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Exchange Rate Effects on Agricultural Exports: Firm-level Evidence from Pakistan

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Exchange rate effects on agricultural exports: Firm-level evidence from Pakistan

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Abstract

This article uses a novel dataset from Pakistan for the recent period (2000–2013) to examine the effects of domestic currency depreciation on agricultural exports and investigate various channels of influence. It conducts an integrated analysis of prices and quantities, together with firm-level trade flows, by using the exchange rates of the actual currencies of invoicing at the transaction level. The study finds that exchange rate movement positively affects both intensive and extensive margins (IM and EM). The increase in the IM operates mainly through the channel of prices, whereas the response of quantities is relatively smaller. Moreover, depreciation improves the EM of firms and products and expands the client base within existing markets. These responses vary widely across products, markets, exporting experience, exchange rate regimes and invoicing currencies.

JEL codes: F13, F14, O13, O24, Q17

Key words: Firms in agriculture, Exchange rate, Currency of transaction, Trade margins, Export diversification

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Exchange rate effects on agricultural exports: Firm-level evidence from Pakistan

Domestic currency depreciation has been used widely as a policy tool to stimulate exports and to improve other macroeconomic imbalances. In particular, many developing countries have employed this strategy either unilaterally or at the behest of multilateral institutions as a part of structural adjustment programmes. The response of exports to exchange rate movement has been highly debated in the existing literature and the current evidence is mixed[1] (for a survey see Auboin and Ruta 2013). The existing micro literature in this stream focuses mainly on the manufacturing sector; the responses of exporting firms in the agriculture sector remain largely unexplored. This article bridges the gap by using a novel dataset on firm-level exports from Pakistan. This dataset describes exchange rate movement at the transaction level and contains information on actual invoicing currencies. The study finds that firm-level exports respond positively to currency depreciation and this effect is transmitted mainly through the channel of price, with the response of quantities relatively smaller. The trade response, however, varies widely across products, markets, exchange rate regime and invoicing currencies.

Examining the reactions of firms in the agriculture sector is important for at least three reasons. First, during the past two decades, the focus of research on international trade has shifted from countries and industries to firms and products. However, owing to data limitations, firms in the agriculture sector have not attracted much attention. Second, the agriculture, despite accounting for a comparatively small share of the global economy, remains central to the lives of a great many people. In 2012, of the world's 7.1 billion people, an estimated 1.3 billion (19%) were directly engaged in farming (World Bank 2012). These

[1] For example, Bernard and Jensen (2004) find no association between the exchange rate and firms' exports and Bugamelli and Infante (2003), Campa (2004), Das, Roberts and Tybout (2007), Greenaway and Kneller (2008) and Greenaway, Kneller and Zhang (2010) find negative and significant effects of exchange rate appreciation. A few product-level studies on the role of the exchange rate in agricultural trade also find conflicting evidence: for example, Kim, Cho and Koo (2004) show that the exchange rate has a significant impact on agricultural trade in the US, whereas Vellianitis-Fidas (1976) finds that it does not.

farmers rarely transact international business, but rather export through intermediary firms; as such, examining the behaviour of mediating firms could shed some light on the responses of upstream producers. Third, much of the existing literature on the exchange rate has attributed the low export response to currency depreciation to the offsetting channel of intermediary inputs used in manufactured goods (Amiti, Itskhoki and Konings 2014). As this intermediary channel is either absent or comparatively weak in the agriculture sector, the estimated trade response to exchange rate movement can be considered a direct effect of currency depreciation.

This study performs an integrated analysis of the response of firm-level exports to exchange rate movement, together with the reactions of prices and quantities, and examines the heterogeneity of the effects along multiple dimensions. It finds that the domestic currency depreciation positively and unambiguously affects both intensive and extensive margins (IM and EM)[2] but the response is not commensurate with the magnitude of depreciation. A depreciation of 10% is associated with an increase in IM of 1.74% on average. Of this, around 75% of the effect is transmitted through the channel of price and 25% through quantities. The corresponding increase in EM is 0.25% along firm EM, 0.14% along product EM and 0.29% along consumer margins. These results hold to a battery of robustness checks.

The heterogeneity analysis reveals that the export response is relatively large for the products that are least dependent on imported inputs. Moreover, firms exporting to developing countries show a greater response compared with those shipping to Europe or North America. Furthermore, producer currency invoicing, prior exporting experience and a fixed exchange rate regime are associated with relatively large trade effects. This article, although it focuses

[2] IM is the value of export per product per firm and EM is defined at four different levels: (1) firm EM – number of firms per product per market; (2) product EM – number of products per firm per market; (3) market EM – number of markets per firm per product; and (4) consumer margins – number of clients per firm per market.

primarily on the effects of exchange rates, reveals a relatively large trade-impeding role of tariffs, as well as the complexity of tariffs and non-tariff measures (NTMs).

This study exploits a novel dataset that is unusually detailed in describing the exchange rate effect at the transaction level on three dimensions in tandem: IM, price and quantity. The data contain information on the exchange rates of actual invoicing currencies firms use and span a period of 14 years (2000–2013) with wide geographical coverage of export markets. This relatively long timespan allows me to observe export responses over time and compare these in two different exchange rate regimes: fixed and floating. Moreover, the disaggregated data make it possible to control for unobserved heterogeneity by incorporating time-varying fixed effects for firms, products and markets, and permit deconstruction of the trade responses across subsectors within the agriculture sector. This focus is novel in the literature on agricultural trade.

This article provides a number of contributions to the existing literature on exchange rates, export diversification and invoicing currencies, besides adding a new dimension to the micro literature on trade in agriculture. The recent literature on agricultural exports looks mainly into changes in producer prices across markets (Liefert 2011) or examines the effects of NTMs (Disdier, Fontagné and Mimouni 2008; Fontagné et al. 2015). A few studies explore the effect of exchange rate volatility in cross-country settings using product-level information (Anderson and Garcia 1989; Cho, Sheldon and McCorriston 2002; Kandilov 2008; Kohler and Ferjani 2015). To the best of my knowledge, this is the first article to extend the frontier of this literature from countries and sectors to firms and products in agricultural trade at such a fine level.

The use of the exchange rates of the actual invoicing currencies at the shipment level distinguishes this article from the vast micro literature in this stream (Berman, Martin and

Mayer 2012; Fabling and Sanderson 2015; Li, Ma and Xu 2015; Fung 2008; Tomlin 2014). In the absence of information on the actual currencies of transactions, these studies use the bilateral exchange rates between trading partners. This approach is based on the implicit assumption that firms transact business in their national currency. However, I observe in the data that exporters settle their transactions mainly in vehicle[3] currencies, and that currency use varies across and within markets, as well as over time (table 1, figures 2). Given the empirical support for this multi-currency world in the dataset, I use the exchange rates of actual invoicing currencies in the estimations, and show that the effect of transaction-level exchange rates is almost half that of bilateral exchange rates between trading partners.

This study also extends the narrow stream of invoicing literature. In this vein, Staiger and Sykes (2010) theoretically show that the effect of the exchange rate, *inter alia*, depends on the currency in which producers invoice their transactions. Gopinath, Itskhoki and Rigobon (2010) examine the heterogeneity of pass-through for dollar- and non-dollar-invoiced transactions. In an extension of these studies, I explore the heterogeneity of trade responses among all major currencies, such as the dollar, euro, pound and dirham, and find that the response of the IM is larger in producer-invoiced transactions. Moreover, I study the relative behaviour of prices and quantities in tandem with that of firm-level exports, which earlier studies on invoicing do not examine (Bacchetta and Van Wincoop 2005; Chung 2016; Goldberg and Tille 2008).

In addition to informing on the response of agricultural exports to exchange rate movement, this study adds to the literature on export diversification. Earlier literature, for instance Hummels and Klenow (2005) and Hausmann, Hwang and Rodrik (2007), highlights the role of EM in export growth; however, the reaction of these margins to the exchange rate

[3] 'Vehicle currency' is a term used in the literature for third country invoicing.

movement in the agriculture sector remains relatively unexplored. Recently, Sekkat (2015) has shown that the exchange rate does not affect diversification within the manufacturing sector. In contrast, this study finds that depreciation positively affects the EM of firms, products and consumers in agriculture, all of which are different dimensions of export diversification.

