

A short-run analysis of exchange rates and international trade

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Abstract

The ICT revolution over the past three decades has transformed the world into an integrated marketplace. Today, producers and consumers alike are able to compare prices of local businesses and worldwide sellers. For an increasing number of tradable goods, they can arbitrage between online and offline transactions. One of the key exogenous elements behind this arbitrage are exchange rate movements. The existing literature on exchange rates has concluded that nominal prices can be assumed to be rigid which thus opens the door to short-term international arbitrage. However, empirical evidence of international short-term arbitrage has so far been lacking due to data constraints. In this paper, we first present a new data set that holds records on daily international exchanges of goods, namely those sent through the international postal logistics network. We then combine this data set with daily data on international exchange rate movements to test the hypothesis of international arbitrage. Applying different econometric techniques, we show that, in an environment of floating exchange rates, almost instantaneous short-term international arbitrage is indeed occurring and that it has a persistent effect.

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1 Introduction

The breakthrough of the internet and the propagation of new means of communications have substantially altered international trade patterns. On the production side, the ICT revolution has made it possible to coordinate complex activities across borders and hence the production of goods has become increasingly unbundled and spread across a number of countries Baldwin (2011). Unbundled production might involve entities within the same firm or collaboration with outside partners, as the ICT revolution has made it easier to find and work with suppliers of particular goods and services in the international market place. Similarly, today's private consumers are able to interact directly and in real-time with e-retailers around the world. In the quest for the best deal, they arbitrage between the prices offered by businesses locally (either *brick-and-mortar* or domestic online shops) and by on-line shops worldwide. The emergence of e-commerce has thus lowered for both, producers and consumers alike, the search costs and thus facilitated the international matching for all three cases: between producers, between consumers, and between producers and consumers.

Arbitrage implies that producers and consumers decide to buy abroad because of a lower price. A first condition for international arbitrage is that transport costs are not excessively high and thus undo all possible gains. However, today for most goods, transport costs account only for a small share in the final good's price, as international logistics chains are organized in a highly efficient way. One of the most efficient distribution networks constitutes the postal network. In the postal network the weight of distance is particularly low and therefore opens the possibility for arbitrage for consumers worldwide.¹ The second condition for international arbitrage is that, once accounted for the handling and shipping costs, the foreign price is still lower than the domestic price. One of the key exogenous determinant of price difference between home and abroad are exchange rate movements.

Exchange rate movements have regained substantive attention during and after the recent Great Recession. As several countries have applied an expansive monetary policy, macroeconomists have been repeatedly confronted with questions related to the role of monetary policy in restoring economic competitiveness. Most prominently, Japan has deliberately and openly chosen to apply an exchange rate oriented monetary policy, which led to concerns by various countries, such as Russia,² about their exporting sectors and some apprehension for commercial balance movements. An important challenge for empirical research is to observe the short run of trade aggregates, including their fluctuations and implied volatility. Due this key data constraint, it has been not be possible to know the short-term impact of exchange rate swings on international trade flows. The debate on the role of expansive monetary policy for short-run gains in competitiveness has so far had little empirical foundation.

¹Recent research by Anson and Helble (2013) finds that the distance coefficient of the gravity equation is only about half of the size compared to traditional trade flows.

²<http://www.bloomberg.com/news/2013-01-16/russia-says-world-is-nearing-currency-war-as-europe-joins.html>.

In our study we investigate to which extent, under floating exchange rate regimes, favorable nominal exchange rate profiles may indeed stimulate, in the short-run, exports to a given destination. We use as a proxy for international trade flows the postal parcel flows collected at dispatch by the Universal Postal Union (UPU)³ and combine them with daily exchange rate data. As we will show later in this paper, international parcel postal flows are highly correlated to traditional trade flows. In addition, as they originate mainly from e-commerce transactions, they are more responsive to exchange rate shocks than the traditional trade and thus an ideal variable to study for the purpose of our study.

Our contribution to the current literature on exchange rates and international trade is mainly twofold. First, we present a new, so far unexploited, database that records short-run international postal flows, which we argue are an excellent proxy for short-term international trade flow movements of e-commerce and related flows. Given the large country coverage and detailed information, the database could be exploited for various research questions in international economics. Second, our study contributes to the empirical research on exchange rates and international trade by providing an important new finding: Using a variety of econometric techniques we find that favorable exchange rate movements stimulate trade in the short-run.

