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Abstract

This study explains the export behavior of Egyptian firms under demand volatility in destination countries using detailed customs data and high-dimensional fixed effects. It finds that demand volatility negatively affects both intensive and extensive export margins. The effects are particularly evident for large firms that reduce their export sales (especially over time) to more volatile destinations/products and are therefore more likely to exit from exporting more volatile products and less (more) likely to enter (exit) more volatile destinations. These findings corroborate recent literature that emphasizes the greater elasticity of large firms to foreign demand shocks. They are also in line with risk aversion models in which the average risk premium increases with firm size. Given the disproportionate adverse impacts on large exporters, we find that higher demand volatility leads to lower aggregate exports, especially to geographically close countries with low trade costs. Accordingly, uncertainty in demand lessens the positive effect of lower trade barriers on exports.

Keywords: Demand volatility, uncertainty, export margins, firm-level, Egypt.
JEL Classifications: F10, F12, F14.

ملخص

تشرح هذه الدراسة سلوك التصدير للشركات المصرية التي تعاني من تقلب الطلب في دول المقصد باستخدام بيانات جمركية مفصلة وتأثيرات ثابتة عالية الأبعاد. ويرى أن تقلب الطلب يؤثر سلباً على هوامش التصدير المكثفة والواسعة. وتتجلى هذه الآثار بوجه خاص بالنسبة للشركات الكبيرة التي تخفض مبيعاتها من الصادرات (خاصة مع مرور الوقت) إلى وجهات/منتجات أكثر تقلباً، ومن ثم تزداد احتمالات خروجها من تصدير منتجات أكثر تقلباً وأقل احتمالاً (أكثر) لدخول (الخروج) إلى وجهات أكثر تقلباً. تؤكد هذه النتائج المؤلفات الحديثة التي تؤكد على المرونة الأكبر للشركات الكبيرة في مواجهة صدمات الطلب الأجنبي. كما أنها تتماشى مع نماذج النفور من المخاطر التي يزداد فيها متوسط علاوة المخاطر مع حجم الشركة. وبالنظر إلى الآثار السلبية غير المتناسبة على كبار المصدرين، نجد أن ارتفاع تقلب الطلب يؤدي إلى انخفاض إجمالي الصادرات، لا سيما إلى البلدان القريبة جغرافيا ذات التكاليف التجارية المنخفضة. وبناء على ذلك، فإن عدم اليقين في الطلب يقلل من الأثر الإيجابي لانخفاض الحواجز التجارية على الصادرات.

1. Introduction

With the availability of finely disaggregated firm-level customs data, studies have increasingly used models of international trade characterized by the presence of heterogeneous firms to examine the behavior of exporting firms. They generally found that the most productive firms, which can afford to pay fixed entry costs into foreign markets, tend to self-select into exporting. They also found that firms perform differently after entry, with some unable to survive. An important factor that explains the high firm turnover (entry and exit) rates is the uncertainty they face in foreign markets (Kasahara and Tang, 2019).

Typical trade models, as in Melitz (2003), assume that a firm knows the exact demand function it faces in destinations, realizes its uncertain parameter (productivity) before any supply decisions, and, once it begins exporting, should export to all destinations forever. However, this is inconsistent with the evidence that most firms delay their entry decision and that many exit after their first year of entry into some destinations. Accordingly, more recent models, such as the one presented by Nguyen (2012), incorporate demand uncertainty to explain firms' entry and exit decisions (i.e., entry delays and export failures), where a firm realizes demand only after entry into a destination. Moreover, such demand uncertainty could affect export prices and quantities (and, consequently, export sales), as it can be caused by factors outside of the firms' control, such as changes in consumer tastes or incomes, the popularity of competing products, and industrial policy (De Sousa et al., 2020). Surveys conducted by consulting firms such as Gartner and Capgemini[2] cite demand volatility as the top obstacle perceived by the supply chain managers of firms. Many marketing studies also attribute product failures to the inaccuracy of forecasting market demand (Crawford, 1977).

This paper contributes to the literature exploring the role of demand factors in influencing the export performance of firms, such as the studies done by Eaton et al. (2011) and Di Comite (2014). Studies that specifically examine the effect of uncertainty/volatility in demand are generally lacking,[3] especially for developing countries. Therefore, using disaggregated customs data at the firm-product-destination-year level, we investigate the effect of volatility in demand on both the intensive and extensive margins of Egyptian firms' exports and test its heterogeneity. The results indicate that demand volatility has a negative impact on both margins. Firms decrease their export sales and are more likely to exit and less likely to enter volatile products/destinations, with these effects being more robust for larger (more productive) firms.

[2] https://www.scdigest.com/ASSETS/FIRSTTHOUGHTS/14-06-26.php?cid=8223 and https://www.capgemini.com/wp-content/uploads/2017/07/The_2011_Global_Supply_Chain_Agenda.pdf.

[3] Other sources of uncertainty in destination markets and their trade effects have been examined in the literature, such as trade policy uncertainty (Handley and Limão, 2017; Feng et al., 2017) and exchange rate volatility (Héricourt and Poncet, 2015; Héricourta and Doncella, 2018).

The paper is organized as follows. Section 2 reviews the theoretical and empirical literature on the effects of demand volatility. Section 3 describes the data and the methodology and offers some descriptive statistics. Section 4 presents the empirical results, and section 5 concludes.

