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Forward Looking Exporters*

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Abstract

This paper studies the role of expectations in driving export adjustment. We assemble bilateral data on spot exchange rates, one year ahead exchange rate forecasts and HS2-product export data for 11 exporting countries and 64 destinations, covering the 2006–2014 period. Results from fixed effects regressions and an instrumental variables approach show that expectations of exchange rate changes are an important channel for export adjustment. A one percent expected exchange rate depreciation over the next year is associated with a 0.96 percent increase in the extensive margin (entry of new exporters) in the 2SLS regression, with statistically insignificant effects on total exports or the intensive margin. We provide intuition for these findings with a simple model with heterogeneous firms and sticky prices, and use our model to discuss the implications of anticipation for subsequent export growth and trade elasticity measurement.

JEL codes: F1

Keywords: Exchange rates, heterogeneous firms, international trade

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1 Introduction

Firms often pay a large destination-specific sunk cost for exporting (Morales et al. 2019 and Alessandria et al. 2021). The decision of whether or not to break into a new export market should therefore be informed not only by current market conditions, but by the whole stream of (expected) profits that can be made from entry (Roberts and Tybout 1997 and Mix 2023). While expectations play a key role in much of the macroeconomic literature, its quantitative importance has rarely been examined in the trade literature. Li and Zhao (2016) and Fan et al. (2018) are two exceptions that empirically investigate the role for exchange rate futures for import price and import volume developments, while Alessandria and Mix (2021) explore the reaction of trade to trade policy expectations in a general equilibrium multi-country model. This paper contributes to the literature by addressing two questions: i) do exchange rate expectations matter for determining trade flows? and ii) do they equally affect average exported quantities (the intensive margin) and exporter entry (the extensive margin)? Delineating between these two margins of trade adjustment is important as they might work in opposite direction (Chaney, 2008).

Empirically, we rely on panel fixed effects regressions that leverage bilateral trade data at the HS2-product level (from the Exporter Dynamics Database (see Fernandes et al. 2016)) as well as oil supply news shocks (from Känzig 2021) as an instrument for forecasted exchange rates for a causal interpretation. For our measure of forecasted exchange rates, we use the median of daily one-year ahead currency forecasts from Bloomberg and average them across each year and currency pair.

We find that the impact of forecasted exchange rates on export adjustment is statistically and economically significant for the extensive margin. A one percent increase in the forecasted proportional difference from the spot exchange rate is associated with close to full pass-through (0.96 percent) to exporter entry when we instrument the forecasted exchange rates with oil supply news shocks. The magnitude is smaller in the OLS specification but the pattern is similar: an expected depreciation of the bilateral exchange rate relative to the spot exchange rate results in exporter entry. By contrast, the response of total exports to a forecasted change in the exchange rate is statistically insignificant, though the coefficient is positive.

We provide intuition for these empirical results in a stylized two-period trade model, where firms pay a random sunk cost to begin exporting and firm productivity grows stochastically with export tenure. In the model, as in the data, new exporters are on average less productive than incumbent exporters and contribute little to total exports. A forecasted depreciation raises the expected value of exporting, leading to substantial entry of new exporters. But, because these new exporters are relatively unproductive, the anticipatory response of total exports is muted. Nevertheless, early entry gives new exporters more time for productivity growth, and as a result, exports grow faster in subsequent years when the depreciation is anticipated relative to a surprise depreciation. We show that anticipatory effects on exports are larger in a model with sticky prices, as the expectation of a depreciation leads both entrants and incumbents to charge lower prices for exports, so the forecast affects both the extensive and intensive margin.

2 Overview of the data

The effect of exchange rates on trade prices and volumes tend to be small in empirical studies (Rodriguez-Lopez, 2011). The literature has investigated the nature of the reduced pass-through from spot exchange rates to export volumes, such as market power (Berman et al. 2012 and Amiti et al. 2014), participation in global value chains (De Soyres et al., 2021) and invoicing currency (Gopinath et al. 2020, Chen et al. 2022 and Frohm 2023). This paper adds to this literature by exploring the forward-looking decisions of firms as another important determinant for export adjustment. To this end, we assemble data for an unbalanced cross-country panel that combines spot exchange rates, 1-year ahead bilateral exchange rate forecasts and data on total exports, number of exporters and average export per firms for origin×HS2-product×destination×year observations.

