Exchange Rate Expectations and Aggregate Dynamics

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Abstract

The paper explores the role expectations play in the economy's response to exchange rate fluctuations. Using data from the Central Reserve Bank of Peru, I analyze firm-level exchange rate forecasts and find that firms deviate from rational expectations by overreacting to new information and overestimating the persistence of the current exchange rate. I also demonstrate that firms that anticipate depreciation are more likely to reduce employment and production. Based on these observations, I develop the behavioral general equilibrium model of a small open economy where the exchange rate is driven by a financial shock to the uncovered interest parity condition. Firms set their prices infrequently and associate expected depreciation with a higher future path of marginal costs. They overestimate the persistence of the shock and contract their economic activity more than under the rational expectations benchmark, potentially reversing the sign of the aggregate output response. If households and financial institutions share this bias, the impact of the shock becomes amplified, contributing to greater exchange rate volatility.

1 Introduction

The exchange rate is one of the most important prices in an open economy, and its fluctuations can have a significant impact on macroeconomic aggregates. The exchange rate influences various decisions made by economic agents, including firms' pricing, output, and investment choices, as well as households' consumption and saving decisions. Since these decisions are forward-looking, they are shaped not only by the current exchange rate but also by agents' beliefs about its future trajectory. In this paper, I address two questions: First, how do economic agents form their exchange rate expectations? Second, how do these expectations affect the transmission of aggregate shocks?

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To address the first question on expectation formation, I analyze firm-level survey data on exchange rate expectations and document two stylized facts. First, forecast errors on the exchange rate are large compared to other macroeconomic variables and can be predicted using the information available at the time of the forecast. Firms tend to excessively adjust their forecasts in response to news and anchor their expectations to the observed exchange rate. Second, firms associate depreciation with a contractionary economic environment. Firms that expect a high exchange rate are more likely to anticipate low output growth and high inflation. Furthermore, these firms report having contracted their own economic activity and intend to reduce it further in the near future.

Next, I examine the aggregate impact of exchange rate expectations. I integrate behavioral overreactive expectations into a general equilibrium model using a standard small open economy framework with segmented asset markets, nominal rigidities, and tradable and non-tradable sectors. To set prices, a firm must forecast future demand and costs, both of which are influenced by exchange rate fluctuations. The shock driving the exchange rate is a financial shock to the uncovered interest parity (UIP) condition, which depreciates the local currency by raising the effective interest rate on dollar assets for domestic agents. Economic agents misspecify the financial shock process and form behavioral expectations. Using survey data to discipline the degree of bias, I show that behavioral expectations, by increasing the perceived persistence of the shock, alter the aggregate output response to the financial shock. In general, the financial shock affects output through two channels that operate in opposite directions. The first channel is expenditure switching: depreciation makes domestic tradables more competitive relative to foreign goods, leading to an expansion in exports. The second channel is a fall in aggregate demand. In response to inflation, monetary authorities increase domestic interest rates, which suppresses consumption and causes a contraction in the non-tradable sector. Behavioral beliefs can affect the relative strength of the two channels. I show that the demand channel is more forward-looking, so overreactive bias makes the output response more contractionary and can even reverse the sign of the output response. Moreover, if households share the same bias as firms, behavioral expectations amplify exchange rate volatility. Then, the contraction becomes quantitatively important.

I study exchange rate expectations using the Monthly Survey of Macroeconomic Expectations conducted by the Central Reserve Bank of Peru, which has collected monthly forecasts from non-financial firms since 2009. In contrast to much of the existing literature on exchange rate expectations, which relies on small datasets of professional forecasters and financial institutions, the Survey allows the study of individual-level responses in a relatively large sample (200 to 300 responses per month). I find that exchange rate errors are large compared to forecast errors on output and inflation, even after accounting for the higher volatility of the realized exchange rate. Exchange rate errors are characterized by a sizable median error and high disagreement among the respondents, indicating that both the common component and heterogeneity in the beliefs play important roles.

