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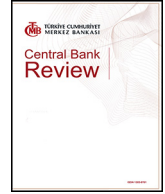
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Heterogeneous effect of exchange rates on firms' exports: Role of labor intensity

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ABSTRACT

Using an extensive firm-level database that combines balance sheet information, social security registry and customs data, we examine whether the relationship between the exchange rate and exports change with the degree of labor-intensity of production. The results based on manufacturing firms in Türkiye suggest that the sensitivity of labor-intensive firms to the exchange rate is higher than that of the less labor-intensive ones, both at the intensive and extensive margins of exports. In addition, export product variety and export market variety of the labor-intensive firms increase more than the others during a currency depreciation. In particular, the increase in the exports of the labor-intensive firms is 2.7 percent higher than the increase in exports of the non-labor-intensive firms in case of a 10 percent decline in the real effective exchange rate. However, we do not find a significant impact on the export prices varying across the labor-intensity of the firms. Our results are robust to alternative definitions of labor-intensity and exchange rates, and the use of different time spans.

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1. Introduction

Much of the recent literature on export-led growth of developing countries documents a positive impact of the undervalued exchange rates on the exports as well as on the economic growth.² Nevertheless, the presumed positive effect of currency depreciation on growth could be constrained by several characteristics inherent to the structure of the economy. This underscores the need to examine the mechanisms through which the exchange rate changes affect the production structure and the export behavior. Following this line of thought, this paper investigates whether the labor-intensity of production has an influence on the relationship between exchange rates and exports. In particular, we ask whether

the depreciation (appreciation) increases (decreases) the exports of labor-intensive firms more than the others.

One explanation for the heterogeneous effect of exchange rate on exports of firms with varying labor intensity might be the *adjustment cost of capacity expansions*. After a currency depreciation, it is relatively easier to raise the number of employees or number of work hours compared to constructing new plants or installing additional machinery. Thus, labor-intensive firms may quickly adjust to the new trade environment and raise their supply. Second, related to the previous explanation, the heterogeneous effect may be related to the *persistence of the currency shocks*. Once there is a depreciation in the local currency, it is unknown to the firms whether the low level of real effective exchange rate (REER) is persistent or not. Thus, there is less incentive to expand the capacity through investment for capital-intensive firms, at least in the short run. Finally, a high ratio of labor cost to total sales also implies a relatively lower ratio of *intermediate goods* to total sales. The latter is correlated with lower intensity of imported inputs in the cost of sales and total sales. As the REER decreases and local currency depreciates, firms with lower share of imported inputs are more likely to benefit from the advantages of depreciation.

To examine the relationship between the exchange rate and exports along with varying degrees of labor-intensity of production,

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¹ The views and opinions presented in this study belong to the authors and do not necessarily represent those of the Central Bank of the Republic of Türkiye.

² Among many others, see Eichengreen (2007), Rodrik (2008), Haddad and Pancaro (2010), Eichengreen and Gupta (2013), Korinek and Serven (2016) and Guzman et al. (2018) for alternative mechanisms through which an undervalued currency would boost exports and economic growth.

we exploit the extensive firm-level data on the manufacturing sector in Türkiye recently provided by the Ministry of Industry and Technology. This comprehensive data set covering more than 3 billion firms provides information on the number of employees and labor cost of the firms, all items on the balance sheet and income statement of legal and real entities that keep accounting records on a balance sheet basis, and the entire customs data at transaction level. The empirical methodology is based on comparing the export performance of firms that are more labor-intensive to those that are less labor-intensive during the changes in the real effective exchange rate. While doing this analysis, we assume that real effective exchange rate of the country is exogenous to firms' individual characteristics, labor-intensity in particular. To support this conjecture, while constructing a firm's labor-intensity, we take the average value of the sample period which is constant over time and less likely to be endogenous with the REER of a certain period. In addition to the export behavior at the intensive and extensive margin, the empirical analysis examines various outcomes such as product variety, market variety and export prices.

Our results suggest that the export sensitivity of labor-intensive firms to changes in the exchange rate is higher than that of the less labor-intensive ones, both at the intensive and extensive margin. First, among exporting firms, a currency depreciation increases the exports of labor-intensive firms more than others. In particular, in case of a 10 percent decline in the real effective exchange rate, the increase in the exports of the labor-intensive firms is 2.7 percent higher than the increase in exports of the non-labor-intensive firms. Second, we find that currency depreciation leads higher number of new labor-intensive firms to enter into the export market than less intensive ones. Finally, export product variety as well as export market variety of the labor-intensive firms increase more than others during a currency depreciation. Specifically, in case of a 10 percent decline in the real effective exchange rate, the increase in the number of product variety exported by a labor-intensive firm is 1.1 percent higher than the increase in the number of product variety exported by a non-labor-intensive firm. However, we cannot find a significant impact on the export prices depending on the labor-intensity of the firms. Our results are robust to alternative definitions of labor-intensity and exchange rates, and the use of different time spans.

This study contributes to the literature in a number of ways. First, currency depreciations are associated with two competing effects for the export performance of developing countries. On the one hand, a weaker currency could create cost advantages for these countries through lower wages in various sectors including manufacturing. On the other hand, currency depreciation might be detrimental for the production due to increasing cost of imported intermediate goods. Hence, the overall impact could be positive or negative depending on the weight of alternative factors in the cost of production. From this standpoint, it is important to take cognizance of the cost structure at the firm level while measuring the impact of exchange rate on the export performance. To the best of our knowledge, this is the first study that analyzes the heterogeneous impact of exchange rate on export performance of firms with various levels of labor-intensity.