2. Literature review

According to Bloom (2014), the literature examining the effect of uncertainty on firms' choices and investment/export decisions can be grouped into four strands: real options, risk aversion, growth options, and Oi–Hartman–Abel effects. While the first two strands emphasize negative channels for uncertainty, the latter two discuss positive effects.

In the ***real options*** approach presented by Dixit and Pindyck (1994), firms can consider their investment choices as a series of options. When the uncertainty of the economic environment is high, the option value of delaying investment is high, especially when the decision to invest is irreversible (Bloom et al., 2007). This can explain the extensive margin of firms' exports under demand uncertainty, where the existence of sunk entry costs into a destination makes firms cautious about entry into new (volatile) markets. In turn, ***risk aversion*** models postulate that when firms are uncertain about the future, they consider the range of possible outcomes. If they are pessimistic, they act as if the worst outcomes will occur and decrease output, thereby displaying a behavior of "ambiguity aversion." Since the variance in firm profits is proportional to the square of the expected output, the risk premium increases with the firm's output. Accordingly, demand uncertainty is expected to negatively affect the intensive margin of the exports of risk-averse firms, with the effect being larger for more productive firms. Reasons why the managers of exporting firms can become risk-averse include high bankruptcy costs, inadequate hedging of risks, and their holding of extensive equity in the firm, which makes them highly exposed to firm-level risk (Panousi and Papanikolaou, 2012; Ilut and Schneider, 2014; Bloom, 2014; and De Sousa et al., 2020).

On the other hand, the ***growth options*** approach argues that uncertainty can encourage investment if it increases the size of potential gains. Under the "good news principle" termed by Bernanke (1983) as opposed to the "bad news principle" emphasized by the real options approach, a mean-preserving increase in demand uncertainty implies higher expected profits, which motivates firms' entry into producing and exporting new and risky products. Similarly, according to the ***Oi–Hartman–Abel effects*** (Oi, 1961; Hartman, 1972; and Abel, 1983), under imperfect competition with constant marginal cost, the relationship between profits and demand is convex, which means that an increase in demand volatility leads to an increase in expected profits. However, this assumes that firms can easily expand or contract output in response to good and bad outcomes, which is more likely to occur in the medium and long run (rather than the short run) due to lower adjustment costs (Bloom, 2014).

As suggested by Békés et al. (2017), ***stochastic inventory models*** can provide yet another framework for understanding the effect of demand volatility on firms' exports. According to these models, firms manage their inventories by determining the frequency of shipments and their size. If the demand is volatile and the cost of the inability to serve consumers is high enough, firms will have to hold larger inventories, which increases marginal costs and leads to lower export sales (Zipkin, 2000). Empirically, Békés et al. (2017) examine how exporting firms respond to uncertainty arising from demand volatility by using monthly customs data from France. They find that firms export less to markets with higher demand volatility and that this effect mainly works through the frequency margin. Specifically, firms send larger, less frequent shipments to more uncertain markets conditional on total exports, which is in line with stochastic inventory models.

Turning to a study on a developing country, Kasahara and Tang (2019) attribute Chinese firms' high rates of entry into and exit from export markets to their rational self-discovery of demand in uncertain markets. A high variance of foreign demand induces firms to enter new markets (i.e., the profit function is convex in demand), where firms hope that the true demand is high while insuring against the risk of low demand by exiting in the next period. An earlier study by Iacovone and Javorcik (2010) finds that the presence of uncertainty facing Mexican exporters in foreign markets implies that most new exporters enter a foreign market with a variety already sold at home, export discoveries of new product varieties are relatively rare, and a large percentage of export varieties do not survive for more than a year in the foreign market.

Using a dataset of Japanese multinational affiliates, Chen et al. (2017) find that a higher variance of temporary foreign demand shocks makes firms' learning about demand less effective, thus reducing entries into exporting and leading to more direct entries into foreign direct investment (FDI) as an alternative mode of serving the foreign market. A study by Berman et al. (2019) also emphasizes the role of demand learning in driving firms' dynamics. Using data on French firms, they find that firms update their beliefs in response to a given demand shock; the younger they are (less tenured in a product-destination) the more this learning process becomes weaker and less age-dependent in more uncertain environments. Another study on French firms by De Sousa et al. (2020) uses a measure of demand volatility at the industry level and finds that demand uncertainty in foreign markets affects firms' export entry and exit decisions (extensive margin) as well as their export sales (intensive margin). Importantly, they find that the more productive exporters are more affected by higher industry expenditure volatility.

Likewise, several studies confirm the heterogeneous effect of uncertainty shocks on individual firms. Using a model calibrated to match US data, Fillat and Garetto (2015) show that exporters and multinational firms (i.e., the most productive firms) are more exposed to risk than firms that do not serve foreign markets, as their profits are more sensitive to fluctuations in global demand. Exiting after a negative shock is less likely for multinationals compared to exporters due to the higher sunk costs paid to start investing abroad. Héricourta and Nedoncelle (2018) also document

a stronger adverse effect of uncertainty in destination markets on the export values of multi-destination firms. Specifically, strongly multi-destination French firms tend to reduce their exports to destinations that face higher exchange rate volatility more significantly, while increasing their exports to all other served destinations. A recent study by Bricongne et al. (2022) provides evidence that the largest firms react more strongly to macro shocks compared to smaller firms. Using the COVID-19 pandemic as a natural experiment, the top French firms are found to exhibit significantly higher elasticity to a given foreign demand shock. Results indicate that, on average, a full destination country lockdown reduced the mid-point growth rate of firms' exports by 0.6 points, with the effect being twice as large for firms in the top 0.1 percent compared to the bottom 99.9 percent.