2.1 Bloomberg Data

We collect spot and forecasted exchange rate data from Bloomberg. In particular, we measure exchange rate expectations by using daily professional forecasts for one-year-ahead exchange rates and we utilize the median forecast across analysts for each currency-pair. We then average these median forecasts for the full years. For each origin-destination-time, we define Forecast-ER$_{odt}$ as the proportional difference between forecasted and spot rates:

$$\text{Forecast-ER}_{odt} = 1 + \frac{\text{Fcast}_{odt} - \text{ER}_{odt}}{\text{ER}_{odt}} \tag{1}$$

Although the Bloomberg forecasts tend to be close to the spot counterparts on average (as evidenced by the mean of 1 in Table 1), there are significant variations where forecasted values are far from the spot values in many cases, as evidenced by the large standard deviation of the difference as well as a large difference between minimum and maximum observations. The mean absolute proportional deviation between spot and one-year-ahead forecasted exchange rate in our sample is 4 percentage points. For example, the average distance between the spot and the forecasted exchange rate between the Mexican Peso and the Japanese Yen is about 9.5 percentage points, and between the Thai Baht and the Ukrainian Hryvnia about 9 percentage points.

Table. 1. Forecast Deviation from Spot: Summary Statistics

	mean	std. dev.	min	max
Forecast-ER$_{odt}$	1.004	.047	.840	1.376

2.2 Exporter Dynamics Database

Examining the exchange rate impact on various export margins requires specific data. The World Bank's Exporter Dynamics Database (EDD) contains a number of structural characteristics and aggregate statistics regarding exporter behavior at the product and bilateral level. Importantly, the database decomposes total exports between two countries into an extensive and intensive margin, as in (3):

$$V_{osdt} = \underbrace{N_{osdt}}_{\text{Number of firms}} \times \underbrace{v^n_{osdt}}_{\text{Average export values per firm}} \tag{2}$$

where the number of exporters N_{odt} is the extensive margin and average export values per firm v^n_{odt} is the intensive margin.

The EDD is available at many levels of aggregation and covers a large number of exporting countries (mainly emerging market economies) and an even greater number of importers.[1] We use the version of the database that has observations for the combination of origin $\times$ HS2-product $\times$ destination $\times$ year. We use this version to obviate issues of reverse causality in our empirical exercise, i.e. that aggregate exports cause exchange rates to change. The data stretches over 1997–2014 and the panel is unbalanced.

The main variables of interest in this paper are bilateral total export volumes, the number of exporting firms and average exports per firm. Since the export values in the database are nominal, we use average unit export values, p^x_{osdt}, from the EDD to obtain total export volumes. This is done by first defining $x_{osdt} = v^n_{osdt}/p^x_{osdt}$ as real average exports per firm. Total export volumes is:

$$X_{osdt} = \underbrace{N_{osdt}}_{\text{Number of firms (EM)}} \times \underbrace{x_{osdt}}_{\text{Average export volume per firm (IM)}} . \tag{3}$$

We focus on non-commodities in the analysis, thereby excluding HS2-product codes below 28, as well as the HS2-codes 72-83 similar to Gopinath et al. (2020). Moreover, we winsorise the sample at the 95^{th} percentile to reduce the impact of outliers. As we use an oil supply news shock to claim causality we exclude sectors that have high use of oil in their energy use.

We use the Energy Accounts that accompany the World Input-Output Tables (Corsatea et al., 2019) to pinpoint sectors in the 10^{th} decile of oil products (fuel oil, gasoline and diesel) in total

[1] https://www.worldbank.org/en/research/brief/exporter-dynamics-database

energy use and match the Energy Accounts ISIC codes to HS2-codes, using the OECD's conversion tables.[2] Product codes that fall into this category are excluded to ensure that our instrument affects the forecasted exchange rates, but not export adjustment.[3] All in all, the dataset is an unbalanced panel with $\sim$ 90,000 observations. The final sample covers the 2006–2014 period and 11 exporting countries. The countries and their share in the number of observations (in parenthesis) are: Spain (21.4%), Norway (15.8%), South Africa (12.5%), Denmark (10.6%), Peru (8.0%), Romania (7.2%), Thailand (6.8%), Colombia (5.9%), Ecuador (5.2%), Mexico (4.6%) and Chile (2.1%).[4]

Table. 2. Variables used in the regressions

Variable	Description	Unit
X_{osdt}	Real exports	Values
N_{osdt}	Number of exporting firms (extensive margin)	Number
x_{osdt}	Average real exports per firm (intensive margin)	Values
Demand_{sdt}	Imports by sector-destination, excluding imports from the origin.	Values
ER_{odt}	Bilateral exchange rate	Currency units
Fcast.-ER_{odt}	One-year ahead forecast of the bilateral exchange rate	Currency units
RMSE-ER_{odt}	Uncertainty around the bilateral forecast, measured as the Root Mean Square Error (RMSE).	Currency units