The paper is structured as follows. In the next section (2) we discuss the current literature of exchange rates and trade as it relates to our work. The section on data (3) presents the postal and exchanges rate database. We show how international postal flows are related to international trade flows and highlight the advantages and shortcomings of the database. Section (4) outlines the econometric approach by first discussing the times series properties of the data set and then explaining the methodology applied. After presenting the results of our baseline model in the section (5) we proceed to the section (5.2) that shows that the same results hold for different levels of time aggregation (weekly and monthly) and for non seasonally adjusted series. Before concluding in section (6), we present an alternative construction of the dependent variable based on residuals towards express flows.

2 Literature Review

In our research we link daily fluctuations in real international postal flows to daily movements in nominal exchange rates. Our goal is to test for consumer and producer international arbitrage in the online market for goods delivered by the international postal network. To carry out our empirical analysis we need to rely on some assumptions that are corroborated by recent literature. Our main hypothesis is that because of price stickiness and its low reaction to exchange rate movements, in other words low exchange rate pass-through, consumers/producers are able to benefit from international arbitrage. A similar hypothesis has been used by Corsetti and Dedola (2005) in their theoretical work,

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in which 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 are observed. In their model this is due to the fact that firms tend to price to the market.

The assumption of price stickiness in the context of exchange rate movements has been tested empirically in several recent studies. For example, Lunnemann and Wintr (2006) mainly focus on internet prices and show, for a subset of products in Germany, Italy, United Kingdom, France and the United States that the median average price change spans from 25 to 68 days. They also point out that 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. The authors conjecture that the average time span seems large enough to allow for consumer arbitrage. 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.

More empirical attempts that highlight cross border price differentials are found in the studies that emerged from the Billion Prices Project (BPP) at the Massachusetts Institute of Technology.⁴ Collecting and exploiting daily price data from large online retailers around the world, these studies have detected different pricing behavior across borders. Among others, Burstein and Gopinath (2013) find that nominal exchange rate movements do not impact domestic sale prices. In the short to medium run there it seems to be a low exchange rate pass-through. Despite these rich insights, the BBP lacks of daily trade flow data to complete the picture. Our dataset, once it is fully product specific,⁵ could add this important additional dimension to this seminal research.

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. Finally, some models assume dollar pricing, when all prices are set in dollars. 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. In a more recent paper Gopinath and Itskhoki (2010) find evidence for U.S. imports that there is a large difference in the pass-through of the average good priced in dollars (25%) versus non-dollars (95 %). Our dataset holds parcel flows between countries of which are generated by purchases from business to businesses, from businesses to consumers or between consumers. We do not know which pricing model is predominant, but we conjecture that in these transactions all three pricing models are applied.

⁴<http://bpp.mit.edu/>

⁵In the near future the UPU will provide product specific parcel data with HS classification.

More broadly, our research relates to two streams of economic literature in the area of exchange rates and trade.⁶

First, our study is related to the literature on exchange rate misalignments and international trade. A key ingredient of almost all trade models are relative prices and unsurprisingly the empirical research on the responsiveness of trade flows to changes in relative prices has started more than six decades ago.⁷ Empirical studies on this topic typically calculate the difference between the nominal and real exchange rate based on consumer price indices, and assess how the level of currency misalignment is related to the trade performance. In contrast to these empirical studies, our data set does not allow to calculate the exact level of misalignment, as we have no high-frequency data on consumer price indices. Our hypotheses therefore is that, based on the assumption of price stickiness, any substantive short-run fluctuations of exchange rates translates into a short-run change in relative prices and offers the possibility for arbitrage.

Another, more recent, stream of literature has studied the relationship between exchange rate devaluations and export surges, instead of focusing on the trade balance. Bernard and Jensen (2004) study the sources of U.S. exports growth from 1987 to 1992. The authors identify changes in exchange rates and rises in foreign income as dominant sources for the export increase, while productivity increases in U.S. plants played a relatively small role. Fang et al. (2006) investigate the effect of exchange rate depreciation on exports for eight Asian countries. They find that depreciation encourages exports, but at the same time increases exchange rate risks which had a negative effect on export growth in six of the eight countries. Freund and Pierola (2008) identify 92 episodes of export surges with an increase in manufacturing exports of at least 6 percent that last for seven years or longer. Their results indicate that export surges in developing countries are preceded by a substantive real depreciation and a reduction in exchange rate volatility. They find that 25 percent of export growth during the surge was generated by more entries into new export products and new markets. Haddad and Pancaro (2010) show that a real underevaluation had a positive effect on economic growth and on export expansion; however the effect was only significant for low-income countries. More specifically, in developing countries with per-capita income levels below 2.500 USD, an increase of 50 percent in real underevaluation led to a 1.7 percent increase in export growth. Using a gravity equation approach, Nicita (2013) estimates that exchange misalignment had a significant impact on exports and thereby produced a trade diversion effect quantifiable in about one percent of world trade.