3. Data, methodology, and descriptive statistics

3.1. Data

This study relies on firm-level customs data for Egypt at the Harmonized System (HS) six-digit product and destination country level over the period 2005-16, provided by the General Organization for Export and Import Control (GOEIC), Ministry of Trade and Industry.[4] A firm-product-destination combination that appears only once over the entire period is dropped so that we focus on persistent export flows rather than temporary ones.

To construct our measure of demand volatility, the BACI dataset for bilateral trade flows at the HS six-digit product level is used.[5] Following Autor et al. (2013) and Békés et al. (2017), demand volatility is measured as the standard deviation of log differences in imports by product-market from all countries except Egypt over six-year rolling periods.[6] It is thus constructed in two steps. First, yearly log differences in imports by product-market over six-year rolling periods are computed. Then, demand volatility is identified as the standard deviation of these yearly log differences.[7] By excluding Egypt's exports, this measure mitigates endogeneity concerns due to a possible reverse causality running from firm trade to volatility. Moreover, we drop outliers based on the annual log differences in imports below the 0.5 percentile or above the 99.5 percentile.

To control for the market size effect on trade, the BACI dataset is also used to measure the mean of import demand by product-market at a given year over the five previous years, again after excluding imports from Egypt.

Lastly, data for bilateral distances from Egypt and regional trade agreements are from the Centre d'Études Prospectives et d'Informations Internationales (CEPII).

[4] Data are available through the Economic Research Forum (ERF) portal: https://erf.org.eg/erf-data-portal/
[5] Data are available on CEPII: http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37
[6] Other rolling periods of five and seven years are used for robustness tests.
[7] A similar measure is adopted by De Sousa et al. (2020). However, their measure is computed at the industry (rather than the product) level.

3.2. Methodology

As in De Sousa et al. (2020), we assume a firm f is producing a product k and facing a downward-sloping demand curve in destination country j: $p_{fkj} = f(q_{fkj}, R_{kj})$, where p_{fkj} and q_{fkj} are the price and the quantity of product k supplied by firm f and R_{kj} is the expenditure (import demand) on product k in country j. If the demand curve is not known for certain and is subject to transitory shocks, then both the first and second moment of a destination country's expenditure distribution (i.e., the mean and the variance) are expected to affect firms' exporting decisions.

To formally examine the effect of demand volatility in destination countries on firms' export margins, we estimate the following equations:

$$\ln y_{fkjt} = \alpha + \beta \ln E_t(R_{kjt}) + \gamma V_t(\dot{R}_{kjt}) + I + \epsilon_{fkjt} \quad (1)$$

$$\Pr(y_{fkjt}) = \alpha + \beta \ln E_t(R_{kjt}) + \gamma V_t(\dot{R}_{kjt}) + I + \epsilon_{fkjt} \quad (2)$$

Where the dependent variable in (1) is the firm's export value (in logs), to capture the intensive margin and in (2) is either the probability of entry or the probability of exit from a product-destination country. To capture the extensive margin,[8] $E_t(R_{kjt})$ is the mean import demand on product k in country j over the five previous years, $V_t(\dot{R}_{kjt})$ is the volatility of import demand on product k in country j measured as the standard deviation of yearly log differences in imports over six-year rolling periods (as illustrated in section 3.1), and I controls for different sets of fixed effects. Standard errors are clustered at the destination market-product level.

As the reviewed literature suggests, we expect heterogeneous firms to respond differently to demand volatility. Thus, we investigate the volatility effect on firms of different sizes.[9]

To get the aggregate effect of demand volatility on both margins (total export value-number of exporting firms), we begin by estimating the regressions at the product-destination-year level before proceeding with the firm-level specifications.

3.3. Descriptive statistics

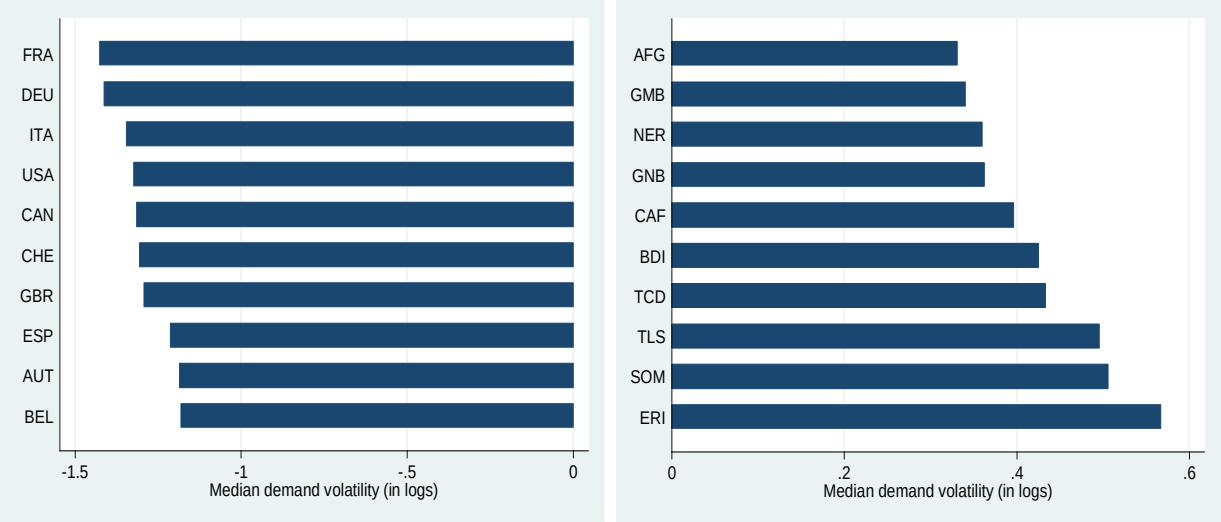
Using our measure of demand volatility (the rolling standard deviation of log differences in imports) at the product-country-year, we compute the median volatility (in logs) for each country

[8] Equation 2 is estimated through a linear probability model.