3 Empirical strategy & results

We rely on panel fixed-effects regressions to examine the impact of spot exchange rates and forecasted exchange rates on export volumes, the intensive margin and the extensive margin. In all specifications, spot exchange rates or the exchange rate forecasts are expressed in currency units of the exporting economy. This means that an increase in ER_{od} or $Fcst - ER_{od}$ represents

[2] https://www.oecd.org/sti/ind/ConversionKeyBTDIxE4PUB.xlsx

[3] The products that fall in this category and are excluded are: 29 = Organic chemicals, 30 = Pharmaceutical products, 31 = Fertilisers, 40 = Rubber and articles thereof, 41 = Raw hides and skins (other than furskins) and leather, 43 = Furskins and artificial fur; manufactures thereof, 50 = Silk, 51 = Wool, fine or coarse animal hair; horsehair yarn and woven fabric, 52 = Cotton, 53 = Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn and 71 = Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin.

[4] The sample includes 64 destinations, covering the largest global trading partners across the world.

a depreciation of the exporting economy's currency relative to the importers' currency. First, we estimate the elasticities with OLS and second with an instrumental variable approach with the two-step least squares estimator (2SLS).

3.1 Using only spot exchange rates

We begin with the specification in (4) to investigate the role of bilateral spot exchange rates for total exports and the two margins, where Y_{osdt} is either X, N or x from (3). ER_{odt} is the bilateral exchange rate and Demand_{sdt} is gross imports of HS2-products in the destination (excluding imports from the origin) to control for importers demand conditions. All regressions utilize origin×HS2×product×destination fixed effects (FE_{osd}) to control for initial levels of trade and heterogeneity. We also include origin×HS2×product×year (FE_{ost}) fixed effects to control for any supply-side factors in the origin affecting firms export adjustment. Note that the inclusion of these time-fixed effects absorbs any exchange rates against "dominant" or "vehicle" currencies (see Gopinath et al. 2020, Chen et al. 2022 and Frohm 2023).

$$\log(Y_{osdt}) = \beta_{Spot}\log(\text{ER}_{odt}) + \alpha\log(\text{Demand}_{dst}) + FE_{osd} + FE_{ost} + \varepsilon_{osdt} \tag{4}$$

3.2 Including forecasted exchange rates

In our second specification (5), we include forecasted exchange rates, defined as the one year ahead proportional deviation from the *spot* exchange rate.

$$\log(Y_{osdt}) = \beta_{Spot}\log(\text{ER}_{odt}) + \beta_{Fcst}\log(\text{Fcst-ER}_{odt}) + \alpha\log(\text{Demand}_{dst}) + FE_{osd} + FE_{ost} + \varepsilon_{osdt} \tag{5}$$

Table (3) reports the results from estimating (4) in the first three columns. Focusing on the bilateral exchange rate (ER), the estimates suggest a very weak elasticity of exchange rates to export volumes that is statistically insignificant at conventional levels. However, the focus on total exports hides adjustment along the intensive and extensive margin. An exchange rate depreciation of one percent increases the extensive margin by 0.17 percent, that drives down average exports per firm (-0.15 percent) as entrants are smaller than incumbents.

Column 4–6 in Table 3 reports the estimate of (5) that adds the proportional difference of the forecast exchange rates to the spot exchange rate in the regression. The point estimates are now somewhat stronger for the spot exchange rate (ER), but more importantly, a *further* expected exchange rate (Fcst-ER) depreciation of one percent raises the extensive margin by an additional 0.36 percent, with a negative albeit statistically insignificant impact on the intensive margin. The demand control is significant across specifications and forms of export adjustment, although higher for the intensive margin than the extensive margin.

Table. 3. OLS estimates

	Total	IM	EM	Total	IM	EM
	(1)	(2)	(3)	(4)	(5)	(6)
Demand	0.341***	0.199***	0.138***	0.340***	0.200***	0.136***
	(0.035)	(0.028)	(0.013)	(0.035)	(0.028)	(0.013)
ER	-0.044	-0.221**	0.174***	-0.036	-0.230**	0.189***
	(0.106)	(0.094)	(0.039)	(0.105)	(0.093)	(0.036)
Fcst-ER				0.184	-0.214	0.370***
				(0.270)	(0.237)	(0.080)
R^2	0.885	0.823	0.975	0.885	0.823	0.975

Notes: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. Robust standard errors are clustered at the currency-pair level. All regressions include 93,255 observations and origin×HS2-product×destination and origin×HS2-product×year fixed effects.

3.3 Using oil supply shocks as instrument for forecasted exchange rates

In our third specification, to claim causality, we instrument the forecasted exchange rates with an "oil supply news shock" from Känzig (2021). He defines the oil market shock by first computing an "oil market surprise" based on 6m-ahead oil futures on days with OPEC announcements as in (6):

$$\text{Surprise}_{t,d} = F_{t+6,d} - F_{t+6,d-1} \tag{6}$$

The oil market surprise is then used as an external instrument in a standard oil market vector auto regression (VAR), that contains the real price of oil, world oil production, world oil inventories, world industrial production, US industrial production and the US consumer price index, to obtain an oil supply news shock (OSS).