Finally, this article contributes to the broad literature on the impact of exchange rates on firm-level exports. The existing micro literature in this stream focuses primarily on the manufacturing firms of developed economies. For example, Berman, Martin and Mayer (2012), Fitzgerald and Haller (2014) and Greenaway, Kneller and Zhang (2010) study the reactions of French, Irish and British firms, respectively. This work, however, examines the responses of firms in the commodity-exporting sector of a developing country – a distinctive empirical setting. Even this atypical setting generates evidence on the offsetting effect of exchange rate through intermediary inputs. It shows that the trade response is relatively larger for the primary products that are the least dependent on imported inputs, which complements the findings of the above studies.

The remainder of the article is structured as follows. The next three sections introduce the dataset, discuss the estimation strategy and present the main results, respectively. The article then explores the variation of exchange rate effects along multiple dimensions of firm and product heterogeneity, following this with additional robustness checks and an examination of the reactions of the EM. The final section concludes with a summary of the findings and their policy implications.

Data and descriptive evidence

This section introduces the dataset and highlights a connection between exchange rate movement and the response of agricultural exports from Pakistan. It also generates descriptive evidence concerning heterogeneity in invoicing currencies across and within

markets, which provides a rationale for the use of the exchange rates of the actual currencies in estimations, rather than the bilateral exchange rate between trading partners.

Data

This study uses the transaction-level data[4] of firms exporting agricultural commodities from Pakistan. This dataset contains information on the identities of firms, export values and quantities for all the products classified in Chapters 1–24 of the Harmonised System (HS) of classification at the 8-digit[5] level of disaggregation. It also contains net weight of each shipment and price, which makes it possible to explore the relative responses of these variables in tandem with the behaviour of firm-level exports. This raw dataset contains 2.4 million transactions for the period from July 2000 to December 2015. To generate a manageable sample, I limit the period of analysis to 14 years, from 2000 to 2013, and drop markets with fewer than 40 transactions per year, which restricts the sample to 142 export destinations. This transformation is necessary as required information on the macro variables of many small economies is not available for the whole period.

Moreover, I truncate the observations falling below the 1st percentile and above the 99th percentile of export values to remove potential outliers, and drop transactions with inconsistent units of measurement. I collapse this information at the firm-product-market-currency of transaction-year level, which generates 703,196 observations. This final sample captures around 95% of Pakistan's agricultural exports and provides wide geographical and temporal coverage of export markets with a good mix of developed and developing countries. A detailed list of export markets and products can be found in the Appendix (tables A1 and A2), which also contains summary statistics of variables (table A3).

[4] These are propriety data of the government of Pakistan and are subject to a confidentiality agreement.
[5] This is finer than the level of disaggregation of international trade data, which are recorded at HS6 level.

This administrative dataset has been constructed after scrutiny at different levels. Exporting firms file this information to customs authorities to seek border clearance for their products; the agency verifies these declarations and reports the same data to various national and international statistical agencies. The data are also scrutinised at the central bank as these firms realise export proceeds through banking channels. The intense scrutiny at these institutions means the data can be considered purged of measurement error. Furthermore, my personal experience of the collection and compilation of the data from 2000 to 2011 while part of the customs administration in Pakistan, as well as the consistency, integrity and accuracy checks performed by comparing aggregation results with the same information retrieved from the UN Comtrade dataset, suggests the data are of high quality.

The agriculture sector of Pakistan

Pakistan is the 26th largest economy in the world and is characterised as being among the emerging and growth-leading countries of the developing world. Its agriculture sector accounts for 18% of gross domestic product (GDP) and a similar fraction of national exports.[6] Pakistan is an interesting case for examining this research question for the following three reasons. First, it is a net exporter of many agricultural products, including wheat, rice, cotton, milk and dates, including other cash crops. In the period 2000–2013 more than 7,758 firms[7] exported around 1,190 agricultural products to 85,995 clients in 162 markets. This huge geographical, sectoral and temporal variation permits examination of the exchange rate effects along multiple dimensions of firm and product heterogeneity.

Second, the agriculture sector is relatively small compared with the rest of Pakistan's economy, which lessens concerns about reverse causality and increases the plausibility of the causal interpretation of results.

[6] http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

[7] Some of these firms own agricultural farms but most of them are intermediaries. They purchase agricultural commodities from the domestic market and export them after sorting, packaging, labelling and completing other necessary requirements.

Third, during the past decade, the national currency (PKR) has experienced a large exchange rate movement: it has depreciated almost 100%, from PKR 54 per dollar in 2003 to PKR 100 per dollar in 2013. In the same period, Pakistan's agricultural exports have almost quadrupled, from less than PKR 100 billion to more than PKR 500 billion. This apparent association between a large exchange rate movement and evolution of agricultural exports seems to provide a nice empirical setting for examining the research question (figure 1).

[Figure 1 about here]

Invoicing behaviour of firms

The data show that the currencies of transactions vary across and within markets. Around 95% of all export transactions are settled in six major currencies. The US dollar is used for negotiating exports to a large number of markets, followed by the PKR (the domestic currency) and the pound sterling (figure 2). Use of the US dollar dropped slightly from 2008 onwards, but it is still the preferred currency of invoicing. The use of other major currencies, such as the euro, pound sterling, Canadian dollar and United Arab Emirates (UAE) dirham, has varied a little over time. This pattern of invoicing in a few major currencies suggests that estimating the trade response using the bilateral exchange rate between trading partners (as is standard practice in the literature) is contrary to the pattern observed in the data.

In addition, invoicing behaviour varies not only across but also within markets. Table 1 presents this heterogeneity for the four largest export markets of Pakistan. It suggests that a majority of firms use either the buyers' currency or the vehicle currency, which is typical of a small country (Goldberg and Tille 2008). In 2013, around 50% of export transactions with the UK and Germany were settled in the US dollar, with the remaining 50% in the currencies of the destination markets: the pound sterling and the euro, respectively. In contrast, almost

all the exports to UAE and China were invoiced in the US dollar, which is neither the currency of the market of origin nor that of the destination.

[Figure 2 about here]

[Table 1 about here]

This heterogeneity in invoicing behaviour across and within markets suggests that the actually observed exchange rate across markets is different from bilateral exchange rates. For example, in 2013, the exchange rates of three major currencies against the PKR were PKR 154/pound sterling, PKR 120/euro and PKR 90/US dollar. As around 50% of exports to the markets of the UK and Germany were invoiced in US dollars (table 1), the actually observed exchange rates of the PKR for these markets are PKR 122/pound and PKR 110/euro,[8] respectively. Similarly, almost all exports to China and UAE were invoiced in US dollars, and the data rarely reflect the currencies of these markets, the dirham and the yuan. Therefore using exchange rates of dirham and yuan to estimate the trade effect of depreciation is contrary to the behaviour of firms.

Overall, these descriptive statistics suggest that invoicing currencies vary across and within markets. Therefore, for precise estimation, this article uses the exchange rates of the actual invoicing currencies, rather than the bilateral exchange rates between trading partners.

Estimation strategy

To quantify the effect of the exchange rate movement on firm-level exports, I use the following regression equation:

$$ln(X)_{ijkct} = \beta_0 + \beta_1 ln(exrt)_{ijkct} + \beta_2 ln(tariffs)_{jkt} + \beta_3 ln(sd\_tariff)_{jkt} + \beta_4 ln(net\_imp)_{jkt} + \alpha_{it} + \gamma_{kt} + \lambda_{jt} + \epsilon_{ijkct} \quad (1)$$

[8] Weighted average of exchange rates of the currencies employed.

The subscripts *i*, *j*, *k*, *c* and *t* denote firms, markets, products, invoicing currency and time, respectively.

The dependent variable, X_{ijkct}, is the intensive margin (IM). This is the value of sales per exporter at product-market-year level by currency of invoicing and is measured in PKR million. Products are identified at HS8 level, the highest level of disaggregation in trade data. This concept of IM is similar to that of Chaney (2008), which defines IM as the value shipped by a marginal exporter. As I observe the value of exports, prices and quantities at the HS8 level, I estimate the model at the same detailed level to avoid aggregation bias.