[9] Since the customs database does not contain information on firm-specific characteristics (such as sales, value-added, capital, and employment), a direct measure of a firm's productivity cannot be obtained. Alternatively, we use the firm's size (as proxied by its total exports across products and destinations) in our estimations to examine the heterogeneous effect of demand uncertainty.

to rank countries based on their demand volatility over all products and years (2005-16). Figure 1 depicts the 10 least and most volatile countries.

Figure 1. The least and most demand-volatile countries over 2005-16

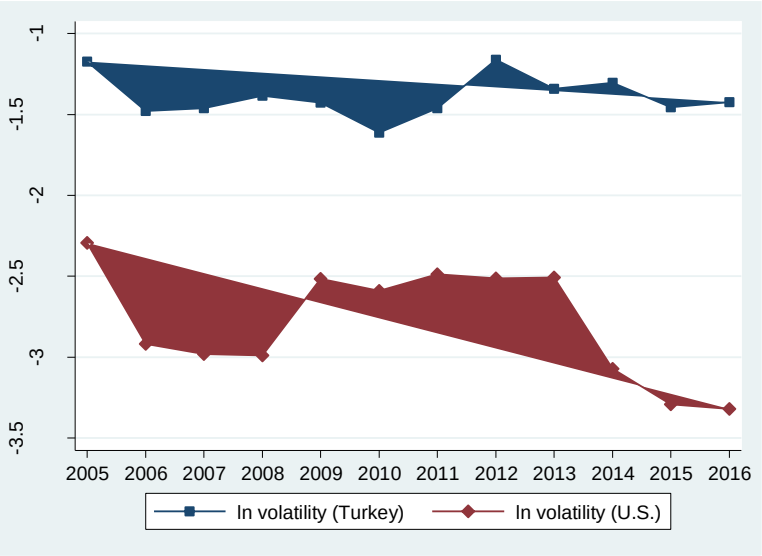


As the figure shows, European countries as well as the US and Canada exhibit the lowest demand volatility, whereas mainly African countries are the most volatile. This is in line with De Sousa et al. (2020) and Bloom (2014), who find that developing countries generally experience higher uncertainty compared to developed countries.

Turning to the median volatility (in logs) by product over countries and years (2005-16), we find that the 10 least volatile products belong to the chemicals, food and beverages, and plastics sectors. On the other hand, the most volatile products belong to the aircraft and transport equipment, and machinery and mechanical appliances sectors. Table 1A in the Appendix shows the 10 least and most volatile HS six-digit products and a description of their corresponding sector.

In addition to variations across countries and products, the volatility measure accounts for demand fluctuations per country-product over time. Figure 2 illustrates the changes in demand volatility over time for one of Egypt's top exported products (cotton trousers, HS 620342) in two major destination countries: Turkey and the US. It indicates that Turkey witnessed higher volatility in the demand for trousers, which peaked in 2012, whereas demand in the US has been more stable, especially over 2009-13, with volatility declining much thereafter.

Figure 2. Demand volatility for HS 620342 over 2005-16: Turkey vs the US



4. Empirical results

We start with aggregate regressions. Table 1 shows a negative impact of the second moment of foreign demand distribution (demand volatility) on the intensive margin, measured by the total Egyptian exports of product k to destination country j in year t. This negative impact is maintained under different sets of fixed effects used to control for unobserved heterogeneity across products and countries: destination-year and product fixed effects (column 1) and product-year and destination fixed effects (column 2). Estimations indicate that doubling the level of demand volatility in a destination country would lower the exports of a given product by around five percent. They also show a positive effect of the first moment of demand distribution (mean demand) on exports. We then examine if the effect of volatility differs according to trade costs, using a dummy to capture whether the destination country is geographically close to Egypt (with a bilateral distance less than the median) and interacted with volatility. The results show that the negative effect of volatility on exports is indeed stronger for closer countries (columns 3 and 4). Accordingly, demand uncertainty reduces the positive impact of lower trade barriers on exports. This is again confirmed by the negative interaction term between volatility and a dummy for countries having a regional trade agreement with Egypt (columns 5 and 6), suggesting that the adverse effect of volatile demand is mainly evident for Egypt's exports to low trade cost countries. These results are in line with De Sousa et al. (2020), who find a magnified impact of volatility on French exports to EU countries that typically share low trade barriers with France.