Second, the previous literature documents that the labor-intensity of manufacturing exports increase in the developing countries in the last three decades. In addition, manufacturing exports increase demand for labor and wages in other sectors providing domestic inputs to the manufacturing sector (Calì et al., 2016). These backward linkages helping support jobs highlights the development of manufacturing sector as a key issue for many developing countries. Our study contributes to this literature documenting that the degree of labor-intensity matters for the correlation between exchange rates and export performance in the

manufacturing sector for the developing countries.

Third, labor content of exports is declining in high-income countries mostly due to labor saving technologies in production. However, the trend is flat in middle-income countries and further increasing in low-income countries (Calì et al., 2016). Hence, as a country develops economically, the labor share of exports is expected to decline. The transition towards more capital-intensive production structures largely depends on the performance of incumbent exporters as well as a functioning export market allowing and further incentivizing new entries. Accordingly, it is important to study the impact of exchange rate changes on both intensive and extensive margins, in relation with other factors that determine the productivity of the firms. Our study confirms that the impact of a weaker domestic currency on exports at the extensive margin is higher for labor-intensive firms in the manufacturing sector.

Fourth, the literature on aggregate exports in Türkiye documents a strong relationship between foreign demand and exports, yet a weaker one between exchange rate and exports. This result is usually motivated with higher integration to global value chains and a high share of imported inputs in exports (Saygılı and Saygılı, 2011). However, the literature that focuses on alternative disaggregated structures reports different results. For example, the impact of changes in real exchange rate is higher in exports to developing countries (Çulha and Kalafatçılar, 2014) or for firms which has high level of foreign liabilities (Toraganlı and Yalçın, 2016). Our study suggests another classification according to the factor-intensity of production and shows that the impact of currency depreciation is more visible in the exports of labor-intensive firms.

The rest of the paper is organized as the following. The next section briefly summarizes the recent literature. The third section introduces the method and the fourth one documents the data. The fifth section documents the results. The sixth section reports the results of robustness checks. The article concludes with a discussion of the policy implications in the sixth section.

2. Literature review

Our paper draws upon several strands of literature. Firstly, our study is related to the broad literature on exchange rates, international trade and firm heterogeneity. Second, we summarize the empirical literature on labor-intensity of exports. Third, we focus on the literature on the role of labor costs in export performance of firms. Lastly, in relation with our case study, we present some studies on the connection between exchange rate and Turkish exports.

The literature provides both theoretical and empirical studies examining the impact of exchange rates on the quantity of exports with a focus on firm characteristics. In his seminal study, Dornbusch (1987) provides a theoretical model for the mark-up adjustment as well as endogenous entry-exit behavior of the firms against exchange rate changes. In his set up, long-term adjustment against a real appreciation would manifest itself in wage cuts in industries in which losses in competitiveness lead to unemployment. However, wages increases in other expanding sectors. Accordingly, firms will exit industries with higher-wages and enter industries with lower wages. The market power is the main determinant of the relative changes of prices of exports and imports in advanced countries, yet the impact is largely proportionate for the small country case.

Melitz (2003) suggests an endogenous entry-exit structure depending on the productivity level of firms. In his set-up, the export market shares and profits of the firms increase with their productivity level. The reallocation of market shares towards the

productive firms contribute to the increase of aggregate productivity.

Rodriguez-Lopez (2011) also utilizes such an endogenous firm entry-exits structure, allowing for endogenous mark-ups and heterogeneous productivity among firms. In his model, exchange rate movements have an impact on the extensive margin through changing the cut-off productivity levels. Among other factors, the change in the relative cost of labor due to a depreciation is a determinant of these cut-off productivity levels. The ultimate impact of the exchange rates shock depends on the strength of two reinforcing effects: The firm-specific effect related to the firm's productivity level and the economy wide effect revealing the change in competitiveness.

Berman et al. (2012) studies the impact of exchange rate movements on export volumes, considering firm-level heterogeneity. They find that increase in size and performance is associated with lower export sensitivity since these firms could absorb exchange rate movements in their mark-ups.³ Chatterjee et al. (2013) examines the impact of exchange rate changes on exports of multi-product firms. They show that the producer prices increase more for the products closer to the core competency of the firm (which are the ones produced with greater productivity). Moreover, firms' sales become less concentrated in these products. As a result, the share of less efficient products increase in the export basket of the firm. Chen and Juvenal (2016) examine the behavior of Argentinian wine exporters and show that the impact of the exchange rate changes on export volume is lower for higher quality goods.

Li et al. (2015) examines the impact of exchange rate changes for Chinese exporters. They show that the responsiveness of the export volume to the exchange rate decreases with share of imported inputs, distribution costs and income level of export markets.⁴ Park et al. (2010) examines the impact of large depreciation in domestic currency in Asian crises for Chinese firms and show that the greater the depreciation in a firm's export partner's currency, the slower the growth in the exports of the firm.⁵ Fauceglia et al. (2018) show that the negative effect of a currency appreciation on export levels and export probability is mitigated in sectors and firms with a higher integration in global value chains.

The second strand of the literature that our analysis relates includes the empirical studies on the labor-intensity of exports. In a recent comprehensive World Bank study, Cali et al. (2016) compiles the labor contents of exports (LACEX) database consisting of 124 countries. They first show that the *global decline in labor-intensity of exports* since 1995 is mostly driven by high-income countries whereas the labor value added is relatively flat in middle-income

³ The stability of the relationship between exchange rates and international trade is also the subject of an ongoing debate in the literature. On the one hand, one strand of the literature argues that exchange-rate pass through has been reduced due to increasing participation in global value chains (Ollivaud et al., 2015; Ahmed et al., 2016). On the other hand, conducting a cross-country exercise, Leigh et al. (2017) shows that both exchange rate pass through and price elasticity of trade is stable over time.