The description of the explanatory variables is as follows:

exrt: Exchange rate of currency of transaction *c* used by firm *i* for exporting commodity *k* to market *j* at time *t*. This is the main regressor of interest and is measured as domestic currency (PKR) per unit of foreign currency. The domestic currency depreciation appears as an increase in the exchange rate. β_1 is our main coefficient of interest and is expected to be positive.

tariff: Applied tariff rate in *ad valorem*; tariffs are a variable cost that are proportional to the export volume. I extract the data on tariffs from the World Trade Organization (WTO) tariff download facility.

sd_tariffs: Standard deviation of the tariff within each Chapter of the HS classifications. This variable measures the complexity of the tariff system of trading partners that can arise as a result of within-product variation in tariffs and seasonal tariff peaks on some commodities.

net_imports: Net imports account for the foreign demand of a specific commodity. This variable represents total imports of trading partner *j* in sector *k* at time *t* minus their imports from Pakistan at time *t*. This variable is constructed using trade flows from the UN Comtrade

database. Its lagged values are used to avoid simultaneity problems. Some studies use GDP as a proxy for demand; others argue that export absorption is a better indicator. I use *net_imports* in baseline estimations and use GDP in robustness checks.

α_{it}, γ_{kt} and λ_{jt} are a set of time-varying fixed effects for firms, products and markets, respectively, and ϵ_{ijkct} is an i.i.d component. Firm-year fixed effects capture the omitted variables affecting the marginal cost of firms over time. Product-year fixed effects soak up seasonal factors affecting trade in these commodities, and market-year fixed effects absorb variation in remoteness of export markets and provide a control for multilateral resistance for destination markets.

This choice of control variables is relatively close to Greenaway, Kneller and Zhang (2010) and Taglioni (2012) and the set of fixed effects is similar to Fitzgerald and Haller (2014). However, I introduce additional control variables, such as trade costs and NTMs, in robustness checks. The data on these variables come from the UN Economic and Social Commission for Asia and the Pacific/World Bank trade-cost dataset, which provides an *ad valorem* equivalent of costs of exporting and splits these along tariffs and NTMs (Arvis et al. 2016).

Given the length of time the dataset covers, I include a time trend in all the estimations. The linear time trend captures secular changes in exports over time. The trend also serves as a deflator of the nominal series used as a dependent variable and some explanatory variables (Paudel and Burke 2015). All estimations are in logarithmic form and the estimation method is ordinary least squares (OLS). To account for autocorrelation, standard errors are clustered at the market-year level.

The same specification is employed to estimate the responses of price and quantity margins and EM. Existing studies define EM at different levels of aggregation and use a variety of

definitions. Some authors employ binary models to study the probability of a firm entering into export markets; others use number of firms and products, number of buyers per firm or number of markets per firm. I follow the second approach[9] and estimate the reactions of four components of the EM: (1) firm EM – number of firms per product per market; (2) product EM – number of products per firm per market; (3) market EM – number of markets per firm per product; and (4) consumer margins – number of clients per firm per market.

In an alternative specification, I compute firm- and market-specific exchange rates over time and use the lagged values in the estimations. This transformation overcomes potential endogeneity caused by the switching of currencies. This stringent specification uses the following regression framework.

$$ln(X)_{ijkt} = \beta_0 + \beta_1 ln(exrt_{ijk})_{t-1} + \alpha_{it} + \gamma_{kt} + \lambda_{jt} + \varepsilon_{ijkt} \quad (2)$$

The subscript *i* denotes the firm, *j* the trading partners, *k* the product and *t* the time (year). α_{it}, γ_{kt} and λ_{jt} are sets of time-varying fixed effects for firms, products and markets to soak up other confounding factors. These two specifications provide more comprehensive estimates.

Main results and discussion

This section initially presents the response of IM and then decomposes the effect along prices and quantities.

Response of intensive margins

Table 2 presents the baseline estimation results. Column (1) contains pure variation in the data. As the results indicate, the coefficient for the exchange rate variable is positive and statistically significant at the 1% level, indicating that currency depreciation positively influences IM. As these estimations are in logs, the coefficient can be directly interpreted as elasticity. The coefficient of 0.179 on exchange rate variable in column (1) means that, on

[9] The reason is that, at a firm level, moving from zero to one products or markets is much different from moving from one to two. Moreover, these elements capture different dimensions of export diversification, which is one of secondary questions this article aims to investigate.

average, a depreciation of 10% in the domestic currency is associated with an increase of 1.79% in IM.

Columns (2) to (5) add other covariates. As expected, tariff bears a negative sign and so does the complexity of tariffs of trading partners, as evidenced by the negative coefficient for the standard deviation of tariffs. In contrast, the positive coefficient for net imports suggests that greater demand in the destination market attracts more exports. The coefficient for the time trend is positive and statistically significant, showing improvement in IM over time, which appears to be evidence in favour of learning through exporting. These estimates indicate that currency depreciation improves the IM of exports and this effect is quite stable in sign and statistical significance.

To isolate the effect of the exchange rate from the unobservable, the estimations in columns (1) to (4) include fixed effects for firms, products and markets. These dummies absorb time-invariant factors (such as distance, language, relative income level). Market fixed effects capture time-invariant reasons for the exports of firms to certain markets being larger than those to others, such as countries' geographical characteristics. The time trend accounts for the changes in these characteristics and controls for the variation in the aggregate economic performance of the market of origin over time. Product fixed effects account for heterogeneity across commodity groups and firm fixed effects absorb the firm-related unobservable affecting the marginal costs.

Column (5) includes time-varying fixed effects for firms, products and markets to account for other factors influencing marginal costs; these dummies control for most of the potentially omitted variables that vary over time. The positive sign for the coefficient of interest and its statistical significance level remain quite stable, which corroborates the stability of the estimates.

The results in column (5) are used as a baseline. Columns (6) to (8) provide initial robustness checks. Column (6) adds firm-market fixed effects, which account for the persistency of export behaviour across markets. Column (7) presents estimation results for equation (2). This alternative specification yields similar results. Column (8) adds fixed effects for firm-product-market, which eliminates concerns about the heterogeneity of product quality across markets. This relatively rigid specification generates results identical to those of the baseline estimates. As row (1) indicates, the coefficient for the exchange rate variable is positive and statistically significant at the 1% significance level in all these estimations, and its magnitude is close to that in the baseline estimates.

In the absence of firm-level studies on the effects of the exchange rate in the agriculture sector, these results are not directly comparable with any earlier work. There is a large literature on the exchange rate effects on agricultural exports from advanced economies including the US, Canada and the EU (for a survey see Kristinek and Anderson 2002) but most of these studies use product-level data. However, when looking at similar work in the manufacturing sector, the positive effect of the exchange rate on IM is consistent with the findings of Berg and Miao (2010) and Freund and Pierola (2008). But it contradicts the results of Bernard and Jensen (2004), which find no association between the exchange rate and firms' exports. The magnitude of the effect differs from that in existing studies. For example, Berman, Martin and Mayer (2012) find that a 10% depreciation increases the exports of an average exporter by 4%. The point estimate of the elasticity found by Fitzgerald and Haller (2014) is 0.64. Compared with these studies, the response of Pakistan's agricultural exports appears to be relatively smaller.

Responses of prices and quantities

To pin down the mechanism of the increase in exports, columns (9) and (10) split the above responses of IM into those of price and quantity margins. The deconstruction indicates that a

depreciation of 10% is associated with an increase in prices of 1.2% and quantities by 0.44%. In relative terms,[10] 75% of the effect of the exchange rate operates through prices and 25% through quantities. This suggests that the increase in exports occurs largely through the channel of prices and the response of quantities is relatively smaller.

The high response of prices represents incomplete pass-through. There could be many reasons for the relatively rigid behaviour of quantities. For instance, price adjustments may mitigate the need for quantity adjustment. Moreover, high airfreight charges may discourage the shipment of large quantities, as the perishable nature of most of these products means they are exported by air. Also, some agricultural products are customised, as buyers have specific packing, labelling and conformity assessment requirements. It may thus be difficult to economise on the cost of changing quantities.

[Table 2 about here]

Heterogeneity analysis

This section examines the variation in exchange rate effects along multiple dimensions of firm and product heterogeneity.

Heterogeneity of trade response across product groups

We should expect a heterogeneous response within the agriculture sector as these products differ in terms of time lag for supply response as well as in terms of the intensity of imported intermediary inputs, which can offset the direct effect of currency depreciation. Table 3

[10] As we use the OLS estimator to decompose the overall effect on IM into its components, the coefficients for price and quantity variables indicate their relative responses because the OLS estimator has an additive property.

decomposes the estimated coefficient in baseline specification[11] across broad commodity groups. The disaggregation suggests that firms in all sectors respond positively to depreciation, but the effect is relatively larger for exporters of primary products (animal and animal products; fruits and vegetables) and comparatively smaller for traders of processed goods (prepared food stuff; animal or vegetable fats).