Table 1. Demand volatility and total export value at product-destination-year

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln Total Export Value $_{kjt}$					
Ln Mean Demand $_{kj, t-1}$	0.309***	0.332***	0.310***	0.333***	0.310***	0.333***
	(0.00970)	(0.0103)	(0.00969)	(0.0103)	(0.00970)	(0.0103)
Ln Demand Volatility $_{kjt}$	**-0.0486*** **	**-0.0507*** **	0.0757**	0.0520	0.0164	0.00309
	(0.0147)	(0.0155)	(0.0312)	(0.0321)	(0.0272)	(0.0273)
Ln Demand Volatility $_{kjt}$ *close market $_{i}$			**-0.153*** **	**-0.127*** **		
			(0.0331)	(0.0341)		
Ln Demand Volatility $_{kjt}$ *RTA $_{jt}$					**-0.0859*** **	**-0.0721** **
					(0.0299)	(0.0297)
Observations	167,402	161,363	167,402	161,363	167,402	161,361
R-squared	0.416	0.467	0.417	0.468	0.416	0.468
Destination-Year Fixed Effects	Yes		Yes		Yes	
Product Fixed Effects	Yes		Yes		Yes	
Product-Year Fixed Effects		Yes		Yes		Yes
Destination Fixed Effects		Yes		Yes		Yes
Estimation Method	OLS	OLS	OLS	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Turning to the extensive margin, Table 2 indicates a negative impact of volatility and a positive impact of mean demand on the number of Egyptian exporting firms per product-country-year. Specifically, the number of exporters decreases by three percent when exporting a given product to a destination with twice as much volatility. The results hold under different fixed effects (columns 1 and 2). As before, volatility mainly impacts exporters to nearby and low trade cost countries (columns 3 to 6).

Table 2. Demand volatility and the number of exporting firms at product-destination-year

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln Number of Firms $_{kjt}$					
Ln Mean Demand $_{kj, t-1}$	0.0797***	0.0857***	0.0799***	0.0859***	0.0801***	0.0862***
	(0.00330)	(0.00363)	(0.00330)	(0.00363)	(0.00330)	(0.00364)
Ln Demand Volatility $_{kjt}$	**-0.0310*** **	**-0.0354*** **	0.0245**	0.0145	0.0115	0.00461
	(0.00503)	(0.00549)	(0.0101)	(0.0106)	(0.00895)	(0.00922)
Ln Demand Volatility $_{kjt}$ *close market $_{i}$			**-0.0681*** **	**-0.0617*** **		
			(0.0110)	(0.0116)		
Ln Demand Volatility $_{kjt}$ *RTA $_{jt}$					**-0.0562*** **	**-0.0536*** **
					(0.0102)	(0.0104)
Observations	167,402	161,363	167,402	161,363	167,402	161,361
R-squared	0.445	0.477	0.445	0.477	0.445	0.477
Destination-Year Fixed Effects	Yes		Yes		Yes	
Product Fixed Effects	Yes		Yes		Yes	
Product-Year Fixed Effects		Yes		Yes		Yes
Destination Fixed Effects		Yes		Yes		Yes
Estimation Method	OLS	OLS	OLS	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Next, we estimate firm-level regressions to obtain a finer picture of volatility effects. Table 3 illustrates the effect on the firm's intensive margin (firm f's exports of product k to destination country j in year t). Column 1 uses firm-product-year fixed effects and destination fixed effects to capture the impact of demand volatility across destination countries. The coefficient of volatility is negative and significant at the 10 percent level, indicating that multi-destination firms favor countries with lower volatility, thus they decrease their export sales of a given product to more volatile destinations. Column 2 uses firm-destination-year fixed effects and product fixed effects to capture the impact across products. Again, the coefficient is negative and significant at the 10 percent level. Thus, multi-product firms prefer to export products with lower volatility, i.e., they decrease the exports of more volatile products to a given destination country. In column 3, firm-destination-product fixed effects and year fixed effects are used to capture the impact across time.[10] The coefficient is negative and now significant at the one percent level, which implies that a firm exporting a given product to a given destination country will lower its export sales as volatility increases over time. When we control for a firm's time-varying characteristics in column 4 (i.e., firms' productivity or size as proxied by their one-year lagged total exports across products and destination countries), the negative effect of volatility is maintained. Additionally, the coefficients of mean demand as well as firm size are positively significant as expected. Firm-level results thus confirm the negative effect of demand volatility on the intensive margin obtained in the aggregate estimations.

Table 3. Demand volatility and firm export value

	(1)	(2)	(3)	(4)

[10] This third set of fixed effects has the most robust effect on the firm's intensive margin when testing alternative rolling periods of five and seven years for the demand volatility measure, as shown in tables 2A and 3A in the Appendix. Moreover, the negative effect of volatility is prevalent across different sectors (Table 4A in the Appendix).

	Ln Firm Export Value $_{fkjt}$			
Ln Mean Demand $_{kj, t-1}$	0.180***	0.115***	0.0534***	0.0432***
	(0.00915)	(0.0129)	(0.0134)	(0.0139)
Ln Demand Volatility $_{kjt}$	**-0.0220***	**-0.0346***	**-0.0389*****	**-0.0334*****
	(0.0130)	(0.0181)	(0.0104)	(0.0105)
Ln Size $_{f, t-1}$				0.133***
				(0.00401)
Observations	338,214	329,131	483,763	413,739
R-squared	0.683	0.747	0.841	0.846
Firm-Product-Year Fixed Effects	Yes			
Destination Fixed Effects	Yes			
Firm-Destination-Year Fixed Effects		Yes		
Product Fixed Effects		Yes		
Firm-Destination-Product Fixed Effects			Yes	Yes
Year Fixed Effects			Yes	Yes
Estimation Method	OLS	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

To examine heterogeneity across firms, we contrast the effect of demand volatility on the export behavior of small vs large firms, where small (large) firms are those with total exports averaged over the period below (above) the median of the distribution.[11] Table 4 indicates that the negative effect of volatility on exports is confined to large/more productive exporters, which is in line with the findings of Bricongne et al. (2022) and di Giovanni et al. (2022) that large firms exhibit higher elasticity to foreign demand shocks. Specifically, large exporters decrease their export sales to more volatile destinations as opposed to smaller firms, which tend to increase exports to such destinations (column 1), decrease their exports of volatile products (column 2), and decrease their exports of a given product-destination country as volatility rises over time (column 3). The biggest effect on large firms' exports occurs over time, as shown by the higher coefficient value in column 3.