The reason to use oil supply news shocks as an instrument for forecasted exchange rates is simple: a shock to the future oil supply should affect expectations of exchange rates, especially for countries with high shares of oil trade. We thus sum-up the monthly OSS values to an annual series (similar to Amberg et al. 2022) and interact the shock with the destination economies oil shares in total trade. The interactions ensure that oil supply news shocks of the same magnitudes are stronger for exchange rates in countries with greater oil trade exposure. Moreover, by interacting the oil supply news shock with the destinations country's oil trade shares we are able to preserve the origin×HS2-product×year fixed effects to control for supply conditions in the exporting economy. Our final instrument is defined as:

$$\text{IV}_{dt} = \text{OSS}_t \times \frac{\text{Oil trade}_{dt}}{\text{Trade}_{dt}}. \tag{7}$$

As will be clear below, this instrument is strong. Additionally, to ensure that the exclusion restriction is respected, we further restrict our sample. In particular, one concern could be that oil supply news shocks would directly affect trade of oil-related products. Since our sample excludes trade of oil (HS2 product category 27) for confidentiality reasons, this direct effect is not relevant here. As discussed in the previous section, some products are highly dependent on oil in their production and could be affected by oil supply shocks over and beyond the effect on exchange rate. To avoid this possible issue, we exclude product codes that fall into the 10^{th} decile of oil products (fuel oil, gasoline and diesel) in total energy use from the Energy Accounts that accompany the World Input-Output Tables (Corsatea et al., 2019). We are left with a sample of products whose export adjustment are unlikely to be directly affected by the oil supply news shocks, but where the oil supply news shocks affect the exchange rates.

Table 4 presents the results from estimating (5) with the 2SLS estimator and the oil supply market shock as an instrument for the forecasted exchange rates. The first stage shows that the instrument is strong (F-statistic of 28) and significant. The second stage confirms the important role for forecasted exchange rates for the extensive margin. A forecasted exchange rate depreciation of 1 percent from the current spot exchange rate leads to a point estimate close to 1 percent (0.96) increase in the extensive margin. With the point estimate very close to unity, these findings imply close to full pass-through of expected exchange rates on the extensive margin. The effect on total exports is positive and the intensive margin is also positive, although not statistically significant at conventional levels.

To gain some intuition for these empirical findings, we turn to a model to examine the dynamic export decision of firms when exchange rates are anticipated and unanticipated and when the future evolution of exchange rates are uncertain.

4 Model

We develop a partial equilibrium model with firms that make export decisions in each period conditional on the exchange rate e, prices p, and their own productivity a and previous export status s. Other factors such as wages, technology, and demand are assumed to be constant both across firms and across time. To export, firms must pay a fixed cost κ drawn from a distribution that depends on previous export status. The distribution for incumbent exporters $F_1(\kappa)$ is first-order stochastic dominated by the distribution for new exporters $F_0(\kappa)$, which ensures that incumbent exporters pay smaller fixed costs on average than new exporters. New exporters produce with productivity a_L and choose their price optimally. In each period that the firm continues

Table. 4. 2SLS estimates

	First stage	—— Second-stage ——		
	Fcst-ER	Total	IM	EM
IV	-0.016***			
	(0.003)			
Demand	0.007***	0.327***	0.192***	0.132***
	(0.003)	(0.034)	(0.028)	(0.013)
ER	-0.040	0.045	-0.181	0.215***
	(0.028)	(0.132)	(0.117)	(0.038)
Fcst-ER		2.161	0.961	1.012**
		(1.341)	(1.254)	(0.455)
F-Stat	29.300			
R^2		0.002	0.001	0.015

Notes: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. Robust standard errors are clustered at the currency-pair level. All regressions include 93,225 observations and origin×HS2-product×destination and origin×HS2-product×year fixed effects.

to export, there is some probability θ that they will be unable to change their price from the previous period. With probability $1 - \rho$, a firm with productivity a_L switches to productivity $a_H > a_L$. A firm with productivity a_H faces the same probability $1 - \rho$ of switching back to productivity a_L. The differences in fixed cost distributions and average productivities for new and incumbent exporters allow the model to match important features of exporter dynamics from the data, such as low churning rates and lower sales of new exporters compared to incumbent exporters (Ruhl and Willis, 2017; Mix, 2023). Furthermore, they help to explain how the extensive margin can respond quite strongly to an exchange rate forecast while the response in total exports is weak enough to be insignificant in the data.