In summary, the existing literature concurs around the finding that prices are sticky, especially in the short and medium-run, and that currency misalignments have often been associated with export growth in the medium-run. What is lacking so far is evidence on how international exchange rate movements and international trade interact in the very

⁶Auboin and Ruta (2013) provide a comprehensive recent survey on the literature on the relationship between currencies and trade.

⁷For example, already in Stern et al. (1976) provide a review of 130 studies that try to estimate import and export demand elasticities.

short-run. Our study attempts to fill this gap.

3 Data

In this section we describe the two main databases used in our regression analysis. 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 flow database sourced from data collected by the UPU as well as the exchange rates data. Finally, we describe the final dataset after merging both datasets.

3.1 The relevance of postal flows in international trade

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 just called postal network) is the interconnections between operators. In the overwhelming majority of international postal exchanges, postal items are handed over from one operator to another in a well-established and standardized procedure that defines an 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 seems thus 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).⁸

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 speedy and reliable exchange of information and goods. 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 4). Benefiting from its interconnections and 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

⁸For another discussion on new technologies and the weight of distance refer to Lendle et al. (2012).

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 for retailers significant delays 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.

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 located abroad which ensures the final delivery. Postal flows are the most universal of all trade flows in terms of geographical access by different populations to their services, for instance in 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 country⁹ recorded in detail the content of all parcels sent, 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 flows therefore reflects the content of cross-border e-commerce. As one might have expected, apparel and clothing as well as print products account for over 25 % of international postal flows. 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 (R^2 of 68 % and 73 %) is observed (see table (6)). 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)¹⁰, but rather neglected by trade economists.

3.2 International Postal Flow Data

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

⁹Due to confidentiality reasons the country name cannot be disclosed.

¹⁰The "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>.

item that is dispatched internationally is scanned and tracked at several stages of the international postal process until it reaches its final destination. For a visual overview of the messaging system refer to figure (4). 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.

For our research question, we are interested in the daily volume of bilateral postal exchanges. We have therefore 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 weighting 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 EMS, the fastest international postal service covering both documents and packages (up to 30 kilograms each). For each day from October 1st 2010 to December 31st 2012, 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 (2), our postal data of aggregated EDI messages covers entries from 185 countries (postal operators) for a total of 14'148 country pairs (corridors). In total, we count 2'224'416 non-zero entries.

The daily aggregated data of postal exchanges presents several statistical challenges to overcome. First of all, postal flows are not uniformly distributed during the week as reported in table (3). In addition, some few countries do not have daily postal flows and dispatches are only sporadic. This is mainly due to logistical reasons and for a question of market size. Secondly, there are many zero records (around 70% of the sample) as we illustrate in table (2). The zeroes come from two different sources. On the one hand, postal flows are scarce during weekends accounting for 30% of the zeros. On the other hand, in some country pairs exchanges are very little or non-existent. The zero trade flows are similar to the trade literature, and relates to the fact that the world trade matrix tends to be sparsely populated (see Hummels).

3.3 Exchange Rate Data

We retrieved daily exchange rates from *Bloomberg*¹¹. 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 new computed exchange rates is consider as a depreciation in the exporting country. The spot prices are

¹¹<http://www.bloomberg.com/>.

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 were computed by dividing each country relative spot price with respect to the US Dollar. The data daily spans from October 1st 2010 to December 31st 2012.

3.4 Sample Data

For our study, we have eliminated all countries with exchange rate regimes that are either pegged or managed. The reason 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 fully floating exchange rates, according to 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 high share of the population with internet access. In 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 (5). After excluding all bilateral pairs which use the same currency (e.g. postal flows 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.