⁴ Depreciation of the domestic currency would lower the price of domestically produced goods but would increase the cost of imported inputs. Hence, the net impact of exchange rate changes depends on the intensity of imported inputs. Conducting an empirical exercise for UK manufacturing firms, Greenaway et al. (2010) shows that these two effects offset each other and exchange rate has no effect on imports.

⁵ Another sub-strand of the literature on the relationship between exchange rates and international trade focuses on the impact of exchange rate uncertainty on the trade flows among countries. For examples of a group of countries see Baum et al. (2004) and Bahmani-Oskooee and Kovryalova (2008). For studies on Türkiye see Vergil (2002), Kasman and Kasman (2005, Solakoğlu et al. (2008) and Alper (2017). Cheung and Sengupta (2003) discusses the asymmetric effects of the exchange rate changes on export behavior by pointing out the varying response of Indian firms towards depreciations and appreciations.

countries, and increasing in low-income countries. Second, the skill composition of exports reveals higher share for low-skilled labor in developing countries compared to the high-income ones. Third, the labor value added in the exports of the service sector is relatively higher compared to other sectors. However, the labor-intensity of the manufacturing exports rises significantly in developing countries over time, mostly due to increasing labor demand in input providing sectors. Lastly, the paper shows that, while the job intensity of exports (how many new jobs are created by a certain value of exports) decreases with the country's income per capita, the opposite case holds for the wage intensity of exports (labor value added share in exports). They argue that when the countries develop economically, the average wage increase could compensate for the decline in job losses per unit of exports. However, there are exceptions to rising share of labor value-added in exports among the developing countries such as South Africa (Cali and Hollweg, 2017) and China (Kee and Tang, 2016).

Another strand of the literature focuses on the role of labor costs in exporters performance. Decramer et al. (2016) examines the impact of changes in unit labor costs on Belgium exports, using firm-level data. They suggest that for the average exporting firm, a 1 per cent increase in unit labor costs reduces exports around 0.3 percent. Moreover, the sensitivity of labor-intensive firms to change in unit labor costs are much higher than the capital-intensive ones.⁶ In a similar firm-level study, Gan et al. (2016) shows that increase in minimum wage in China is associated with declines in probability of exporting goods as well as volume of export sales.⁷

The last part of our literature review focuses on studies investigating the relationship between the exchange rate and Turkish exports. Türkiye provides a good case to investigate the interaction of exchange rates with labor-intensity of firms in a number of aspects. First, as a developing country with a relatively integrated economy to the global value chain, the export performance of firms is of interest to academics and policy makers. The outward-oriented policies of 1980s including import liberalization, export promotion and capital account liberalization; as well as the customs union agreement with EU in 1996 resulted in high export performance over the following decades. Exports show a fivefold increase from 2002 to 2018 in US dollar terms while their share in GDP oscillates between 20 and 30 percent during the same period (Fig. 1).

A number of studies using aggregated data document that the real exchange rate changes has relatively lower impact on exports, while foreign demand is the key determinant of Turkish exports (Saygılı and Saygılı, 2011; Çelgin et al., 2019). However, studies focusing on alternative disaggregated structures report different results. For example, Çulha and Kalafatçılar (2014) suggests that exports to developed countries is more responsive to foreign demand while exports to developing countries are affected by the changes in the real exchange rate. Toraganlı and Yalçın (2016) shows that the sensitivity of the exports to exchange rates is higher for the firms with higher foreign exchange denominated debt to exports and lower for the firms in sectors that use high level of imported inputs. Conducting a firm-level study on Turkish manufacturing firms for 2007–2014 Akhan et al. (2018) show that the depreciation results in higher increase in export volumes of the productive firms than those of the lower productive ones. Our

⁶ They also report that the impact of changes in unit labor costs are higher for the extensive margin.

⁷ Malgouyres and Mayer (2018) examine the role of labor costs in exporters performance studying the impact of a tax credit policy aiming to increase competitiveness through lower labor costs and conclude that the causal effects of the policy are hardly significant.

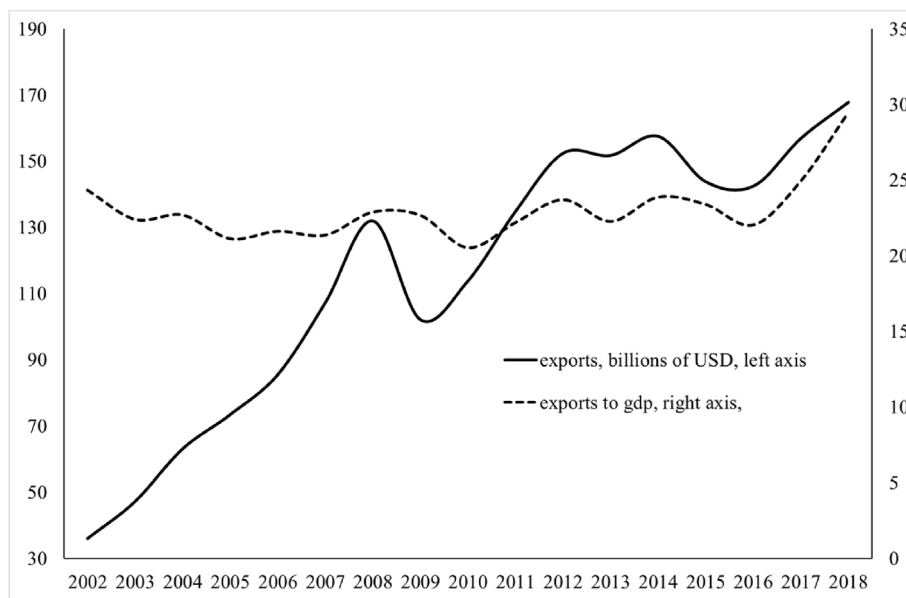


Fig. 1. Total exports and exports to GDP
Source: TURKSAT (Exports / Special Trade System)

study contributes to this literature, investigating another breakdown depending on the production structure. We argue that the impact of a currency depreciation is higher for firms with a labor-intensive production structure.