Foreign demand for a firm's output is decreasing in the firm's price $q = p^{-\gamma}$. Each unit of production requires a units of labor. Prices are expressed in the buyer's currency. Thus, profits for an exporter with price p and productivity a facing exchange rate e can be expressed as:

$$\pi(p, a, e) = q(p)\,(pe - wa) = p^{-\gamma}\,(pe - wa)\,.$$

Firms in the model are infinitely lived and receive zero profits if they choose not to operate (export) in any given period. For all $t < 0$, we assume the exchange rate is fixed at $e = \bar{e}$. At $t = 0$, all firms receive an exchange rate forecast e_f. With probability ϕ, the forecast is correct and $e = e_f$ for all $t > 0$. With probability $1 - \phi$, the exchange rate stays at $\bar{e}$ forever. For all $t \neq 0$, firms anticipate that the exchange rate will be constant at its current value forever.

Consider the problem of a firm that can choose its price p and has productivity a and export status s under exchange rate regime e in some period $t \neq 0$ (in other words, where there is no uncertainty about the future exchange rate). The firm will export as long as the optimal value of exporting $V_1(a,e)$ minus their fixed cost draw $\kappa \sim F_s(\kappa)$ is greater than the value of not exporting $V_0(e)$. Then, as long as $V_1(a,e) > V_0(e)$, the firm exports when its fixed cost falls below the threshold:

$$\kappa(a,e) = V_1(a,e) - V_0(e).$$

Notice that the threshold does not depend on export status, but that the probability of drawing a fixed cost below that does. We can define similar values for firms that come into the period with a fixed price p, where $V_1(p,a,e)$ is the value of exporting given price p and $\kappa(p,a,e) = V_1(p,a,e) - V_0(e)$ is the relevant threshold.

Using the thresholds defined above, we can express the value of exporting for a firm that chooses its own price recursively as:

$$\begin{aligned}
V_1(a,e) = &\max_p \quad \pi(p,a,e) \\
&+ \beta\Bigg\{\theta \Bigg[\rho \left(F_1(\kappa'(p,a,e))V_1'(p,a,e) + (1 - F_1(\kappa'(p,a,e)))V_0'(e) - \int_0^{\kappa'(p,a,e)} \kappa dF_1(\kappa)\right) \\
&+(1-\rho) \left(F_1(\kappa'(p,a',e))V_1'(p,a',e) + (1 - F_1(\kappa'(p,a',e)))V_0'(e) - \int_0^{\kappa'(p,a',e)} \kappa dF_1(\kappa)\right)\Bigg] \\
&+ (1-\theta) \Bigg[\rho \left(F_1(\kappa'(a,e))V_1'(a,e) + (1 - F_1(\kappa'(a,e)))V_0'(e) - \int_0^{\kappa'(a,e)} \kappa dF_1(\kappa)\right) \\
&+(1-\rho) \left(F_1(\kappa'(a',e))V_1'(a',e) + (1 - F_1(\kappa'(a',e)))V_0'(e) - \int_0^{\kappa'(a',e)} \kappa dF_1(\kappa)\right)\Bigg] \Bigg\}
\end{aligned}$$

where β is the discount rate on future profits. Once again, the value of exporting for a firm with a fixed price is similar but with p as a state variable rather than a choice variable that the firm can use to optimize profits.

The firms optimal price maximizes lifetime profits, recognizing that their price might be stuck at its current level in future periods even if the firm's productivity changes. The optimal price $p(a,e)$ can be defined implicitly as a weighted average of the optimal static price under the two productivity levels:

$$p(a,e) = \frac{\gamma}{\gamma - 1} \frac{w}{e} \left(\frac{\frac{1}{a} + \eta(p,a',e)\frac{1}{a'}}{1 + \eta(p,a',e)} \right)$$

where

$$\eta(p,a',e) = \frac{\beta\theta(1-\rho)F_1(\kappa(p,a',e))}{1 - \beta\theta\rho F_1(\kappa(p,a',e))}.$$

Notice that if prices are perfectly flexible ($\theta = 0$), firms fully discount the future ($\beta = 0$), or the productivity state is absorbing ($\rho = 1$), then the optimal price reverts to the static optimal price as $\eta(\cdot) = 0$.

The value to the firm of staying out of the export market today is the same for all firms and can be expressed as:

$$V_0(e) = \beta \left[F_0(\kappa'(a_L, e))V_1'(a_L, e) + (1 - F_0(\kappa'(a_L, e)))V_0'(e) - \int_0^{\kappa'(a_L,e)} \kappa dF_0(\kappa) \right].$$

With these firm values in hand, we can solve for the stationary equilibrium exporting thresholds and prices for all $t \neq 0$. When the future exchange rate is certain, all high-productivity firms choose the same price p_H and all low-productivity firms choose the same price p_L. Thus, there are four possible productivity-price states in a stationary equilibrium with a constant exchange rate: firms can have a_L and p_L, a_L and p_H, a_H and p_H, a_H and p_L.