4 A Dynamic Model for Testing International Arbitrage

Our sample consists of a large number of time series observations of international postal exchanges and exchange rates (more than two years on a daily basis) and large number of groups (406 corridors). The main objective of our econometric analysis is to test the hypothesis of short-run international arbitrage. Traditionally, such a problem would have been tackled using either of the two following procedures: First, one can 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 take into account 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 this approach the intercepts are allowed to differ across groups while it is assumed that all other coefficients and error variance are identical. Pesaran et al. (1999) have developed an intermediate approach which we argue is the most appropriate for our setup, 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) 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. We therefore specify the model in a way that identifies the impact of transitory short-run shocks and of permanent equilibrium shocks. We discuss the specification in the section below where we also define the dependent variable as a seasonal adjusted version of postal flows.

Before discussing our econometric model we define our dependent variable. As discussed in section (3) since postal dispatches show seasonal patterns specific to each corridor. This is mainly due to logistics, every network has its own, and purely seasonal effects. For every country pair ij our dependent variable is the residual between postal flows and a regression of first-difference detrended postal flow with day of the week dummies. Our dependent variable is the residual of the regression on day of the week dummies. As a result the adjusted dependent variable does not contain seasonal components¹². We choose the dummy variable technique because of the deterministic type of seasonality exhibited in postal networks.

In order to determine if there is consumer arbitrage in the short-run (i.e. parcel flows co-move with exchange rate movements) we need to establish a dynamic model. The main idea is that because of price stickiness, short-run nominal exchange movements may shift consumer expenditure from domestic markets (online or offline) to foreign online retailers. The underlying assumptions are that consumers adjustment expenditure costs are low, because the internet makes price comparisons easier, and that transport costs are low, because of the postal network. We model the dynamics between exchange rates and parcel flows with the help of Pesaran et al. (1999) Pooled Mean Group (PMG) estimator, which is an extension of the Vector Error Correction (VEC) to panels with two high dimensions. Stacking up the time series for a given country pair, ij , the PMG estimator focus on the equation:

$$\Delta \ln EXP_{ij} = (\xi(\theta)_{ij})\phi_{ij} + \sum_{s=1}^p \Delta \ln EXP_{ij,-p} \lambda_{ijp} + \sum_{s=1}^p \Delta \ln FX_{ij,-p} \delta_{ijp} + u_{ij} \iota_T + \epsilon_{ij}$$

$$\xi(\theta)_{ij} = \ln EXP_{ij,-1} - \theta \ln FX_{ij,-1} \quad ij = 1, \dots, N; t = 1, \dots, T \quad (1)$$

The dependent variable is $\Delta \ln EXP_{ij}$, the percentage change of parcels dispatched from country i to country j . $\ln FX_{ij}$ is the exchange rate and $\Delta \ln EXP_{ij,-p}$ and $\Delta \ln FX_{ij,-p}$ are the p lags of the percentage change in parcels and in exchange rates. ϵ_{ij} is the error term assuming to be Gaussian for every panel.

The interpretation of model (1) 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

¹²When 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.

panel. The equilibrium relationships refers to how will parcel flows change following a permanent nominal depreciation. The parameter θ can be interpreted as the elasticity of parcel flows with respect to the exchange rate. On the other hand, the speed of returning to the equilibrium, or error correction term (ϕ_{ij}) is country pair specific. This allows for more flexibility, the average ϕ_{ij} can be seen as the percentage time, in days, that takes to be back to the equilibrium after a shock to the system. We allow the short-run parameters, $\lambda_{ijp}, \delta_{ijp}$ to be specific to each corridor. This controls for the fact that for some country pairs short-run movements can be more important. The parameters can be viewed as the response to a 1% daily depreciation that is not sustained. In addition, our specification allows for a time invariant, (ν_T being a vector of ones), corridor fixed effects u_{ij} . The most important coefficients are θ and the average of the ϕ_{ij} . θ is seen as as the elasticity of dispatched parcels from country i to country j following a sustained one percent depreciation of country j currency. A significant and negative average ϕ_{ij} is a necessary condition for the existence of the equilibrium relationship. We discuss the estimation of equation (1) in section (5).

5 Estimation Results

We examined the exchange rate dynamics and the question of international consumer arbitrage for the sample of countries classified by the IMF as having a free floating exchange rate regime. This way we can assume that for these markets exchange rate are exogenous to monetary policy. We emphasize the fact that the corresponding sample contains mostly well integrated economies with a large percentage of the population having internet access. The inference only apply to countries with similar characteristics. The baseline results are discussed in section (5.1) while we provide alternative specifications in section (5.2).