3. Data

The firm level data used in this study are from the Entrepreneur Information System (EIS) maintained by the Ministry of Industry and Technology of Türkiye. The EIS brings together confidential administrative data sets from multiple sources and make possible to link the separate data sets through unique firm identifiers. We have used the Social Security Administration records to calculate firm level employee numbers and labor cost; the balance sheet and income statement of all legal and real entities that keep accounting records on a balance sheet basis to calculate the firm level total sales, and the entire customs data at transaction level to calculate the firm level export market indicators.⁸ The transaction level customs data allowed us to calculate firm level product and destination variety indicators as well as a weighted firm level export price.

World export data at the aggregate HS 2-digit product level are drawn from the UN Comtrade database. Annual average of the consumer price index based real effective exchange rate is retrieved from the Electronic Data Delivery System (EVDS) of the Central Bank of the Republic of Türkiye.

The annual firm level data are available for the period from 2006 to 2018 and exclude public sector. In all our analysis, we restricted our sample to manufacturing firms with at least one registered employee and to the period in which the firm level data is available. Table 1 compares the mean values of the key variables in our

⁸ Social Security Administration records are presented at a monthly level and only available for the third, sixth, ninth, and the 12th months of a year. We take the month with maximum number of employees among these 4 months as the year employment number. To calculate the annual total gross wages, we sum the reported wage costs for the four months and multiply it by 3. We further multiply the annual total gross wages by 1.175 to account for the employer share of social security contributions.

sample for the beginning and end of the sample period. For the period between 2006 and 2018, we have 1,218,526 firm-year observations in our sample, 213,546 of which have a positive export value. The average number of employees in the comprehensive sample is 30.79. Among the observations with a positive export level, the mean value of exports is 4.11 million US Dollars, and the median value of exports is 250,000 US Dollars. Fig. 2 shows the evolution of the REER and exports.

4. Empirical methodology

In this part, we first describe the empirical methodology and then the data used in the study. The empirical methodology is based on comparing the export performance of firms that are more labor-intensive to those that are less labor-intensive during a change in the real effective exchange rate. The primary question is how the labor-intensity of the firms affects their response to a change in the value of a currency. Our identification strategy relies on the assumption that real effective exchange rate of the country is exogenous to firms' individual characteristics, labor-intensity in particular. To strengthen this conjecture, measuring a firm's labor-intensity, we take the average value of the sample period following Amiti et al. (2014), which is less likely to be endogenous with the

Table 1
Summary statistics (mean values).

	2007	2018
Number of firms ^a	75,142	125,219
Exporter share	0.23	0.20
Export value	3,303,845	3729 039
Number of export products	10.85	11.28
Number of export destinations	5.14	6.63
Number of export markets (product-destination)	22.15	28.01
Labor intensity (median)	0.13	0.14
Number of employees	31.64	30.45

^a Manufacturing firms with at least one employee.
Source: Entrepreneur Information System (EIS). Data covers 2016–2018 and exclude public sector.

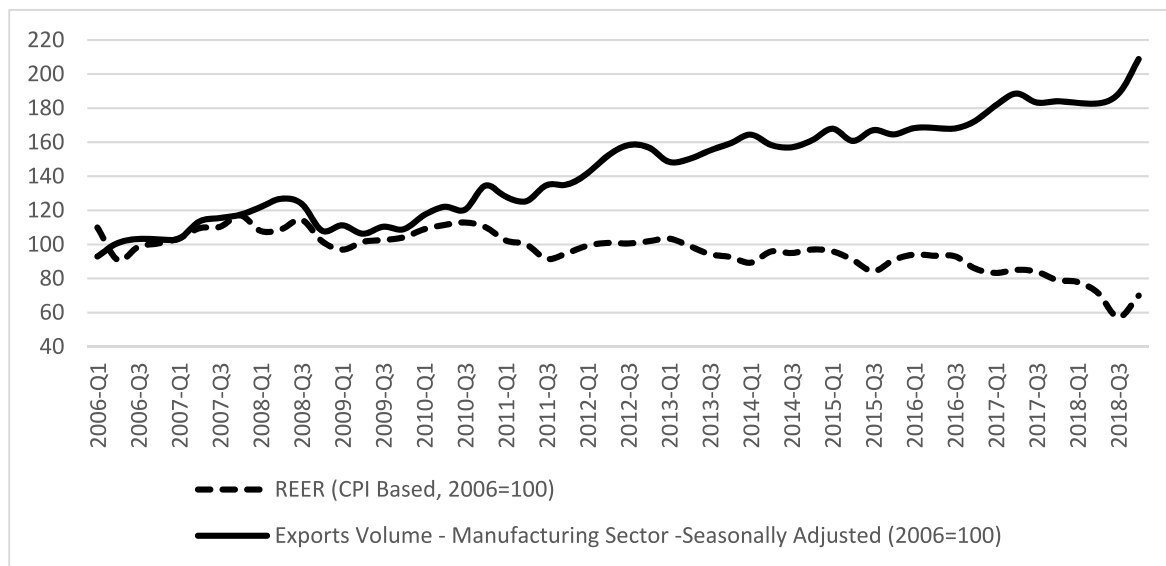


Fig. 2. Real effective exchange rate (CPI based) and exports. Source: CBRT, Turkstat