Overall, large responses appear to come from the products that are least dependent on imported intermediate inputs, such as fruits and vegetables, as these products are least likely to be affected by the offsetting channel of imported inputs. In contrast, the effect is relatively smaller for goods requiring imported inputs for production, such as prepared food stuffs or animal or vegetable fats. As manufacturing of these value-added products requires imported chemicals or machinery, the rise in the price of imported inputs because of depreciation may partially offset the effect of the exchange rate on exports.

Columns (2) and (3) show that the positive response along the IM transmits mainly through prices and the reaction of quantities is weak, except for in fruits and vegetables. In particular, the response of quantities is statistically insignificant for animal and animal products and animal or vegetable fats. This heterogeneity in the responses of quantities across sectors potentially coincides with the time required for a supply response: vegetables can be grown quickly but raising animals requires a substantial long-time lag.

[Table 3 about here]

Further decomposition of the exchange rate effect across the subsectors within agriculture reveals a high degree of variation in the responses of trade margins (figure 3). (For detailed estimates of these sub-groups, see table A4 in the Appendix.) This indicates that the effect is greater for primary commodities, such as cereals, meat and fish products, than it is for

[11] The estimates in column 5 of table 2 are used as a baseline.

processed food items, such as sugar, beverages and oils. This heterogeneity seems to come, *inter alia*, from the offsetting channel of imported inputs, as the products that are least dependent on imported inputs show a larger response. The deconstruction of the effect along prices and quantities reveals a relatively large response through the channel of prices, which supports the baseline results.

[Figure 3 about here]

Heterogeneity of trade effects along invoicing behaviour and exchange rate regimes

Panel A of table 4 decomposes the coefficient on the exchange rate variable along invoicing currencies to understand the differences in responses across various currency groups. These estimates show that the response of the IM is relatively large for domestic currency (PKR) invoicing compared with those along vehicle currencies. As the US dollar is the most widely used currency, the magnitude of the coefficient for dollar-invoiced transactions is similar to that in the baseline results.

The decomposition of the response of the IM to that of price and quantity margins in columns (2) and (3) along invoicing currencies reveals that the responses of both price and quantities are positive and statistically significant. Although the magnitude of the effect varies along invoicing currencies, the relative effects along prices and quantities are similar. In all these estimations, the magnitude of the effect is larger for price margins. This suggests that depreciation reduces marginal costs and exporters seem to raise their prices.

[Table 4 about here]

Panel B of table 4 examines the heterogeneity of exchange rate effects in fixed and floating exchange rate regimes. Pakistan's currency was initially pegged to the US dollar, with this peg removed in 2007. A comparison of estimates for the fixed and free floating periods

shows that the response of the IM is almost double in the former, suggesting that the type of exchange rate regime also matters. In the pegged regime, the responses of both quantities and prices are positive and similar in magnitude. In the floating regime, however, the entire effect is transmitted through prices, indicating firms' ability to adjust prices in response to exchange rate movement (Hoffmann 2007).

Many studies show that the effect of the exchange rate depends on the time period of the investigation: the long-run effect may differ from the short-term effect as prices are less sticky in the former. Given the long timespan of the dataset, I decompose the average effects on trade margins into yearly periods to see if any specific year drives the results. Figure 4 presents the results; the detailed estimates are in the Appendix (table A5).

[Figure 4 about here]

As this decomposition suggests, the effect of the first depreciation in 2000 is large but transitory, as the magnitude of the coefficient decreases gradually from 2000 to 2007, whereas that of the second depreciation in 2007 appears small but somewhat persistent. This difference coincides with the changes in the exchange rate regime as mentioned above, when the country moved from a fixed regime to a free-floating system.

The deconstruction of response of the IM into price and quantity margins indicates that the adjustment in price drives this effect. Quantities respond positively in the initial period but do not respond to the second depreciation in 2007. Most likely, the quantities do not respond in the free-floating regime as this allows for adjustment in prices in reaction to external shocks. Second, this later period is associated with the rise of protectionism following the global financial crisis. These estimates also show that the short-term effect of depreciation is relatively larger and firms make gradual adjustments.

Heterogeneity of exchange rate effects across markets and firms' exporting experience

Panel A of table 5 presents the exchange rate effect for various market groups. It indicates that the highest response comes from exports to the markets of South Asia, East Asia and sub-Saharan Africa. The larger effect for these markets of developing economies indicates a rising pattern of South–South trade. In contrast, the exchange rate effect is much smaller for the markets of North America and Europe, which could be because of stringent NTM imposed by these markets on agricultural imports (UNCTAD 2013).

[Table 5 about here]

To investigate whether the increase in IM owes to larger exports by incumbents (existing firms) or to entrants, panel B of table 5 decomposes the estimated coefficients along firms' exporting experience. Entrants started exporting at time t but did not export at time $t\text{-}_1$; incumbents exported at $t\text{-}_1$ and also at time t but ceased exporting at $t+_1$. Firms are considered entrants only in their first year of exporting and are treated as incumbents in subsequent periods. These results suggest that both cohorts respond positively to currency depreciations but the magnitude of the effect is slightly greater for incumbents. Moreover, incumbents ship larger quantities, whereas entrants increase exports mainly through the channel of prices. This is also quite intuitive as incumbents may benefit from their established presence in export markets.

Further robustness checks

This section tests the robustness of the benchmark results by including additional covariates and allowing for the differential response of firms to macroeconomic variables. It also shows the effect of using the bilateral exchange rate in estimations.

Controls for omitted variables

Table 6 shows the effect of additional regressors on the main results. In addition to the standard set of covariates incorporated in the baseline estimations, it adds NTMs, trade costs, GDP per capita and the market share of firms. These estimations obviate the threat that our regressor of interest may be picking up the effect of any of these variables. In all these estimations, the effect of the exchange rate is positive and statistically significant and the magnitude of the coefficient is in the range of the baseline results. Moreover, these additional covariates bear the expected signs. For example, the coefficient for NTMs and trade costs is negative, whereas that for the GDP of destination markets is positive, as expected.

[Table 6 about here]

Column (4) incorporates the lagged market share of firms in addition to the standard set of covariates. This variable captures how large a firm was in a particular market in the previous year. A positive and statistically significant coefficient for this regressor indicates that the effect of the exchange rate is relatively large for already established firms. This further supports the analysis in panel B of table 6 that incumbents show a larger response than entrants. A similar effect of existing market share is observed in Devereux, Dong and Tomlin (2017). Column (5) shows the combined effect of all regressors, which also supports the baseline findings.

Variable response of firms to macroeconomic factors

Fitzgerald and Haller (2014) argue that imposing the same response for all firm-market pairs to macroeconomic variables (such as tariffs and NTMs) may lead to misleading inferences as the effect of these factors may vary with firm characteristics. To examine this proposition, table 7 allows for differential responses to macroeconomic variables by including the

interaction of firm size[12] with tariffs, NTMs and the standard deviation of tariffs as additional regressors. Column (1) adds these interactions for tariffs, column (2) for NTMs and column (3) for the standard deviation of tariffs. Column (4) explores the combined effect of all these variables.

The baseline results hold to the inclusion of differential responses of these additional regressors; moreover, all the explanatory variables bear the expected sign. For instance, tariffs, NTMs and standard deviation of tariffs have negative and significant effects in all the estimations. However, this effect is moderated for larger firms. The positive coefficients for the interaction of firm size with tariffs and NTMs (columns 1 and 2) and for the standard deviation of tariffs (column 3) show that these barriers are relatively low inhibitors of the exports of larger firms. These estimations generate an identical effect of the regressor of interest, but they point towards the heterogeneity of the effect of these macroeconomic variables across firm size.

[Table 7 about here]

Using bilateral exchange rate in the estimations

As the existing literature mainly uses the bilateral exchange rate between trading partners, to reconcile the results of this article with existing studies I replicate the same estimations with this alternative measure of exchange rate. Moreover, I re-estimate the effect of the transaction-level exchange rate with the same sample, for comparison of results. Table 8 presents the results. It shows that the estimations with the transaction-level exchange rate (column 2) generate a smaller effect compared with that using bilateral level exchange rates (column 1). This substitution of the key independent variable increases the magnitude of the trade effect to the tune of 50%. This large relative difference in the magnitude of effect

[12] Information on numbers of employees is unavailable, thus the computation of firm size follows the approach of Fontagné et al. (2015).

suggests that ignoring the role of invoicing currencies may lead to overestimation of the effect of currency depreciation.