5.1 Baseline Regression Results

In table (7) we show the result for the PMG estimation of model (1). We present four models with different lag structure. The number of difference lags represents the order of the underlying VAR model. Our dependent variable are the seasonally adjusted dispatched parcels. We estimate model (1) by profiled maximum likelihood with a custom modified version of Pesaran's Stata command `xtpmg`. The custom command is available upon request to the authors¹³. 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. This might be due to the fact that exchange rate depreciations are transmitted very quickly into the internet market. When a consumer makes her decision to buy online, she will look at her budget and at the price of the good. The search cost she faces is very low because as it is fairly simple to compare prices online. With low expenditure adjustment cost and price stickiness the nominal exchange rate will trigger the arbitrage to balance the online market. The absence of short-run dynamics, may also indicate that transitory shocks have little impact on exports, what is needed is a sustained change for at least a

¹³It is mainly based on Pesaran's command, but with a few improvements in the likelihood part of the algorithm.

few days. The error correction coefficient is negative and close to 1 indicating a fast return to the equilibrium. The equilibrium relationship suggests that a one percent depreciation will increase postal flows between 0.5 to 0.6 percent. Notice that the effect is persistent. Since the elasticities are statistically different from unity, this suggest that either there is incomplete exchange rate pass-through or that goods in foreign parcels are imperfect substitutes to domestic goods. Furthermore the general results do not depend on the lag structure.

5.2 Robustness Checks

As an alternative to introduce corridor-specific day of the week dummies, one may aggregate the data at the week level. The week aggregation takes the log of the sum of postal dispatches in a week on the left-hand side of equatio (1) and the log of average of the daily exchange rates. Table (9) shows the results for the estimation of model (1) with weekly data. The conclusion is similar as before, there are little short-run dynamics but a strong equilibrium relationship. A sustained one percent depreciation will increase exported parcels by roughly one percent to a given destination¹⁴. A similar conclusion is obtained in table (10) where we use monthly aggregated data. I this case the one percent depreciation leads to a 0.6 percent increase in parcels dispatched. Eventually we try a different approach for the definition of our dependent variable. In fact, the database contains information about express dispatches which are related to some extent to international parcels with a few differences. The express service is more expensive than the international parcels. It exhibits higher transport costs for a faster service. On the other hand, express flows are highly correlated with international parcels. This is due to the fact that they reflect similar seasonal patterns and also changes in demand due to changes in taste towards a given origin. Moreover, express flows are less sensitive to exchange rate movements because of high transport costs. Therefore, a way for controlling for seasonal patters and changes in demand is to first regress parcel flows onto express flows. This way we control for seasonal patterns while tacking into account demand changes that are unrelated to exchange rates. In table (8) we present the results where the dependent variable is the residual of the regression between international parcel dispatches and express dispatches. Once again the results are roughly the same as before. The error correction coefficient is negative and close to unity, indicating a fast return to the equilibrium. A one percent sustained one percent depreciation leads to an increase of exports of about 0.6 percent.

6 Discussion and Conclusion

For the first time, we use a high-frequency international exchange data set 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 allow consumer to face low transport cost. This coupled with price rigidity and low search cost allow for international arbitrage. Combining daily postal flows with daily exchange rate movements,

¹⁴The result is the same when specific month-corridor dummies are included.

we find that exchange rate movements do indeed matter for bilateral trade flows in the short-run. A currency appreciation triggers an increase of postal inflows by the magnitude of 0.5 percent.

Future extensions of this research are to include countries with active monetary policy. A sampling strategy could be to exclude only partners sharing a common currency anchor. In the near future, systematic information on customs declaration, including value, quantity and good category for each international postal shipment, will be generated 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 those 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 part of international supply chains. As pointed out repeatedly by leading trade economists, trade policies need to be adapted to the realities of the 21st century's trade dominated by international supply chains. Yet, international supply chains are still poorly understood. 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.

7 Tables and Graphs

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 thereof	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	Nuclear reactors, boilers, mchy & m	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 for one developed country.