REER of a certain period.⁹ Thus, we have a single value of labor-intensity for each firm, constant over time. This acts as an embedded firm characteristic in our empirical estimation since the production structure of a firm is a sunk cost and we do not expect it to be significantly affected by the cyclical exchange rate movements given the time horizons we use in our regressions. We later run a robustness check with a shorter time period. We proxy for a firm's labor-intensity using a measure similar to the unit labor cost that is defined as follows:

$$Labor\ intensity_i = \frac{\sum_{t=1}^{T_i} \frac{Labor\ Cost_{it}}{Net\ Sales_{it}}}{T_i} \tag{1}$$

Here labor cost is the annual cost of labor including social security contributions for firm *i* at time *t*, net sales is the total annual sales, and *T* is the total number of years we observe firm *i* in the sample. Then, we generate a binary indicator for labor-intensive firms by parting the labor-intensity of firms in a specific 4-digit industry into two, and define the ones above the median as labor-intensive. Thus for each industry, half of the firms are grouped as labor-intensive, and the other half are not-labor-intensive.

We first examine the heterogeneous impact of the real effective exchange rate on exports through a regression analysis at the firm level. Then, we estimate a regression model at the aggregated product category level. We employ different alternative dependent variables in our firm level empirical exercise. The first one is a binary indicator that takes the value one if a firm has a positive level of export during a year, and zero otherwise¹⁰. The second dependent variable refers to the intensive margin of exports and is related to the exporters who export in both periods *t*-1 and *t*. The other outcome variables are the log difference of export performance indicators including export value, product variety, market variety,

and export prices across years. In other words, we subtract the log value of an export indicator of year *t*-1 from the log value of the same export indicator of year *t*. This way, we smooth out the variation across firms in the levels, and focus on the change from one year to another.

$$\Delta Y_{ijrt} = \beta_0 + \beta_1 \Delta REER_t * LabInt_{ijr} + \beta_2 LabInt_{ijr} + \beta_3 L_{i,t-1} + \gamma_j + \lambda_r + \delta_t + \epsilon_{ijrt} \tag{2}$$

The empirical model we employ in estimating the heterogeneous effect of REER on export performance at the firm level is given by equation (2). An increase in REER implies appreciation of TL against USD conditional on relative price indices. In this specification, the outcome variable is *Y_{ijrt}* the annual growth rate of the export indicator of firm *i*, in region *r*, in sector *j* and year *t*, or a binary indicator for exporting in the corresponding year. The focal point of the estimation is the interaction of REER with labor-intensity, and the coefficient of interest is β_1 . *L_{i,t-1}* is log level of lagged firm employment and controls for the firm size. NACE revision 2 industry fixed effects at 4 digit γ_j , region fixed effects λ_r , and year fixed effects δ_t are included in the main specification. While equation (2) is our baseline model, we test the robustness of the results using a variety of different specifications that include sector specific year fixed effects and region specific year fixed effects to control for shocks at the region and sector level that may be correlated with the movement of REER across years. We cluster the standard errors at the firm level in all regression models since the treatment variable, labor-intensity, varies at the firm level.

We estimate equation (2) for several outcome variables: export dummy that indicates if a firm exported in year *t*; annual change in export value; annual change in the number of product variety exported by a firm according to 6-digit HS product classification; annual change in the number of export markets defined as the total number of product-country combination exported by a firm; and finally change in the weighted mean of prices of products exported by a firm, which is calculated using the formula below:

⁹ We performed a data cleaning procedure by removing outliers before calculating the average firm level labor-intensity. Any value that is more than 3 times interquartile range away from the sector by year median is defined as an outlier.

¹⁰ This binary indicator explains the extensive margin of exporting that is related to the entering exporters who do not export in period *t*-1 but export in period *t*.

$$P_{it} = \sum_{g=1}^{G_{it}} \frac{ExpVal_{itg}}{ExpAmount_{itg}} \times \frac{ExpVal_{itg}}{ExpVal_{it}} \quad (3)$$

where P_{it} is the firm level weighted price in year t , $ExpVal_{itg}$ and $ExpAmount_{itg}$ are the value and amount of the exported product g by firm i in year t , $ExpVal_{it}$ is the total value of exports by firm i in year t , and G_{it} is the total number of product variety exported by firm i in year t . All empirical specifications above use the firm level data and exploit the variation in labor-intensity across firms within the same industry.

Finally, we estimate the differential impact of the REER at HS 2-digit product level using the equation below:

$$\Delta Y_{jt} = \alpha_0 + \alpha_1 \Delta REER_t * LabInt_j + \alpha_2 LabInt_j + \alpha_3 Exp\ 2006_j + \alpha_4 \Delta WorldExp_{jt} + \delta_t + \epsilon_{it} \quad (4)$$

Here, the outcome variable is the annual change in log exports in product category j at time t . $\Delta REER_t * LabInt_j$ is the interaction between the annual log change in real effective exchange rate and the labor-intensity dummy that takes value 1 if the weighted mean of the unit labor cost of firms in product category j is above the median unit labor cost across product categories. $Exp\ 2006_j$ is the log level exports in product category j in 2006 and controls for the initial size of the exports. $\Delta WorldExp_{jt}$ is the annual change in global exports in product category j at time t and controls for the time varying product level global demand. Finally, δ_t represents the year fixed effects and absorbs any year specific shocks common across all product categories that might impact the outcome variable. Controlling for year fixed effects will drop the real effective exchange rate but our key variable, the interaction term between the labor-intensity dummy and real effective exchange rate, will survive.