[11]Accordingly, out of a total of 11,768 firms, only 2,986 firms are classified as small (i.e., around 25 percent of total firms). This indicates that the export structure in Egypt is very concentrated; most export sales are dominated by a few large firms, also called export superstars (Freund and Pierola, 2020).

Table 4. The heterogeneous effect of demand volatility on firm export value

	(1)	(2)	(3)
	Ln Firm Export Value $_{fkjt}$		
Ln Mean Demand $_{kj, t-1}$	0.180***	0.115***	0.0534***
	(0.00915)	(0.0129)	(0.0134)
Ln Demand Volatility $_{kjt}$ *small firm	**0.142*** **	0.00324	-0.0446
	(0.0437)	(0.0394)	(0.0291)
Ln Demand Volatility $_{kjt}$ *large firm	**-0.0251***	**-0.0361** **	**-0.0387*** **
	(0.0131)	(0.0180)	(0.0107)
Observations	338,214	329,131	483,763
R-squared	0.683	0.747	0.841
Firm-Product-Year Fixed Effects	Yes		
Destination Fixed Effects	Yes		
Firm-Destination-Year Fixed Effects		Yes	
Product Fixed Effects		Yes	
Firm-Destination-Product Fixed Effects			Yes
Year Fixed Effects			Yes
Estimation Method	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Turning to the extensive margin, Table 5 shows the effect of demand volatility on the probabilities of firm entry and exit. We adopt a conservative definition for firm entry/exit, where the probability of entry is a dummy variable that equals 1 if the firm exports a given product-destination combination in years t and t+1 but did not export it in years t-1 and t-2. On the other hand, the probability of exit is captured by a dummy variable that equals 1 if the firm does not export a given product-destination in years t and t+1 but exports it in years t-1 and t-2. This two-year entry/exit definition reduces potential bias due to the churning of firms. Columns 1 and 3 use firm-product-year fixed effects and destination fixed effects to examine the effect of volatility on entry/exit across destination countries, while columns 2 and 4 use firm-destination-year fixed effects and product fixed effects to examine the effect across products.

Our results indicate a negative (positive) effect of volatility on the probability of firm entry (exit) across destination countries, i.e., firms exporting a given product k are less likely to enter/more likely to exit more volatile destinations (columns 1 and 3). Volatility across products does not have a significant effect on the probability of firm entry, but has a positive and significant effect on firm exit (columns 2 and 4). Results also indicate that a higher mean demand increases the probability of firm entry and decreases the probability of exit across destination countries/products. These results confirm the adverse effect of demand volatility on the extensive margin found in aggregate estimations.[12]

[12] We reach qualitatively similar firm-level findings when testing alternative rolling periods of five and seven years for the demand volatility measure and when adopting a less conservative (one-year) definition for firm entry/exit, as shown in tables 5A, 6A, and 7A in the Appendix.

Table 5. Demand volatility and probability of firm entry and exit

	(1)	(2)	(3)	(4)
	Probability of Firm Entry		Probability of Firm Exit	
Ln Mean Demand $_{kj, t-1}$	0.00597***	0.00248***	-0.0177***	-0.0185***
	(0.000576)	(0.000547)	(0.00193)	(0.00246)
Ln Demand Volatility $_{kjt}$	**-0.00394*** **	-0.000222	**0.00855*** **	**0.0127*** **
	(0.00102)	(0.000963)	(0.00299)	(0.00378)
Observations	348,501	371,495	110,871	94,761
R-squared	0.627	0.674	0.607	0.664
Firm-Product-Year Fixed Effects	Yes		Yes	
Destination Fixed Effects	Yes		Yes	
Firm-Destination-Year Fixed Effects		Yes		Yes
Product Fixed Effects		Yes		Yes
Estimation Method	LPM	LPM	LPM	LPM

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Lastly, Table 6 provides evidence of the heterogeneous effect of demand volatility on firms' entry and exit decisions. Both small and large firms exporting a given product k are less likely to enter more volatile destinations (column 1). Only small firms have a larger probability of entry into more volatile products (column 2), which could be explained by the growth options approach, where uncertainty in product demand can be associated with higher expected profits that encourage entry. As for exit decisions, we find that the large exporters (in contrast to small ones) are more likely to exit both more volatile destinations and more volatile products, thus reflecting their risk-averse behavior (columns 3 and 4). The biggest adverse effect of volatility occurs through large firms' exiting from more volatile products, as shown by the higher coefficient value in column 4. Our findings are in line with De Sousa et al. (2020), who document a higher response of the more-productive French firms' intensive and extensive export margins to increased demand volatility.