At $t = 0$, firms face a very similar problem to the above, except that the expected future value will include possible outcomes of the exchange rate in addition to possible outcomes of pricing and productivity. Solving for optimal prices chosen by firms and the exporting thresholds at $t = 0$ is thus similarly straightforward. Then, tracking the response of exporters and exports to the exchange rate forecast and subsequent change in the exchange rate is simply a matter of tracking the number of exporters in each productivity-price state across time.

For example, let $\bar{p}_a$ be the optimal price of a firm with productivity a in the $t < 0$ stationary equilibrium and let $N_{pa,t}$ be the number of exporters with price p and productivity a at time t. We normalize the number of potential exporters to 1. Then, for $t < 0$, the laws of motion for exporters are:

$$\begin{aligned}
N_{\bar{p}_H L,t} =& \theta F_1(\kappa(\bar{p}_H, a_L, \bar{e}))[\rho N_{\bar{p}_H L,t-1} + (1-\rho)N_{\bar{p}_H H,t-1}] \\
N_{\bar{p}_L H,t} =& \theta F_1(\kappa(\bar{p}_L, a_H, \bar{e}))[\rho N_{\bar{p}_L H,t-1} + (1-\rho)N_{\bar{p}_L L,t-1}] \\
N_{\bar{p}_H H,t} =& F_1(\kappa(\bar{p}_H, a_H, \bar{e})) \left[\rho(N_{\bar{p}_H H,t-1} + (1-\theta)N_{\bar{p}_L H,t-1}) + (1-\rho)(N_{\bar{p}_H L,t-1} + (1-\theta)N_{\bar{p}_L L,t-1})\right] \\
N_{\bar{p}_L L,t} =& F_1(\kappa(\bar{p}_L, a_L, \bar{e})) \left[\rho(N_{\bar{p}_L L,t-1} + (1-\theta)N_{\bar{p}_H L,t-1}) + (1-\rho)(N_{\bar{p}_L H,t-1} + (1-\theta)N_{\bar{p}_H H,t-1})\right] \\
& + F_0(\kappa(\bar{p}_L, a_L, \bar{e}))(1 - N_{t-1})
\end{aligned}$$

where the total number of exporters N_t is the sum of exporters across all exporter states in time t. Total exports can be expressed as:

$$Exports_t = N_{\bar{p}_H,t}\bar{p}_H^{-\gamma} + N_{\bar{p}_L,t}\bar{p}_L^{-\gamma}$$

where $N_{p,t} = N_{pL,t} + N_{pH,t}$.

Assume, without loss of generality, that $e_f > \bar{e}$, so the forecast is for a depreciation. At time $t = 0$, firms with productivity a that can choose their price choose a price $p_{0a} \leq \bar{p}_a$, with the inequality strict if $\theta > 0$. Then, firms can have any one of four possible prices (either one of the two optimal prices from the stationary equilibrium that they are stuck with or one of the two optimal prices that they choose that period) and two possible productivity states. We can construct similar laws of motion as above for firms with any combination of prices and productivity, and thus come up with a measure of exporters and, using the prices, total exports. We can also repeat these steps to solve for the number of exporters and exports in time $t > 0$ for either exchange rate $\bar{e}$ or e_f.

4.1 Quantification

To calibrate the model, we begin by setting the discount rate $\beta = 0.96$ and normalizing the constant wage $w = 1$ and low-state productivity $a_L = 1$. We assume that the distribution of fixed cost draws among previous exporters (non-exporters) is log-normal with mean μ_1 (μ_0) and standard deviation σ of the associated normal distribution.

Our empirical finding that total exports are not significantly affected by a forecast of a depreciation is consistent with either θ close to zero or θ close to one. With $\theta = 0$, firms can choose their price flexibly in each period and thus do not lower their price in expectation of a future depreciation. With $\theta = 1$, incumbent firms are stuck with their initial price chosen at entry, so exports of incumbents do not respond to a future depreciation even though firms would like to choose a lower price. Given that firms are presumed to change their price at least some of the time, our baseline model assigns $\theta = 0$. The point estimate for exports, however, is quite large, which is more consistent with positive θ, so we also consider a calibration with $\theta = 0.5$. These two calibrations have different implications for the measurement of trade elasticities, as we show in the next section.