5. Results

Table 2 presents the heterogeneous effect of real exchange rate on firms' export likelihood and export performance. As mentioned before, we define a firm labor-intensive if its labor-intensity measure is above the 4-digit sector median. Thus, we treat half of the firms as labor-intensive in each manufacturing sub-sector. The reported coefficients are for the interaction term between the change in log of real effective exchange rate, and the labor-intensity dummy.

The dependent variable in panel (A) is a binary indicator that takes the value one if a firm has positive export in the corresponding year; in panel (B) is the change in the logarithm of export value; in panel (C) is the change in the logarithm of the number of export varieties at HS 6-digit product level sold by a firm; in panel (D) is the change in the logarithm of the number of markets (product by country) reached by a firm; and in panel (E) is the change in the weighted mean of export prices for each transaction in a year.

Our baseline sample includes all manufacturing firms that report balance sheet information and have at least one registered employee. Column (1) reports the results of the baseline specification in equation (2) and include 4-digit sector, NUTS-2 region, and year fixed effects and lagged labor size as a control variable. In column (2), we

add sector-year fixed effects to absorb any sector specific time varying shocks that might drive the results such as changes in global demand, trade terms, or supply conditions. In column (3), we further control for region-year fixed effects that take care of any region specific time varying shocks such as migration and political instability.¹¹ Our preferred specification is column (3). We replicate the column (3) specification with a restricted sample of firms that have at least ten registered employees in column (4).

Our preferred specification in column (3) of panel (A) suggests that a 10 percent decline in real effective exchange rate increases the probability of exporting among labor-intensive firms by 0.32 percent more relative to less labor-intensive firms. The result is robust when we exclude small firms with less than 10 employees. From a Melitz (2003) type of firm export behavior, this result suggests that in each sector a decline in real effective exchange rate reduces the threshold productivity level for exporting and more firms enter to the export market.

Panel (B) of Table 2 reports results for the change in log exports, which can be defined as the intensive margin of exports. Our preferred specification in column (3) implies that in case of a 10 percent decline in the real effective exchange rate, the increase in the exports of the labor-intensive firms is 2.7 percent higher than the increase in exports of the non-labor-intensive firms. This finding suggests that firms that are relatively more labor-intensive in each sector, benefit more from the currency depreciation. Excluding small firms reduces the magnitude of impact but the coefficient is still statistically significant at 10 percent level. The reduction in the magnitude and the precision is not surprising since the majority of small firms are labor-intensive.

The relative advantage of the labor-intensive firms in the face of currency depreciation may be through the expansion of export capacities in existing markets as well as their entry into new markets and products. To test the existence of the second channel, in panel (C) and (D), we run regressions on the total number of product varieties and markets that a firm exports. We define each HS 6-digit product category as a product variety and each product-country combination as an export market. Our results suggest that in case of a 10 percent decline in the real effective exchange rate, the increase in the number of product variety exported by a labor-intensive firm is 1.1 percent higher than the increase in the number of product variety exported by a non-labor-intensive firm. The relative percentage increase in the number of export markets is almost the same. Excluding small firms from the sample does not alter the significance and direction of the results yet the magnitude rises slightly.

Finally in panel (E), we tested if there is heterogeneous impact on the firm level weighted export prices. The outcome variable here is the firm level weighted price calculated using the formula in equation (3). We found no statistically significant impact on export prices of labor-intensive firms relative to non-labor-intensive firms. A recent study on Turkish exports (Aydin and Gül, 2020) provides some observations on the pricing strategy of Turkish exporters. Turkish exporters mostly employ pricing to market strategy, i.e. they adjust their prices (and/or profits) in different markets in response to changes in the exchange rate. The share of US dollars or Euros as invoicing currencies for exporters is above 90 percent in 2019.¹² As the argument goes, in response to a currency depreciation, the exporters might either keep their export prices constant

¹¹ Türkiye received about 3.5 million Syrian Refugees between 2011 and 2018. Only very small portion of these refugees are granted work permits thus majority of them are employed informally with lower costs than the formal employees. If labor-intensive firms are more likely to employ refugees as informal labor, they will have a cost advantage relative to less labor-intensive firms. If there is a correlation between the real effective exchange rate and the refugee intensity in a region, our estimates will be biased. By controlling for the region-year fixed effects, we cancel out any region specific time varying effects.

¹² Exporters in most developing countries (with low market share) either use a vehicle currency (USD or Euro) or employ local currency pricing. A survey by the Bureau of Labor Statistics for the period 1994–2005 asks US firms to report on the currency of denomination of their import prices. The results indicate that from all developing countries the share in the exporters currency is close to zero (Gopinath et al., 2010, 2011). Accordingly, this dominant currency pricing behavior in trade dampens the impact of exchange rate variations on exports.

Table 2
The heterogeneous impact of REER on firm level exports.