[Table 8 about here]

Extension: Responses of extensive margins

To examine the responses of EM, I estimate equation (1) using alternative dependent variables: EM of firms, products, markets and clients. As the results in table 9 indicate, the EM of firms, products and clients respond positively, which means that depreciation incentivises the entry of more firms into exporting; moreover, firms widen their exported product set and increase penetration in existing markets (columns 1, 2 and 4, respectively). The responses of EM vary with the nature of the exchange rate regime. The relatively large effect in a fixed regime suggests that low uncertainty or reduced volatility in the exchange rate incentivises entry into exporting and diversification of the export product mix (columns 1 and 2 of panel B). In contrast, the growth in exports along the EM in the floating regime through these channels, though positive, is relatively smaller.

[Table 9 about here]

Conclusions and policy implications

This study examines the effects of exchange rate movement on the margins of trade in the agriculture sector of Pakistan using highly disaggregated transaction-level data for the recent period (2000–2013). It finds that domestic currency devaluation improves both intensive and extensive margins (IM and EM). These positive responses of trade margins are very robust for Pakistan's firms, although the magnitude of the effect is very small. The increase in IM comes mainly through the channel of prices, whereas the reaction of quantities is relatively smaller. Similarly, the increase in exports along the EM operates through the channels of entry of more firms into exporting, expansion of the export product mix and growth of the

client base in existing markets. These effects are relatively stronger in the fixed exchange rate regime compared with those under a floating period. The trade response varies widely across firms, products and markets. The effect is relatively larger for traders of primary commodities than for exporters of processed goods, and it is slightly higher for incumbents compared with entrants. Similarly, the effect is larger for exports sent to other developing countries compared with those destined for Europe or North America.

The analysis reveals that the precise estimations need to account for the exchange rates of actual invoicing currencies, not the bilateral exchange rate between trading partners. As firms settle most transactions in few currencies, the bilateral exchange rate may overestimate the trade effect. Although the study focuses primarily on the effects of exchange rate, these estimations also point to the large trade-impeding effects of non-tariff measures (NTMs) and the complexity of tariffs in the agriculture sector.

One might expect a greater response of agricultural exports to currency depreciation because of a relatively weak offsetting channel of intermediary input, but the estimated elasticity is much lower than that found in earlier studies on manufacturing sectors. This difference in estimates results from the use of an alternative measure of exchange rate, as evidenced in the data, rather than bilateral exchange rates between trading partners. Another potential reason for the smaller trade response could be slow transmission of the exchange rate effect to producers because they rarely engage in exporting directly but rather rely on intermediary firms.

The pivotal role agriculture plays in the development process and its interactions with other economic sectors mean that promoting agricultural trade is a priority for most developing countries. Middle-income countries, such as China, India, Brazil and Indonesia, represent a rising share of agricultural exports (Alston and Pardey 2014). Despite there being much

interest in this area, researchers have not explored the behaviour of firms in the agriculture sector, mainly because of data limitations. This study bridges this important gap in the literature and the lessons learnt from this analysis can be applied to other economies similar to Pakistan. The low elasticity of exports in agriculture to currency depreciation suggests that policy-makers need to be cautious in employing exchange rate adjustment as a tool for export development strategies.

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Figures

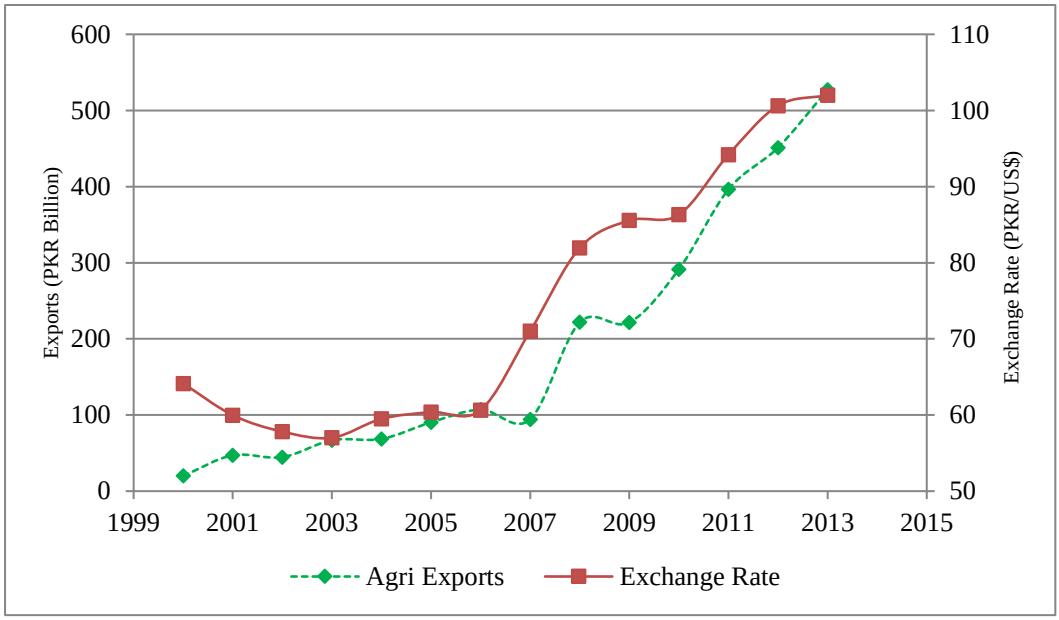

Figure 1. Response of agricultural exports to exchange rate movement in Pakistan

Note. Exchange rate is domestic currency (PKR) per unit of US dollar.
Source: Author's own elaboration using the Pakistan Customs dataset.

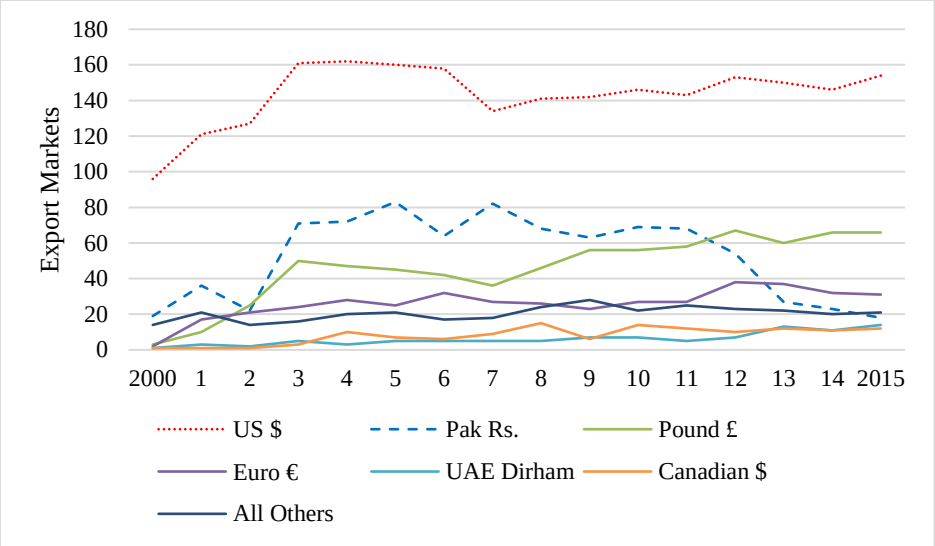

Figure 2. Pattern of invoicing currencies use over time

Source: Author's own elaboration using the Pakistan Customs dataset.

