
$\Delta \ln E_{ij,t-4}$				−1.135
				(0.874)
$\Delta \ln c_{ij,t-1}$	−0.104***	−0.132***	−0.120**	−0.121***
	(0.012)	(0.015)	(0.051)	(0.041)
$\Delta \ln c_{ij,t-2}$		−0.047***	−0.122***	−0.001
		(0.007)	(0.029)	(0.062)
$\Delta \ln c_{ij,t-3}$			−0.072***	0.004
			(0.019)	(0.047)
$\Delta \ln c_{ij,t-4}$				0.099
				(0.087)
Error correction	−0.427***	−0.426***	−0.401***	−0.429***
	(0.018)	(0.020)	(0.025)	(0.042)
Constant	1.279***	1.287***	1.250***	1.385***
	(0.093)	(0.092)	(0.116)	(0.131)
Number of observations	60709	59246	57996	56943

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

Standard errors in parenthesis clustered by corridor

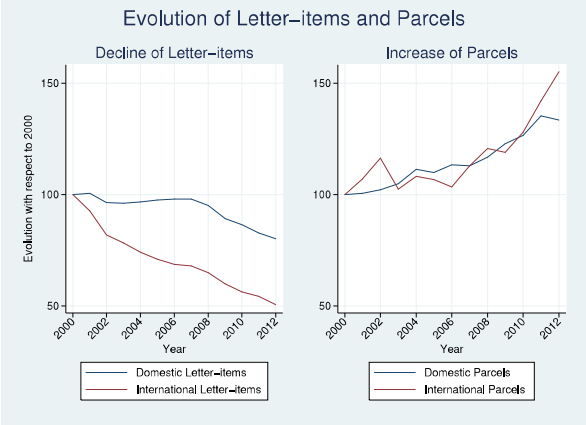
Figures

Figure 1: World Internet Usage



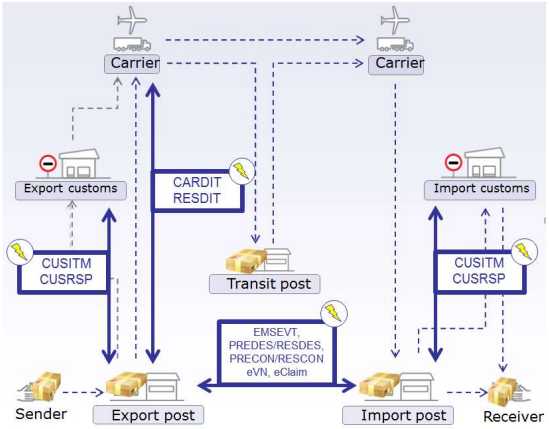
Source: authors' calculations using ITU global statistics
http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

Figure 2: Evolution of the Postal Sector



Source: authors' calculations using UPU postal statistics,
http://www.upu.int/en/resources/postal-statistics/about-postal-statistics.html

Figure 3: EDI Messaging System



Source: UPU, http://www.upu.int/

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