Given a value for θ, we choose the values of μ_1, μ_0, a_H, and ρ to target four moments from the data related to export participation in the stationary equilibrium before the exchange rate forecast. The first two moments are from Mix (2023), who calculates the median share of total exports sold by entering or exiting exporters and the fraction of exporters that are entrants or exiters to be about 7 and 42 percent, respectively, among countries in the EDD. These two moments pin down the relative productivity of incumbent exporters (a_H and ρ) and the relative ease of exporting for incumbent exporters (μ_1 relative to μ_0). Similar to Mix (2023), we use Mexican export-level data retrieved from the EDD and find that the share of exports made by exporters in their first two years of tenure is about 2.4 times the initial share of entrant exporters alone. This finding gives us our third target, which helps to pin down how quickly new exporters become high-productivity exporters (ρ). Finally, we assume that export participation among domestic firms for the bilateral destination represented in the model is 10 percent, which pins down the average value of μ_0 and μ_1.

The four parameters that determine exporter behavior can be calibrated for any elasticity γ and standard deviation σ. Lacking conclusive estimates on the elasticity of substitution γ, we choose the standard value of 1.5. We then choose $\sigma = 3$ so that the long-run trade elasticity from a permanent 10 percent depreciation is about 6, which lies within the range of estimates from the literature. Finally, $\phi = 0.9$ is chosen to match the increase in exporters associated with a forecast of a 10 percent depreciation.

In summary, exporter fixed cost distributions and productivity transitions are calibrated to match facts about the exporter life-cycle. Given these targets, our choices of price stickiness θ and the weight firms put on the forecast ϕ allow the model to match the estimates from our empirical work. A table with the calibrated values for all parameters can be found in the appendix.

4.2 Implications for the trade elasticity

The forward-looking decisions of firms have important implications for measures of the short-run trade elasticity. In particular, firms that anticipate a change in the exchange rate adapt their export strategy before the actual movement. Since these changes are a consequence of the (expected) future exchange rate movement, it is important to take into account these anticipated movements when measuring trade elasticity. This argument is reminiscent of Khan and Khederlarian (2021) who show that predictable phaseouts of tariffs during the North American Free Trade Agreement led firms to decrease purchases before a scheduled tariff decrease and then increased them directly after, which amplified the estimated trade elasticity.

In our case, the forecast of a future depreciation in $t = 0$ shifts the fixed cost threshold to export to the right, leading more firms at the margin to continue or begin exporting in anticipation. If the depreciation occurs, even more firms begin exporting, while some of the entrants in $t = -1$ become high-productivity exporters. Thus, the elasticity of trade with respect to the exchange rate deprecation from $t = -1$ to $t = 0$ is higher than if the depreciation is a surprise.

To give further intuition, the top panels of Figure 1 shows the cumulative trade elasticities–calculated as the negative of the log change in real exports over the log change in the exchange rate–over time for the calibrations with $\theta = 0$ and $\theta = 0.5$. In a world with perfectly flexible prices, the anticipatory effect of the forecast on exports is quite small, accounting for only 3 percent of the total trade response. If firms can choose their price optimally in each period, then incumbent firms do not change their pricing behavior because of the forecast for a depreciation. So, the only increase in exports from $t = -1$ to $t = 0$ comes from a large influx of low-productivity entrants (see the bottom panel of the figure), all of whom export very little relative to the average exporter. After the depreciation, some of these entrants become high-productivity exporters and more low-productivity firms enter. Overall the growth in the number of exporters from $t = -1$ to $t = 0$ is 35 percent higher when the depreciation is anticipated relative to an unanticipated depreciation. Furthermore, incumbent exporters all lower their prices at $t = 0$. Together, these changes lead to a bigger jump in the trade elasticity than when the depreciation at $t = 0$ is a surprise. Overall, the cumulate trade elasticity in the anticipated case is about 0.4 points higher at $t = 0$ than in the surprise case. The long-run elasticity in the two cases is identical, as the new exchange rate yields the same stationary equilibrium in both models.