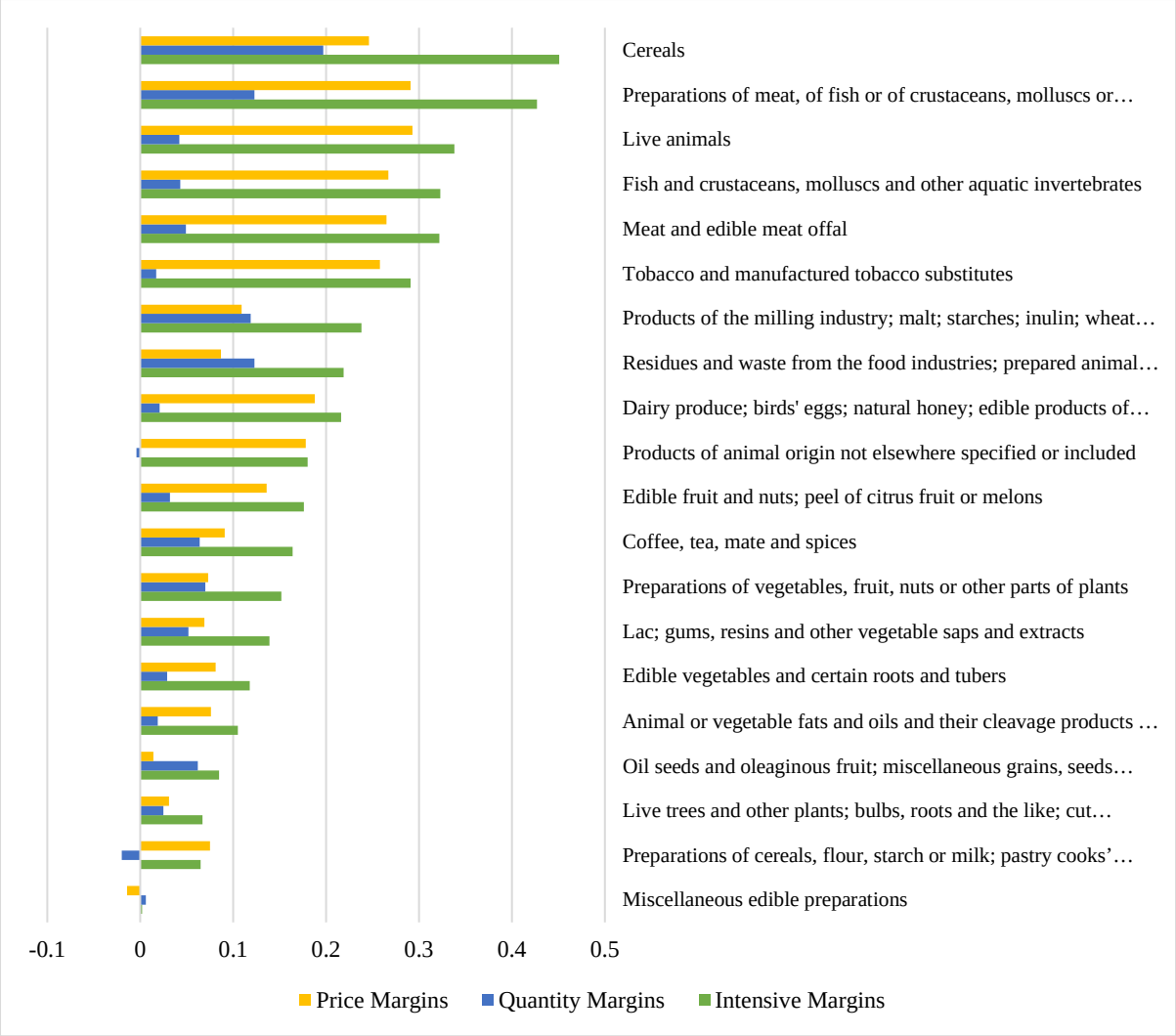

Figure 3. Heterogeneity of exchange rate effects along trade margins across sub-sectors

Notes: The chart plots the estimated coefficients on trade margins. The coefficients on price and quality margins add up to that on the intensive margin.

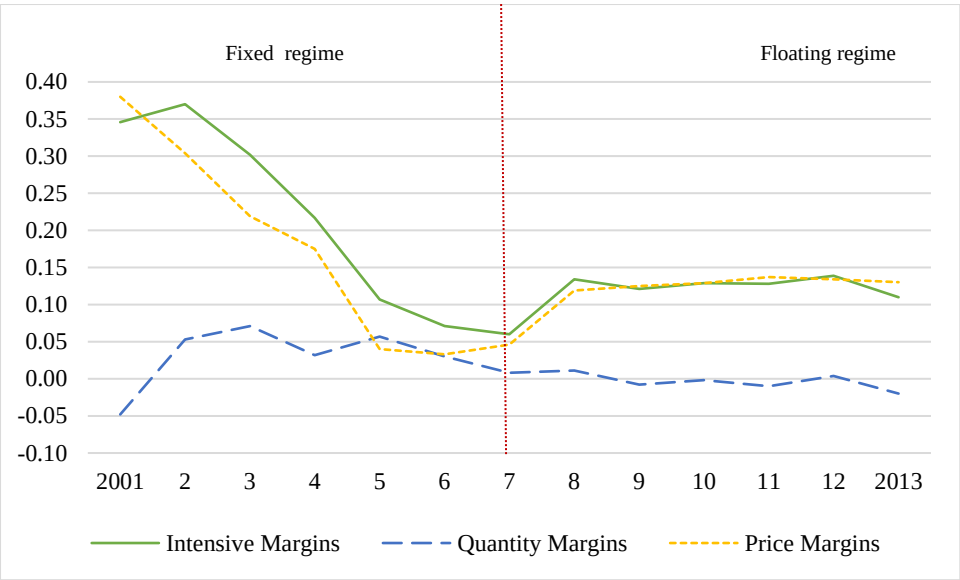

Figure 4. Heterogeneity in exchange rate effects over time

Notes: The figure plots the estimated coefficients on the intensive margin and its two components, prices and quantities, over time. The vertical line indicates the switching of the exchange rate regime from fixed to floating.

Tables

Table 1. Export Transactions (%) by Invoicing Currency for Major Export Markets, 2013

	Export market			
Currency	UK	Germany	China	UAE
US$	50.77	49.01	98.8	95.67
Euro	1.6	50.34	0.28	0.62
STG	46.4	0.17	0.02	0.39
Rupee	1.03	0.36	0.89	1.79
Dirham	0.12	-	-	1.52
Total	55,664	34,252	44,741	77,532

Note. The table shows the variations in invoicing currencies use within export markets. The data indicate fraction of total transactions by market.
Source: Author's calculations using the administrative dataset.

Table 2. Main Results: Responses of Intensive Margins, Price Margins and Quantity Margins

Dependent variables	Intensive margins (columns 1 to 8)								Quantity	Price
	Equation-1 (columns 1 to 6)						Equation-II		Equation-I	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Exchange rate	0.179***	0.183***	0.187***	0.188***	0.174***	0.145***	0.205***	0.272**	0.044***	0.121***
	(0.014)	(0.014)	(0.004)	(0.014)	(0.014)	(0.013)	(0.050)	(0.110)	(0.011)	(0.009)
Additional controls										
Net imports		0.038***	0.037***	0.036***	0.104***	0.098***			0.086***	0.018***
		(0.001)	(0.000)	(0.001)	(0.001)	(0.001)			(0.001)	(0.001)
Tariffs			-0.073***	-0.069***	-0.087***	-0.116***			0.004	-0.092***
			(0.002)	(0.003)	(0.004)	(0.004)			(0.003)	(0.003)
St. dev. of tariffs				-0.025***	-0.117***	-0.126***			0.002	-0.119***
				(0.003)	(0.005)	(0.006)			(0.004)	(0.004)
Time trend	0.143***	0.133***	0.132***	0.132***		0.145***		0.112***		
	(0.001)	(0.001)	(0.001)	(0.001)		(0.013)		(0.001)		
FE (firm, product, market)	Y	Y	Y	Y						
Firm-year					Y		Y		Y	Y
Product-year					Y	Y	Y		Y	Y
Market-year					Y	Y	Y		Y	Y
Firm-market						Y				
Firm-product-market								Y		
R2	0.704	0.721	0.721	0.723	0.721	0.791	0.747	0.738	0.721	0.723
N	703,196	703,196	703,196	703,196	692,015	690,048	35,995	23,139	692,015	692,015

Notes: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of direct interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All the estimations are in logs. Columns (6) and (7) have fewer observations as these estimations are performed at a higher level of aggregation. Similarly, columns (5), (8) and (9) have relatively smaller numbers of observation compared with those in column (4) as singleton observations are dropped by Stata. The coefficients in columns (9) and (10) add up to that in column (5). The addition of time-varying fixed effects absorbs the effect of time trend.