Table 6. The heterogeneous effect of demand volatility on the probability of firm entry and exit

	(1)	(2)	(3)	(4)
	Probability of Firm Entry		Probability of Firm Exit	
Ln Mean Demand $_{ki, t-1}$	0.00597***	0.00247***	-0.0177***	-0.0185***
	(0.000576)	(0.000547)	(0.00193)	(0.00247)
Ln Demand Volatility $_{kjt}$ *small firm	**-0.00451***	**0.00555*****	**-0.0326*****	**-0.0195***
	(0.00235)	(0.00206)	(0.0125)	(0.0106)
Ln Demand Volatility $_{kjt}$ *large firm	**-0.00392*****	-0.000578	**0.00916*****	**0.0138*****
	(0.00104)	(0.000989)	(0.00302)	(0.00385)
Observations	348,501	371,495	110,871	94,761
R-squared	0.627	0.674	0.607	0.664
Firm-Product-Year Fixed Effects	Yes		Yes	
Destination Fixed Effects	Yes		Yes	
Firm-Destination-Year Fixed Effects		Yes		Yes
Product Fixed Effects		Yes		Yes
Estimation Method	LPM	LPM	LPM	LPM

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This paper studies how Egyptian firms respond to an increase in demand volatility in destination countries using disaggregated export data at the firm-HS six-digit product-destination country-year level.

As a first step, we conduct aggregate estimations that point to a negative effect of demand volatility on both export margins: total export values (intensive margin) and the number of exporting firms (extensive margin) at the product-destination-year level. The adverse effects of volatility are particularly found for exports to closer and low trade cost destination countries (i.e., countries with which Egypt trades the most).

Firm-level regressions confirmed these aggregate findings while providing a finer picture of the heterogeneous response of differently-sized firms. Specifically, large firms reduce their export values in response to increased uncertainty, thereby reflecting risk-averse behavior. For the extensive margin, the effect of volatility is also found to be more robust for large firms, which are less likely to enter more volatile destinations (in line with the real options approach in Dixit and Pindyck, 1994) and are more likely to exit more volatile destinations and products. In line with risk aversion models and the findings of De Sousa et al. (2020), since risk premium increases with the firm's output, large firms are more sensitive to higher volatility. Our results are robust to the inclusion of different sets of fixed effects and the adoption of different year windows for measuring demand volatility.

In summation, higher demand volatility reduces Egypt's total exports through both intensive and extensive margins. The main channels are the lower export values of large firms over time to a volatile product-destination and the higher probability of large firms exiting from exporting more volatile products.

By dropping the assumption in heterogeneous firm models of firms facing certain demand in destination markets, this paper contributes to the literature that examines firm behavior under uncertain environments. It also corroborates the higher responsiveness of large firms to foreign demand shocks highlighted in recent literature by Bricongne et al. (2022) and di Giovanni et al. (2022).

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Appendix

Table 7A. The least and most demand volatile products 2005-16

HS six-digit product	Median volatility (in logs)	Sector
Least volatile products		
300490	-1.767	Pharmaceutical products.
330499	-1.542	Essential oils and resinoids; perfumery, cosmetic/toilet preparations.
210690	-1.542	Miscellaneous edible preparations.
210390	-1.531	Miscellaneous edible preparations.
190530	-1.512	Preparations of cereal, flour, starch/milk; pastrycooks' products.
170490	-1.506	Sugars and sugar confectionery.
382200	-1.503	Miscellaneous chemical products.
190590	-1.459	Preparations of cereal, flour, starch/milk; pastrycooks' products.
392690	-1.458	Plastics and articles thereof.
220421	-1.441	Beverages, spirits, and vinegar.
Most volatile products		
890520	.909	Ships, boats, and floating structures.
880260	.86	Aircraft, spacecraft, and parts thereof.
840110	.789	Nuclear reactors, boilers, machinery, and mechanical appliances; parts.
890590	.764	Ships, boats, and floating structures.
860390	.753	Railway/tramway locomotives, rolling stock, and parts thereof.
890510	.737	Ships, boats, and floating structures.
840211	.735	Nuclear reactors, boilers, machinery, and mechanical appliances; parts.
841012	.732	Nuclear reactors, boilers, machinery, and mechanical appliances; parts.
890110	.729	Ships, boats, and floating structures.
840681	.718	Nuclear reactors, boilers, machinery, and mechanical appliances; parts.

Table 8A. Demand volatility and firm export value: Five-year rolling standard deviation of log differences in import demand

	(1)	(2)	(3)	(4)
	Ln Firm Export Value $_{fkjt}$			
Ln Mean Demand $_{kj, t-1}$	0.183***	0.119***	0.0547***	0.0441***
	(0.00927)	(0.0130)	(0.0139)	(0.0144)
Ln Demand Volatility $_{kjt}$	-0.0146	-0.0241	**-0.0229*** **	**-0.0194** **
	(0.0112)	(0.0152)	(0.00801)	(0.00807)
Ln Size $_{f, t-1}$				0.133***
				(0.00403)
Observations	336,332	326,453	480,488	411,010
R-squared	0.683	0.747	0.841	0.846
Firm-Product-Year Fixed Effects	Yes			
Destination Fixed Effects	Yes			
Firm-Destination-Year Fixed Effects		Yes		
Product Fixed Effects		Yes		
Firm-Destination-Product Fixed Effects			Yes	Yes
Year Fixed Effects			Yes	Yes
Estimation Method	OLS	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Table 9A. Demand volatility and firm export value: Seven-year rolling standard deviation of log differences in import demand