	(1) Employment >0	(2) Employment >0	(3) Employment >0	(4) Employment ≥ 10
A- Export probability				
Δ Ln RER * Labor-intensity	-0.0342*** (0.0078)	-0.0322*** (0.0078)	-0.0328*** (0.0079)	-0.0379*** (0.0138)
N	1,218,164	1,218,148	1,218,148	547,164
R-squared	0.264	0.267	0.267	0.260
B- Δ Export value (Log)				
Δ Ln RER * Labor-intensity	-0.2519*** (0.0933)	-0.2741*** (0.0955)	-0.2697*** (0.0965)	-0.1815* (0.1078)
N	213,586	213,546	213,546	171,538
R-squared	0.009	0.024	0.025	0.031
C- Δ Product variety (log)				
Δ Ln RER * Labor-intensity	-0.0902* (0.0533)	-0.1110** (0.0545)	-0.1115** (0.0549)	-0.1414** (0.0602)
N	213,584	213,544	213,544	171,536
R-squared	0.002	0.016	0.017	0.022
D- Δ Market variety (Log)				
Δ Ln RER * Labor-intensity	-0.0939* (0.0540)	-0.1116** (0.0552)	-0.1114** (0.0556)	-0.1289** (0.0608)
N	213,586	213,546	213,546	171,538
R-squared	0.005	0.019	0.021	0.025
E- Δ Weighted price (log)				
Δ Ln RER * Labor-intensity	-0.0982 (0.1107)	-0.1295 (0.1147)	-0.1138 (0.1156)	-0.0439 (0.1250)
N	213,583	213,543	213,543	171,535
R-squared	0.004	0.019	0.021	0.025

Note: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are clustered at the firm level. The baseline sample includes all firms that report balance sheet information and have at least 1 registered employee. All models include 4-digit sector, NUTS-1 region, and year fixed effects and lagged labor size as a control variable. Column (2) includes sector by year fixed effects, column (3) and (4) include both sector by year fixed effects and region by year fixed effects. The reported coefficients are for the interaction term between the change in Ln RER, log of reel effective exchange rate, and the labor-intensity dummy, a binary variable that takes value 1 if firm's labor share in total costs are above the 4-digit sector median. The dependent variable in panel A is a binary indicator that takes the value one if a firm has positive export in the corresponding year, panel B is the change in the logarithm of export value, panel C is change in the log number export varieties at HS 6-digit product level sold by a firm, panel D is the change in the log number of markets (product by country) reached by a firm, and panel E is the change in the weighted mean of export prices for each transaction in a year.

(and raise their profit margins) or lower their export prices measured in foreign currency (and gain competitiveness). They show that, despite the gradual depreciation of the Turkish lira in the last decade, export prices measured in foreign currency did not fall too much. Our results suggest that this weak adjustment in export prices does not change with the degree of labor intensity.

The finding that the decrease in the REER increases the exports of labor-intensive firms more than others may be explained in a number of ways. First one is the *adjustment cost of capacity expansions*. In case of depreciating currency, a firm can increase its capacity through increasing the number of workers (or work hours) instead of relatively costly choice of constructing new plants or installing additional machinery. Second, the heterogeneous effect may be related to the *persistence of the currency shocks*. Capital-intensive firms which are uncertain about the persistence of the REER might be reluctant to expand the capacity through investment, at least in the short run. Finally, a high ratio of labor cost to total sales also indicates a relatively lower ratio of *intermediate goods* to total sales. This would imply lower share of imported inputs in total costs. Hence, firms with lower share of imported inputs are more likely to benefit from a depreciation.

Next, we examine the product level heterogeneity at the aggregate level (equation (4)). Table 3 reports results of the product level estimation. The dependent variable in column (1) is the log change in exports and column (2) is the log change in the number of export markets, which is defined as the number of HS 6 digit by country combination. The coefficient of interest is the interaction term between the change in log REER and labor-intensity indicator. We expect this coefficient to be negative if the exports of labor-intensive products are more positively impacted from a currency depreciation. The estimated coefficients are negative but statistically insignificant thus we cannot suggest a differential positive

impact on the exports of labor-intensive products due to currency depreciation. Also, we do not observe any statistically differential impact on the number of export markets. The lack of statistically significant effect in this specification may be partially explained by the difficulty of measuring labor-intensity at the product level. As

Table 3
The heterogeneous impact of REER on aggregate product level exports.

	(1) Δ Export value (Log)	(2) Δ Market variety (Log)
Δ Ln RER * Labor-intensity	-0.1054 (0.1024)	-0.0063 (0.0527)
Labor-intensity	-0.0231** (0.0099)	-0.0092** (0.0039)
Ln exports (2006)	-0.0046 (0.0033)	-0.0036** (0.0017)
Δ Ln World exports	0.5821*** (0.0957)	0.0396 (0.0425)
Constant	0.1783*** (0.0297)	0.0770*** (0.0168)
Year FE	Yes	Yes
Observations	762	792
R-squared	0.575	0.127

Note: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are clustered at the 2-digit product level. The sample is of a balanced panel of all 2-digit HS products. The dependent variable in column (1) is the change in the logarithm of export value and in column (2) is the change in the log number of markets (product by country) reached in a product category. The reported coefficients are for the interaction term between the change in Ln RER, log of reel effective exchange rate, and the labor-intensity dummy, a binary variable that takes value 1 if the unit labor cost of a product category is above the median. Ln export (2006) is the log level of exports in 2006 that controls the beginning year export size in a product category. Δ Ln World exports is the change in the global exports in a product category and controls for the change in the global demand in a product category.

mentioned in Section 3, the labor-intensity of a product category is deduced from the producing firm. Since each firm produces more than one product, assigning the labor-intensity of a producer to a product category may reduce the precision of the labor-intensity measure at that level. Another explanation is that the Turkish firms are price takers in the world market since their total market share is less than one percent in a large majority of the product varieties. Thus, a currency depreciation increases the competitive advantage in most of the product varieties independent of the sectoral differences and we do not observe a heterogeneous effect at the product level.