Table 3.Heterogeneity across Broad Product Groups

Dependent variables	Intensive margins (1)	Quantity margins (2)	Price margins (3)
Exchange rate x			
Animals and animal products	0.245***	0.020	0.217***
	(0.016)	(0.013)	(0.010)
Fruits and vegetables	0.207***	0.067***	0.131***
	(0.015)	(0.011)	(0.009)
Animals or vegetable fats	0.138***	0.020	0.110***
	(0.023)	(0.019)	(0.021)
Prepared food stuffs	0.118***	0.022*	0.086***
	(0.015)	(0.012)	(0.010)
R2	0.721	0.691	0.570
N	692,015	692,015	692,015

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The coefficients in columns (2) and (3) add up that in column (1).

Table 4: Effects of Invoving Behaviour and Exchange Rate Regimes

A: Heterogeneity of responses of trade margins along invoicing currencies

Dependent variables	Intensive margins (1)	Quantity margins (2)	Price margins (3)
Exchange rate x			
US dollar	0.188***	0.040***	0.139***
	(0.015)	(0.011)	(0.009)
Pak rupee	0.322***	0.093**	0.223***
	(0.060)	(0.045)	(0.068)
Pound sterling	0.183***	0.044***	0.130***
	(0.014)	(0.011)	(0.009)
Euro	0.166***	0.051***	0.107***
	(0.014)	(0.010)	(0.009)
Canadian dollar	0.166***	0.029**	0.127***
	(0.016)	(0.012)	(0.011)
All others	0.286***	0.048***	0.226***
	(0.023)	(0.017)	(0.018)
R2	0.721	0.698	0.585
N	692,015	692,015	692,015

B: Heterogeneity of responses of trade margins across exchange rate regimes

Exchange rate x			
Fixed regime	0.258***	0.137***	0.107***
	(0.021)	(0.016)	(0.012)
Floating regime	0.115***	-0.020	0.130***
	(0.016)	(0.012)	(0.011)
R2	0.729	0.69	0.57
N	692,015	692,015	692,015

Note: Robust standard errors are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01. The regressions include fixed effects for firms, products and markets but their coefficients are not reported. These estimates were obtained using Stata 13 SE. These dependent variables are defined at the head of each column. The estimation method is OLS using Stata 13.0 SE. The coefficients in columns (2) and (3) add up that in column (1). The coefficients in columns (2) and (3) add up that in column (1).

Table 5. Heterogeneity across Products and Markets

A: Heterogeneity across export markets

Dependent variables	Intensive margins (1)	Quantity margins (2)	Price margins (3)
Exchange rate x			
East Asia & Pacific	0.128***	0.029**	0.093***
	(0.015)	(0.012)	(0.009)
Europe & Central Asia	0.097***	-0.001	0.091***
	(0.014)	(0.011)	(0.008)
Latin America & Caribbean	0.069***	-0.006	0.067***
	(0.018)	(0.015)	(0.014)
Middle East & North Africa	0.153***	0.063***	0.082***
	(0.015)	(0.011)	(0.009)
North America	0.047***	-0.047***	0.086***
	(0.015)	(0.012)	(0.009)
South Asia	0.242***	0.083***	0.149***
	(0.015)	(0.012)	(0.009)
Sub-Saharan Africa	0.182***	0.090***	0.083***
	(0.015)	(0.012)	(0.009)
R2	0.709	0.695	0.575
N	692,105	692,105	692,105

B: Heterogeneity across firms' exporting experience

Exchange rate x			
Entrants	0.151***	0.007	0.142***
	(0.023)	(0.019)	(0.018)
Incumbents	0.177***	0.049***	0.118***
	(0.015)	(0.012)	(0.010)
R2	0.721	0.698	0.585
N	692,105	692,105	692,105

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In panel A export markets are grouped following the regional classification of World Bank. In panel B firms are grouped as follows. Entrants started exporting at time t but did not export at time t-1, incumbents exported at t-1 and also at time t but ceased exporting at t+1. IM stands for intensive margins. The coefficients in columns (2) and (3) add up that in column (1).

Table 6. Effect of Additional Covariates on the Baseline Results

The dependent variable is the intensive margin

	(1)	(2)	(3)	(4)	(5)
Exchange rate	0.177***	0.177***	0.166***	0.185***	0.206***
	(0.014)	(0.014)	(0.015)	(0.014)	(0.010)
NTMs	-0.233***				
	(0.028)				
Trade costs		-0.232***			-0.099**
		(0.027)			(0.046)
GDP per capita			0.228***		0.136***
			(0.020)		(0.025)
Market share $_{t-1}$				0.183***	0.321***
				(0.005)	(0.008)
R2	0.732	0.732	0.730	0.730	0.568
N	660,502	660,502	692,105	692,105	692,105

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Allowing Variable Response to Macroeconomic Factors

The dependent variable is the intensive margin

	(1)	(2)	(3)	(4)
Exchange rate	0.176***	0.172***	0.177***	0.173***
	(0.014)	(0.014)	(0.014)	(0.014)
Tariffs	-0.300***	-0.099***	-0.096***	-0.176***
	(0.005)	(0.003)	(0.003)	(0.005)
Tariffs # firm size	0.051***			0.020***
	(0.001)			(0.001)
NTMs	-0.198***	-0.496***	-0.226***	-0.453***
	(0.028)	(0.027)	(0.028)	(0.027)
NTMs # firm size		0.054***		0.049***
		(0.001)		(0.001)
SD. of tariff	-0.053***	-0.053***	-0.239***	-0.104***
	(0.003)	(0.003)	(0.006)	(0.006)
SD. of tariff # firm size			0.046***	0.013***
			(0.001)	(0.001)
R2	0.734	0.739	0.733	0.740
N	660,520	660, 520	692,105	692,105

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Firm size captures the relative size of firms measured in terms of total exports of a firm in a particular year.

Table 8. Effect of Using Bilateral Exchange Rates in Estimations

The dependent variable is the intensive margin

	Bilateral exchange rate	Invoicing currency exchange rate
	(1)	(2)
Exchange rate	0.392***	0.177***
	(0.032)	(0.016)
R2	0.699	0.700
N	527,448	527,448

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample size in this estimation is different as bilateral exchange rate information is not available for all trading partners of Pakistan for all years. Information on bilateral exchange rates is downloaded from the Penn World Table (PWT 8.1).

Table 9. Responses of Extensive Margins

A: Overall effect along extensive margins

	Firm EM	Product EM	Market EM	Consumer EM
	(1)	(2)	(3)	(4)
Exchange rate	0.025***	0.014**	-0.003	0.029***
	(0.008)	(0.009)	(0.005)	(0.007)
R2	0.577	0.478	0.518	0.245
N	32,547	54,222	72,458	117,680

B: Heterogeneity across exchange rate regimes

Exchange rate x				
Fixed regime	0.034***	0.028**	-0.007	0.037***
	(0.010)	(0.013)	(0.007)	(0.008)
Floating regime	0.018*	-0.004	0.001	0.021**
	(0.011)	(0.013)	(0.006)	(0.010)
R2	0.574	0.529	0.511	0.244
N	32,547	54,222	72,458	117,680

Note: Robust standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions include fixed effects for firms, markets and time but their coefficients are not reported. These estimates were obtained using Stata 13 SE. These dependent variables are mentioned at the head of each column and defined as follows: firm EM (number of firms per product per market); product EM (number of products per firm per market); market EM (number of markets per firm per product); (4) consumer EM (number of clients per firm per market).