Table 2: Postal Raw Data Overview

Number of countries	185
Number of currencies	144
Number of corridors	14'148
Time span	01oct2010-31dec2012
Number of records	7'822'404
Number of zero observations	5'597'988

Table 3: Daily percentage deviations in internation 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 4: Floating sample overview

Number of countries	26
Number of corridors	406
Time span	01oct2010-31dec2012
Average numer of observations per corridor	815

Table 5: 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 6: 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 (0.013)***	0.032 (0.007)***	0.710 (0.020)***	0.898 (0.011)***	0.024 (0.005)***	0.655 (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 7: Dynamic model for exchange rates and parcel dispatches, daily frequency

Dependent variable	PMG	PMG	PMG	PMG
$\Delta \ln EXP$	Estimates	Estimates	Estimates	Estimates
Equilibrium relationship				
$l. \ln FX$	-0.600 (0.092)***	-0.626 (0.102)***	-0.636 (0.104)***	-0.494 (0.105)***
Short-run dynamics (averaged)				
$l. \Delta \ln FX$	2.601 (6.706)	1.407 (3.465)	1.111 (1.466)	-0.864 (4.433)
$l2. \Delta \ln FX$		1.614 (1.238)	-0.721 (1.674)	-6.050 (4.539)
$l3. \Delta \ln FX$			0.873 (1.844)	-0.412 (3.773)
$l4. \Delta \ln FX$				-3.477 2.638
$l. \Delta \ln EXP$	-0.044 (0.095)	-0.127 (0.048)***	-0.045 (0.037)	0.270 (0.082)***
$l2. \Delta \ln EXP$		-0.030 (0.030)	-0.032 (0.033)	0.208 (0.110)*
$l3. \Delta \ln EXP$			0.003 (0.022)	0.167 (0.059)***
$l4. \Delta \ln EXP$				0.204 (0.075)***
Error correction	-0.779 (0.088)***	-0.714 (0.044)***	-0.762 (0.033)***	-1.049 (0.086)***
Constant	1.233 (0.124)***	1.427 (0.164)	1.615 (0.138)***	2.065 (0.214)***
Number of observations	106491	85875	67969	55663

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

Standard errors in parenthesis clustered by corridor

Table 8: PMG estimations results with express flow residuals

Dependent variable $\Delta \ln EXP$	PMG Estimates	PMG Estimates	PMG Estimates
Equilibrium relationship			
$l.\ln FX$	-0.530*** (0.078)	-0.619*** (0.101)	-0.601*** (0.106)
Short-run dynamics (averaged)			
$l.\Delta \ln FX$	-2.204 (2.209)	6.879 (5.119)	0.191 (2.534)
$l2.\Delta \ln FX$		-0.637 (3.728)	-2.556 (7.223)
$l3.\Delta \ln FX$		7.614 (5.902)	2.752 (5.178)
$l4.\Delta \ln FX$			-24.840 (4.732)
$l.\Delta \ln EXP$	-0.021 (0.073)	-0.153** (0.067)	0.039 (0.114)
$l2.\Delta \ln EXP$		-0.159** (0.065)	-0.128 (0.082)
$l3.\Delta \ln EXP$		-0.070* (0.038)	-0.086 (0.154)
$l4.\Delta \ln EXP$			-0.193 (0.165)
Error correction	-1.001*** (0.320)	-0.686*** (0.081)	-0.678*** (0.068)
Constant	-0.119 (0.319)	-0.562** (0.233)	0.005 (0.281)
Number of observations	68951	48799	41252

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

Standard errors in parenthesis clustered by corridor

Table 9: PMG estimations results with weekly data

Dependent variable $\Delta \ln EXP$	PMG Estimates
Equilibrium relationship	
$l. \ln FX$	-0.978*** (0.083)
Short-run dynamics (averaged)	
$l. \Delta \ln FX$	-0.562 (0.381)
$l. \Delta \ln EXP$	-0.050*** (0.009)
Error correction	-0.599*** (0.048)
Constant	1.597*** (0.129)
Number of observations	39272