Then, I show that firms' forecasts deviate from the rational expectations benchmark. Exchange rate forecast errors are predictable based on information available at the time of forecasting, indicating that firms do not use available information optimally. They revise their forecasts too strongly in response to the new information, which I show by documenting a systematic relation between the errors and forecast revisions. Additionally, the firms anchor their expectations to current conditions: a firm observing a high exchange rate at the time of the forecast is likely to predict excessive depreciation. While findings of overreactive expectations are prevalent in behavioral macroeconomics (see Kohlhas and Walther, 2018; Bordalo et al., 2020), this paper extends these insights to individual-level exchange rate forecasts. Furthermore, I investigate how exchange rate forecasts relate to expectations about aggregate economic conditions, as well as firms' anticipated and recent actions. Firms that expect greater depreciation than others in the same period are more likely to higher inflation along with lower GDP growth, demand, wages, and employment. These firms expect to reduce their production and employment over the next three months and report having already started to do so in the previous month. The result holds after controlling for output and inflation forecasts.

Motivated by these observations, I explore the impact of behavioral bias in exchange rate expectations on the transmission of aggregate shocks. I employ a small open economy model where firms set sticky prices, with exchange rate expectations shaping anticipated future production costs and demand for a firm's variety of goods. The primary driver of the exchange rate is the financial shock, proposed by Itskhoki and Mukhin (2021) as a potential solution to exchange rate disconnect puzzles — a set of stylized facts about exchange rate comovement with macroeconomic variables that standard international macro models struggle to explain. A financial shock acts as a wedge in the cost of dollar borrowing for domestic agents, requiring a depreciation to preserve the no-arbitrage condition between local currency and dollar-denominated bonds. The model is augmented with behavioral expectations. To capture the overreaction bias, I assume that the firms misspecify the financial shock process, expecting it to be overly persistent. Then, I study how behavioral expectations affect the transmission of aggregate shock, focusing on the response of aggregate output.

Under rational expectations, a positive financial shock that increases the cost of dollar borrowing has an ambiguous effect on aggregate output. On one hand, it causes depreciation, making domestic goods and factors of production cheaper in terms of international prices. Tradable firms expand exports, and households switch consumption from imports to domestic goods. On the other hand, the financial shock hurts domestic demand by raising both prices and the costs of borrowing. In this paper, I show that the relative strength of these two opposing channels depends on the perceived persistence of the financial shock. Both channels increase in shock persistence as firms excessively raise local-currency-denominated prices for the domestic market and excessively lower dollar-denominated export prices. However, the contractionary demand channel is more sensitive to firms' expectations. As the price-setting of overreactive firms amplifies inflation, monetary authorities increase the real interest rates. Then, forward-looking households expect higher borrowing costs and decrease their consumption. In contrast, the demand of the external sector doesn't respond to the choices of the small open economy exporters. Thus, in the behavioral economy, depreciations are more contractionary than in the rational expectations economy.

Additionally, overreacting beliefs amplify the economy's response to the financial shock. If economic agents expect the financial shock to be persistent, the future path of exchange rates is revised upward. Since the price of a currency depends on its future value, the exchange rate depreciates more compared to the rational expectations benchmark.

I calibrate the model by targeting key Peruvian macroeconomic variables determining the structure of the economy, such as trade openness and the share of employment in the service sector. I discipline both the true and perceived persistence of the financial shock using empirical estimates of the overreaction to current conditions and the expected persistence of the exchange rate. I validate the model by comparing the performance of behavioral and rational specifications against the unconditional moments — excess volatility of exchange rates and the negative correlation between real exchange rate and relative consumption (Backus-Smith puzzle). For forward-looking agents, expectations matter more than initial conditions; as a result, contemporaneous moments are shaped primarily by perceived shock persistence, with minimal influence from the true parameter. If the shock is believed to be temporary, the real variables respond weakly to exchange rate fluctuations, thereby exaggerating the excess volatility properties of financial shocks. Additionally, low expected persistence weakens the negative link between the real exchange rate and relative consumption. As long as rational and behavioral models share the perceived persistence (which, in the case of the rational model, is equal to the true parameter), they can account for the same unconditional contemporaneous moments. However, the two models differ in the persistence of the realized variables, with the empirical persistence of UIP deviations and the pace of exchange rate pass-though into consumer prices being more in line with the behavioral model. In addition, by construction, only the behavioral model can account for the facts documented using the Survey.

I demonstrate the model's consistency with the cross-sectional data by examining the response of small price-taking firms receiving news about the financial shock. The model replicates the patterns in firms' beliefs and actions documented in the Survey. Firms that expect a depreciation anticipate declines in output and spikes in inflation and are more likely to report a recent contraction in their economic activity. These results hold for tradable and non-tradable firms, though the effect is stronger in the non-tradable sector.