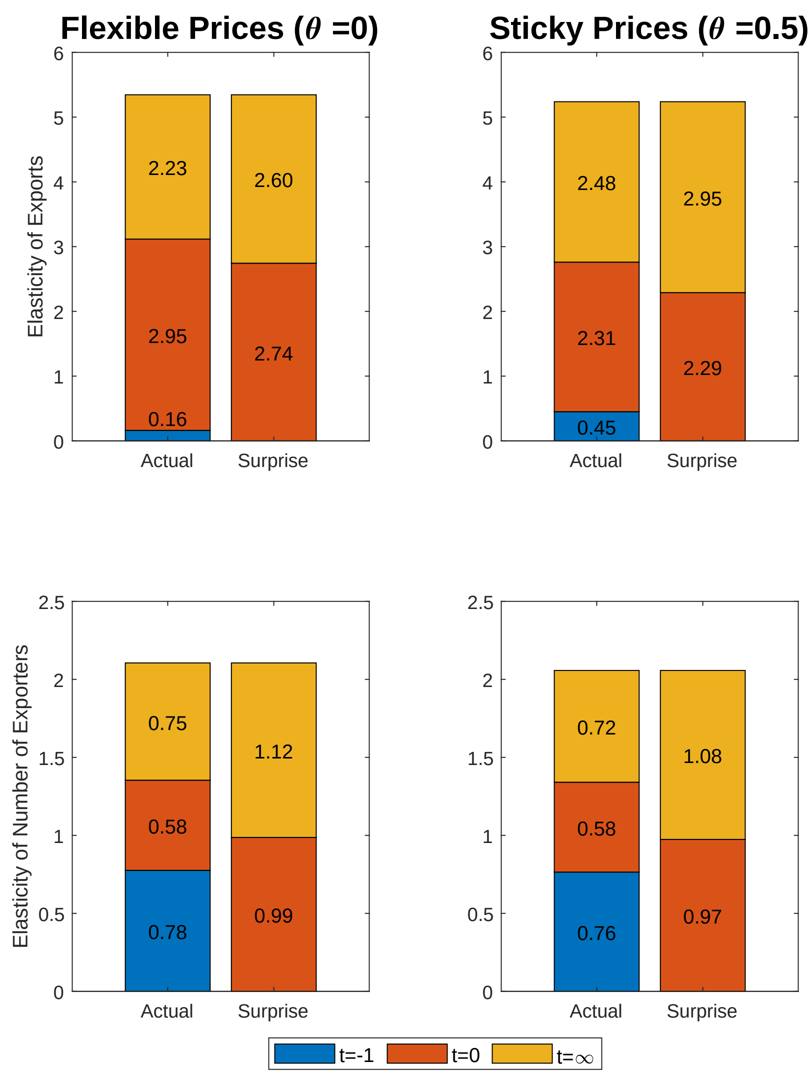
The anticipatory effects are much stronger when prices are sticky, accounting for 9 percent of the total trade response. As in the flexible price model, there is an influx of low-productivity entrants who contribute little to total exports. Indeed, the extensive margin elasticities are nearly identical to those in the flexible price model. But, sticky prices also changes the pricing behavior of incumbent firms in anticipation. Recognizing that they may not be able to change prices after the depreciation, firms that can choose their price in $t = -1$ maximize expected discounted profits by weighing the price-dependent profits of today and the future. The optimal price with a depreciated exchange rate is lower than the optimal price with $e = \bar{e}$, so the average price among incumbents falls in $t = -1$, which then implies that average exports among incumbents rise. All told, the trade elasticity in response to the forecast is nearly 0.5. When the depreciation hits in $t = 0$, incumbent firms adjust their prices downward again, though by less than in the flexible-price model given that some of the adjustment has already been made. Also, half the incumbent firms are unable to lower their prices in $t = 0$. All together, the cumulative trade elasticity in the anticipated case is 0.5 points higher at $t = 0$ than in the surprise case.

In summary, expected changes in the exchange rate have anticipatory effects for trade. When prices are flexible, these effects are small on impact but set up the export market to grow or shrink more quickly after exchange rates actually change because of movements in the extensive margin. When prices are sticky, the anticipatory effects are larger on impact as the expectation of a new exchange rate has effects on both the extensive and intensive margin of the export market. As a result, a correct measurement of the contemporaneous trade response to a change in the exchange rate relies heavily on the extent to which the the change was expected.

5 Concluding remarks

Using an instrumental variable and various fixed effects, we have shown that firms are forward-looking in their export decisions. When forecasts suggest a depreciation of the home currency in the next year, exporter entry increases with almost full pass-through. By contrast, the anticipatory effect of a forecasted depreciation on total exports is statistically insignificant. We reconciled these two facts from the data in a model where the decision to export depends on the entire path of expected exporting profits and new exporters are much less productive on average than incumbent exporters. Then, a forecasted depreciation increases exporter entry by increasing the value of exporting but has a much smaller effect on total exports as new exporters are relatively

Figure 1. Cumulative Trade Elasticity with Flexible and Sticky Prices



unproductive. If we assume prices are sticky, the anticipatory effects are larger, accounting for 10 percent of the long-run export response. As in the flexible price model, new firms enter the export market. In addition, incumbent firms lower their prices in anticipation of a lower future exchange rate, increasing exports in the intensive margin as well. In both the flexible and sticky price models, the short-run export response to an anticipated exchange rate depreciation is 14 percent higher than if the depreciation is unanticipated.

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