	(1)	(2)	(3)	(4)
	Ln Firm Export Value $_{fkjt}$			
Ln Mean Demand $_{kj, t-1}$	0.179***	0.114***	0.0511***	0.0420***
	(0.00914)	(0.0128)	(0.0131)	(0.0135)
Ln Demand Volatility $_{kjt}$	**-0.0287** **	**-0.0399** **	**-0.0587*** **	**-0.0515*** **
	(0.0145)	(0.0202)	(0.0131)	(0.0132)
Ln Size $_{f, t-1}$				0.133***
				(0.00401)
Observations	338,947	330,252	485,083	414,898
R-squared	0.683	0.747	0.841	0.846
Firm-Product-Year Fixed Effects	Yes			
Destination Fixed Effects	Yes			
Firm-Destination-Year Fixed Effects		Yes		
Product Fixed Effects		Yes		
Firm-Destination-Product Fixed Effects			Yes	Yes
Year Fixed Effects			Yes	Yes
Estimation Method	OLS	OLS	OLS	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Table 10A. Demand volatility and firm export value: Sectoral effects

	(1)
	Ln Firm Export Value $_{fkjt}$
Ln Mean Demand $_{kj, t-1}$	0.0446***
	(0.0139)
Ln Demand Volatility $_{kjt}$*Food	-0.0174
	(0.0257)
Ln Demand Volatility $_{kjt}$*Minerals	**-0.0966***
	(0.0563)
Ln Demand Volatility $_{kjt}$*Chemicals	**-0.0406****
	(0.0201)
Ln Demand Volatility $_{kjt}$*Wood/Paper	-0.0488
	(0.0380)
Ln Demand Volatility $_{kjt}$*Textiles/Apparel	**-0.0479***
	(0.0247)
Ln Demand Volatility $_{kjt}$*Stone/Glass	**-0.0699***
	(0.0382)
Ln Demand Volatility $_{kjt}$*Metals	**-0.0936*****
	(0.0314)
Ln Demand Volatility $_{kjt}$*Machinery/Electrical	**-0.0705***
	(0.0423)
Ln Demand Volatility $_{kjt}$*Miscellaneous	**-0.0872*****
	(0.0310)
Ln Size $_{f, t-1}$	0.133***
	(0.00401)
Observations	413,739
R-squared	0.846
Firm-Destination-Product Fixed Effects	Yes
Year Fixed Effects	Yes
Estimation Method	OLS

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Table 11A. Demand volatility and probability of firm entry and exit: Five-year rolling standard deviation of log differences in import demand

	(1)	(2)	(3)	(4)
	Probability of Firm Entry		Probability of Firm Exit	
Ln Mean Demand $_{kj, t-1}$	0.00604***	0.00252***	-0.0185***	-0.0199***
	(0.000589)	(0.000557)	(0.00193)	(0.00246)
Ln Demand Volatility $_{kjt}$	**-0.00324*** **	-0.000167	**0.00635** **	**0.00869*** **
	(0.000950)	(0.000858)	(0.00260)	(0.00328)
Observations	345,927	367,454	110,300	93,948
R-squared	0.627	0.674	0.607	0.665
Firm-Product-Year Fixed Effects	Yes		Yes	
Destination Fixed Effects	Yes		Yes	
Firm-Destination-Year Fixed Effects		Yes		Yes
Product Fixed Effects		Yes		Yes
Estimation Method	LPM	LPM	LPM	LPM

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Table 12A. Demand volatility and probability of firm entry and exit: Seven-year rolling standard deviation of log differences in import demand

	(1)	(2)	(3)	(4)
	Probability of Firm Entry		Probability of Firm Exit	
Ln Mean Demand $_{kj, t-1}$	0.00586***	0.00240***	-0.0176***	-0.0180***
	(0.000574)	(0.000538)	(0.00194)	(0.00246)
Ln Demand Volatility $_{kjt}$	**-0.00439*** **	-0.000473	**0.00983*** **	**0.0156*** **
	(0.00110)	(0.00102)	(0.00328)	(0.00417)
Observations	349,869	373,825	111,091	95,136
R-squared	0.627	0.674	0.607	0.664
Firm-Product-Year Fixed Effects	Yes		Yes	
Destination Fixed Effects	Yes		Yes	
Firm-Destination-Year Fixed Effects		Yes		Yes
Product Fixed Effects		Yes		Yes
Estimation Method	LPM	LPM	LPM	LPM

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1

Table 13A. Demand volatility and probability of firm entry and exit: One-year definition for firm entry/exit

	(1)	(2)	(3)	(4)
	Probability of Firm Entry		Probability of Firm Exit	
Ln Mean Demand $_{kj, t-1}$	0.00648***	0.00316***	-0.0135***	-0.0120***
	(0.000541)	(0.000517)	(0.00143)	(0.00168)
Ln Demand Volatility $_{kjt}$	**-0.00282*** **	-0.00107	**0.00831*** **	**0.00725*** **
	(0.000927)	(0.000946)	(0.00218)	(0.00244)
Observations	704,306	758,022	313,497	307,349
R-squared	0.463	0.499	0.414	0.461
Firm-Product-Year Fixed Effects	Yes		Yes	
Destination Fixed Effects	Yes		Yes	
Firm-Destination-Year Fixed Effects		Yes		Yes
Product Fixed Effects		Yes		Yes
Estimation Method	LPM	LPM	LPM	LPM

Robust standard errors in parentheses, clustered by destination-product.
*** p<0.01, ** p<0.05, * p<0.1