Appendix

Table A1. List of Pakistan's Trading Partners Included in the Analysis

Afghanistan	Equatorial Guinea	Libya	Sierra Leone
Albania	Eritrea	Lithuania	Singapore
Algeria	Estonia	Madagascar	Slovak Republic
Angola	Ethiopia	Malawi	Slovenia
Argentina	Fiji	Malaysia	Somalia
Armenia	Finland	Maldives	South Africa
Australia	France	Malta	South Korea
Austria	Gabon	Mauritania	Spain
Azerbaijan	Gambia	Mauritius	Sri Lanka
Bahamas	Georgia	Mexico	Sudan
Bahrain	Germany	Mongolia	Swaziland
Bangladesh	Ghana	Morocco	Sweden
Belarus	Greece	Mozambique	Switzerland
Belgium	Guatemala	Myanmar	Syria
Benin	Guinea	Namibia	Taiwan
Botswana	Guinea-Bissau	Nepal	Tajikistan
Brazil	Haiti	Netherlands	Tanzania
Brunei	Honduras	New Zealand	Thailand
Bulgaria	Hong Kong	Niger	Togo
Cameroon	Hungary	Nigeria	Trinidad and Tobago
Canada	India	North Korea	Tunisia
Cape Verde	Indonesia	Norway	Turkey
Chile	Iran	Oman	Turkmenistan
China	Iraq	Pakistan	Uganda
Colombia	Ireland	Panama	Ukraine
Comoros	Italy	Paraguay	United Arab Emirates
Congo	Jamaica	Philippines	United Kingdom
Cote d'Ivoire	Japan	Poland	United States
Croatia	Jordan	Portugal	Uzbekistan
Cyprus	Kazakhstan	Qatar	Venezuela
Czech Republic	Kenya	Romania	Vietnam
Democratic Republic.	Kuwait	Russia	Yemen
Denmark	Kyrgyz Republic	Rwanda	Zambia
Djibouti	Latvia	Saudi Arabia	Zimbabwe
Dominican Republic	Lebanon	Senegal	
Egypt	Liberia	Seychelles	

Table A2. List of Agricultural Products Included in The Study[13]

SECTION I: LIVE ANIMALS; ANIMAL PRODUCTS

1. Live animals
2. Meat and edible meat offal
3. Fish and crustaceans, molluscs and other aquatic invertebrates
4. Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
5. Products of animal origin not elsewhere specified or included

SECTION II: VEGETABLE PRODUCTS

6. Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage
7. Edible vegetables and certain roots and tubers
8. Edible fruit and nuts; peel of citrus fruit or melons
9. Coffee, tea, mate and spices
10. Cereals
11. Products of the milling industry; malt; starches; inulin; wheat gluten
12. Oil seeds and oleaginous fruit; miscellaneous grains, seeds and fruit; industrial or medicinal plants, straw and fodder
13. Lac; gums, resins and other vegetable saps and extracts
14. Vegetable plaiting materials; vegetable products not elsewhere specified or included

SECTION III: ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS; PREPARED EDIBLE FATS; ANIMAL OR VEGETABLE WAXES

15. Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes

SECTION IV: PREPARED FOODSTUFFS; BEVERAGES, SPIRITS AND VINEGAR; TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES

16. Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates 17. Sugars and sugar confectionery
18. Cocoa and cocoa preparations
19. Preparations of cereals, flour, starch or milk; pastry cooks' products
20. Preparations of vegetables, fruit, nuts or other parts of plants
21. Miscellaneous edible preparations
22. Beverages, spirits and vinegar
23. Residues and waste from the food industries; prepared animal fodder
24. Tobacco and manufactured tobacco substitutes

13 The numbers correspond to the relevant chapter of the Harmonised System of classification.

Table A3. Summary Statistics

Variable	Observations	Mean	St. dev.
Exchange rate (PKR/currency of transaction)	703,196	76.6	57.3
Bilateral exchange rate (PKR/currency of trading partners)	527,488	48.4	77.6
Intensive margins (exports per firm per product by market)	703,196	2.8	21.3
Tariffs (ad valorem)	703,196	6.6	16.2
Standard deviation of tariff	703,196	2.8	8.2
Quantity margins (tonne)	703,196	158	1704
Price margins (PKR million)	703,196	0.2	11.6
Non-tariff measures (ad valorem)	660,520	222	71.5

Table A4. Heterogeneity of the Effect of Currency Depreciation across Sub-Sectors

	Dependent variables	Intensive margins	Quantity margins	Price margins
Sr.	Exchange rate x			
1	Live animals	0.338***	0.042**	0.293***
		(0.020)	(0.017)	(0.016)
2	Meat and edible meat offal	0.322***	0.049***	0.265***
		(0.022)	(0.017)	(0.015)
3	Fish and crustaceans, molluscs and other aquatic invertebrates	0.323***	0.043***	0.267***
		(0.017)	(0.015)	(0.011)
4	Dairy produce; birds' eggs; natural honey; edible products of animal origin	0.216***	0.021	0.188***
		(0.017)	(0.014)	(0.012)
5	Products of animal origin not elsewhere specified or included	0.180***	-0.004	0.178***
		(0.020)	(0.017)	(0.015)
6	Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	0.067***	0.025	0.031*
		(0.020)	(0.018)	(0.017)
7	Edible vegetables and certain roots and tubers	0.118***	0.029***	0.081***
		(0.015)	(0.011)	(0.010)
8	Edible fruit and nuts; peel of citrus fruit or melons	0.176***	0.032***	0.136***
		(0.014)	(0.011)	(0.010)
9	Coffee, tea, mate and spices	0.164***	0.064***	0.091***
		(0.015)	(0.012)	(0.010)
10	Cereals	0.451***	0.197***	0.246***
		(0.015)	(0.012)	(0.010)
11	Products of the milling industry; malt; starches; inulin; wheat gluten	0.238***	0.119***	0.109***
		(0.017)	(0.013)	(0.012)
12	Oil seeds and oleaginous fruit; miscellaneous grains, seeds and fruit …	0.085***	0.062***	0.014
		(0.015)	(0.012)	(0.011)
13	Lac; gums, resins and other vegetable saps and extracts	0.139***	0.052**	0.069***
		(0.026)	(0.026)	(0.024)
14	Vegetable plaiting materials; vegetable products not elsewhere specified	-0.073***	-0.016	-0.066***
		(0.016)	(0.013)	(0.013)
15	Animal or vegetable fats and oils and their cleavage products …	0.105***	0.019	0.076***
		(0.022)	(0.018)	(0.021)
16	Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates	0.427***	0.123***	0.291***
		(0.018)	(0.015)	(0.012)
17	Sugars and sugar confectionery	-0.006	-0.038***	0.024**
		(0.015)	(0.011)	(0.010)
18	Cocoa and cocoa preparations	-0.016	-0.046**	0.024
		(0.024)	(0.022)	(0.020)
19	Preparations of cereals, flour, starch or milk; pastry cooks' products	0.065***	-0.020*	0.075***
		(0.015)	(0.012)	(0.011)
20	Preparations of vegetables, fruit, nuts or other parts of plants	0.152***	0.070***	0.073***
		(0.015)	(0.012)	(0.010)
21	Miscellaneous edible preparations	0.002	0.006	-0.014
		(0.017)	(0.013)	(0.012)
22	Beverages, spirits and vinegar	-0.007	0.048***	-0.067***
		(0.019)	(0.014)	(0.014)
23	Residues and waste from the food industries; prepared animal fodder	0.219***	0.123***	0.087***
		(0.016)	(0.013)	(0.011)
24	Tobacco and manufactured tobacco substitutes	0.291***	0.017	0.258***
		(0.024)	(0.022)	(0.021)
	R2	0.72	0.69	0.58
	N	692,015	692,015	692,015

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table A5. Effects of Currency Depreciation on Trade Margins over Time

Dependent variables	Intensive margins (1)	Quantity margins (2)	Price margins (3)
Exchange rate x			
2001	0.346***	-0.048**	0.380***
	(0.026)	(0.022)	(0.019)
2002	0.370***	0.053***	0.304***
	(0.021)	(0.016)	(0.014)
2003	0.302***	0.071***	0.219***
	(0.018)	(0.014)	(0.012)
2004	0.217***	0.032**	0.175***
	(0.017)	(0.013)	(0.011)
2005	0.107***	0.057***	0.040***
	(0.015)	(0.012)	(0.010)
2006	0.071***	0.030***	0.033***
	(0.014)	(0.011)	(0.009)
2007	0.060***	0.008	0.046***
	(0.014)	(0.011)	(0.009)
2008	0.134***	0.011	0.119***
	(0.014)	(0.010)	(0.009)
2009	0.121***	-0.008	0.125***
	(0.014)	(0.011)	(0.009)
2010	0.129***	-0.002	0.129***
	(0.015)	(0.011)	(0.010)
2011	0.128***	-0.010	0.137***
	(0.016)	(0.012)	(0.011)
2012	0.139***	0.004	0.134***
	(0.018)	(0.013)	(0.012)
2013	0.110***	-0.020	0.130***
	(0.020)	(0.015)	(0.013)
R2	0.730	0.698	0.600
N	692,015	692,015	692,015

Note: Robust standard errors are in parentheses. These coefficients were obtained using Stata 13 SE; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions include fixed effects for firms and markets but their coefficients are not reported as they are not of direct interest. Pakistan moved to a free-floating exchange rate regime in 2007.