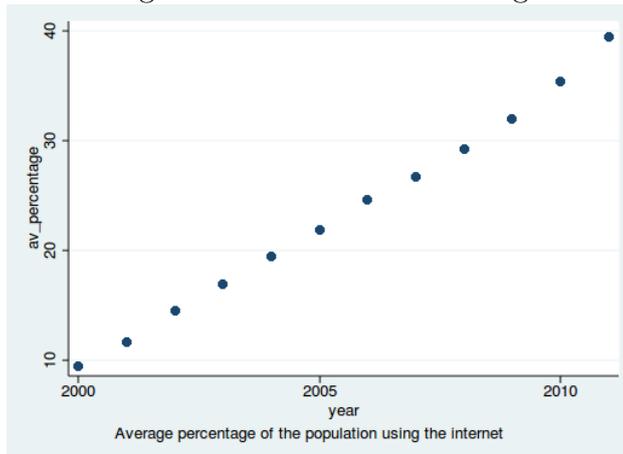
* p<0.10, ** p<0.05, *** p<0.01

Table 10: PMG estimations results with monthly data

Dependent variable $\Delta \ln EXP$	PMG Estimates
Equilibrium relationship	
$l. \ln FX$	-0.597*** (0.108)
Short-run dynamics (averaged)	
$l. \Delta \ln FX$	-0.629 (0.737)
$l. \Delta \ln EXP$	0.038** (0.015)
Error correction	-0.696*** (0.020)
Constant	2.725*** (0.127)
Number of observations	9471

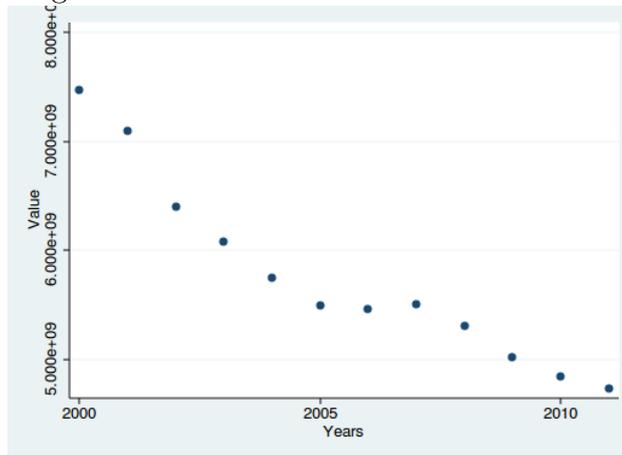
* p<0.10, ** p<0.05, *** p<0.01

Figure 1: World Internet Usage



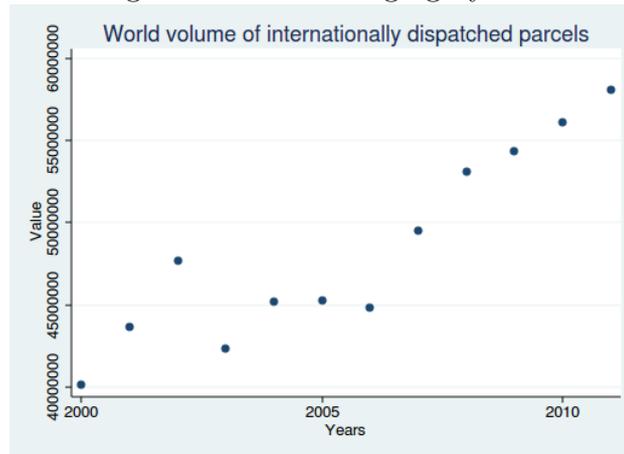
Source: ITU, <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>

Figure 2: International letter-items decline



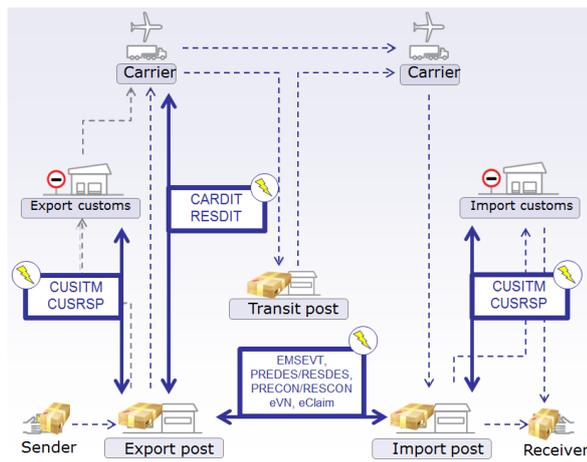
Source: UPU, <http://www.upu.int/en/resources/postal-statistics/about-postal-statistics.html>

Figure 3: EDI Messaging System



Source: UPU, <http://www.upu.int/en/resources/postal-statistics/about-postal-statistics.html>

Figure 4: International parcels dispatched



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

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