6. Robustness checks

We run our preferred specification in column (3) of Table 2 for alternative definitions of time period and key variables in our estimation. Table 4 reports the results of the robustness checks. Column (1) is for reference and reports our baseline results. In column (2) we restricted the time period to 2010–2018 to see if the global financial crises in 2008 and 2009 is contaminating our results. Our results for main outcome variables are robust but we lose precision for product and market variety outcomes. In column (3), we define the labor-intensity as the ratio of number of employees to the value of capital, capital being the total fixed assets in the balance sheet. In this alternative framework, in each sector the firms that have a ratio above the median are considered as labor intensive. Majority of our results survive and are close to the baseline results. In column (4), we use nominal exchange rate to control for the currency depreciation. The results are very similar to the

baseline estimates. The direction of the estimates reverses in column 4 since an increase in exchange rate implies a reduction in the REER. In column (5) and column (6), we cluster standard errors at sector level and restrict the sample to the exporters with at least 1000 USD annual export, respectively. The results are quite robust to the baseline specification.

7. Conclusions

In this paper we analyze the heterogeneous impact of exchange rate changes across firms with varying degree of the labor-intensity of production for Türkiye. Previous literature documents i) weakened elasticity of exchange rate in determining Turkish exports and ii) higher labor-intensity for manufacturing exports in developing countries. We argue that the heterogeneity in the impact of exchange rate on exports among firms with different degrees of labor intensity could be a result of relatively lower adjustment cost of capacity expansions, uncertainty regarding the persistence of currency shocks or a low ratio of imported inputs in production for labor-intensive firms. We use a comprehensive dataset that combines balance sheet information, social security registry and customs data for all firms in Turkish manufacturing sector. We find that the exports of labor-intensive firms increase more than the others during a currency depreciation, both at the intensive and extensive margins. In addition, a decline in the value of local currency increase the export product variety and export market variety of the labor-intensive firms more than others. The findings are robust to alternative definitions of labor-intensity and exchange rates, and the use of different time spans. Our results providing empirical

Table 4
Robustness checks.

	(1) Baseline Specification	(2) Alternative time period	(3) Alternative labor-intensity	(4) Alternative exchange rate	(5) Alternative cluster	(6) Restr. Sample (1000+ exp)
A- Export probability						
$\Delta \ln \text{RER} * \text{Labor-intensity}$	-0.0328*** (0.0079)	-0.0632*** (0.0099)	-0.0430*** (0.0079)	0.0157** (0.0068)	-0.0328*** (0.0116)	-0.0299*** (0.0078)
N	1,218,148	883,028	1,198,161	1,218,148	1,218,148	1,218,148
R-squared	0.267	0.271	0.266	0.267	0.267	0.261
B- Δ Export value (Log)						
$\Delta \ln \text{RER} * \text{Labor-intensity}$	-0.2697*** (0.0965)	-0.1964* (0.1185)	-0.0281 (0.1010)	0.2514*** (0.0677)	-0.2697*** (0.0889)	-0.2145*** (0.0821)
N	213,546	154,413	212,807	213,546	213,546	208,870
R-squared	0.025	0.020	0.026	0.026	0.025	0.026
C- Δ Product variety (log)						
$\Delta \ln \text{RER} * \text{Labor-intensity}$	-0.1115** (0.0549)	-0.0648 (0.0709)	-0.1998*** (0.0600)	0.1068*** (0.0351)	-0.1115** (0.0512)	-0.1115** (0.0549)
N	213,544	154,411	212,805	213,544	213,544	213,544
R-squared	0.017	0.016	0.017	0.017	0.017	0.017
D- Δ Market variety (Log)						
$\Delta \ln \text{RER} * \text{Labor-intensity}$	-0.1114** (0.0556)	-0.0771 (0.0722)	-0.1543** (0.0612)	0.1074*** (0.0362)	-0.1114** (0.0523)	-0.1114** (0.0556)
N	213,546	154,413	212,807	213,546	213,546	213,546
R-squared	0.021	0.019	0.021	0.021	0.021	0.021
E- Δ Weighted price (log)						
$\Delta \ln \text{RER} * \text{Labor-intensity}$	-0.1138 (0.1156)	-0.1655 (0.1424)	-0.1230 (0.1215)	-0.0068 (0.0761)	-0.1138 (0.1172)	-0.1138 (0.1156)
N	213,543	154,413	212,804	213,543	213,543	213,543
R-squared	0.021	0.016	0.021	0.021	0.021	0.021

Note: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are clustered at the firm level. The sample includes all firms that report balance sheet information and have at least 1 registered employee. All models include sector by year fixed effects, region by year fixed effects and lagged labor size as a control variable. Column (1) is the baseline results from column (3) in Table 2, column (2) reports the results when the time period is restricted to 2010–2018, column (3) reports results for an alternative labor-intensity defined according to capital per employee, column (4) reports results when the log nominal USD/TL exchange rate is used as the exchange rate variable, column (5) reports the results with an alternative cluster at sector level instead of firm level, and column (6) reports the results when the sample is restricted to exports with at least 1000 USD. The reported coefficients are for the interaction term between the change in the log of real effective exchange rate (USD/TL in column 4), and the labor-intensity dummy, a binary variable that takes value 1 if firm's labor share in total costs are above the 4-digit sector median. The dependent variable in panel A is a binary indicator that takes the value one if a firm has positive export in the corresponding year, panel B is the change in the logarithm of export value, panel C is change in the log number export varieties at HS 6-digit product level sold by a firm, panel D is the change in the log number of markets (product by country) reached by a firm, and panel E is the change in the weighted mean of export prices for each transaction in a year.

evidence on the heterogeneous effect of exchange rates would further contribute to the understanding of export performance of Türkiye.

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