The variance in expectations generated by a domestic shock other than a financial shock results in patterns that do not align with the Survey evidence. Since the exchange rate is determined by the UIP condition and monetary policy targets inflation, depreciation occurs when both the interest rate and inflation fall. Firms anticipating low inflation are more likely to decrease their prices and expand. Therefore, when expected depreciation is driven by domestic shocks, such as total factor productivity (TFP) or demand shocks, the resulting link between firm's expectations and actions contradicts empirical evidence. The only exception is monetary policy shock, which does generate a contraction in firms' economic activity. However, in this case, the expected depreciation results from anticipated monetary easing and is accompanied by rising aggregate demand and output. In contrast, expectations driven by financial shock are consistent with contraction on both micro and macro levels.

Finally, I examine the aggregate dynamics of the economy in response to a financial shock using the calibrated quantitative model. The impact of expectations is strong enough to reverse the output response to depreciation: the rational expectations model predicts an expansion, while the behavioral model generates a recession. I extend the analysis to isolate the roles of firms' and households' expectations, showing that the contractionary effect of firms' behavioral expectations does not depend on a similar bias in household expectations. For the increase in the importance of the demand channel, households are only required to accurately anticipate the evolution of prices and the monetary policy response. However, the behavioral expectations of households are necessary for a recession to be quantitatively important since their expectations amplify exchange rate fluctuations by affecting the UIP condition. The bias on the side of both firms and households creates an economy with a volatile exchange rate and strong recessionary impact of depreciations.

Related literature. First, the paper contributes to the literature on exchange rate dynamics and its interaction with macroeconomic aggregates in the context of segmented asset markets (see Gabaix and Maggiori, 2015; Itskhoki and Mukhin, 2025; Fanelli and Straub, 2020). The model builds on Itskhoki and Mukhin (2021), an influential paper that proposes financial shocks as a solution to exchange rate disconnect puzzles. While preserving the key features of their model, I allow the expected persistence of the financial shock to differ from the true process, influencing its transmission to the economy and affecting the unconditional moments.

Beyond capturing comovement with macroeconomic aggregates, segmented financial market models are also used to identify the underlying drivers of exchange rate dynamics. Eichenbaum et al. (2017), Engel and Wu (2023), Kekre and Lenel (2024) and Bodenstein et al. (2024) estimate the share of exchange rate fluctuations that can be accounted for by financial shock. The answer to this question largely depends on the choice of key moments. While Eichenbaum et al. (2017) and Engel and Wu (2023) find financial shock to be the main driver of exchange rates, Kekre and Lenel (2024) and Bodenstein et al. (2024) attribute the key role to demand and trade rebalancing shocks, respectively. I contribute to this discussion by presenting survey evidence that shows economic agents' expectations align with financial shocks but not with other domestic shocks.

Additionally, I add to the ongoing debate on the output response to depreciation. Auclert et al. (2021) discuss the relative importance of expenditure switching and aggregate demand channels. However, unlike my model, where the strength of the aggregate demand channel depends on expectations, Auclert et al. (2021) argue that recessionary depreciations result from household heterogeneity combined with low trade elasticities. Fukui et al. (2023) explores the question by using a novel identification strategy for UIP shocks and interpreting the results within a financially-driven model with two separate financial shocks: expansionary and contractionary. In contrast, my paper examines the ambiguity of the output response to financial shock, as in Itskhoki and Mukhin (2021).

The implications of this paper are relevant to broader questions in international macroeconomics. The paper builds on the idea that exchange rate expectations play a crucial role in both firms' price-setting behavior and households' aggregate demand. Incorporating exchange rate expectations is an important consideration for the literature on the distributional effect of exchange rate fluctuations (e.g., Cravino and Levchenko, 2017; Guo et al., 2023; De Ferra et al., 2020) and the literature on exchange-rate pass-through (e.g. Amiti et al., 2014; Devereux and Engel, 2002; Burstein et al., 2007; Drenik and Perez, 2021; Amiti et al., 2019).

The empirical section of the paper builds on behavioral macroeconomics literature studying expectation formation. Such papers as Bordalo et al. (2018), Coibion and Gorodnichenko (2015), Bordalo et al. (2020), Kohlhas and Walther (2018) and Angeletos et al. (2021) document the behavioral bias using survey expectations of economic agents. Using a large sample of individual-level forecasts, I show that overreaction bias exists in expectations of exchange rates, a relatively understudied variable in this strand of literature. Since the data I use do not allow for establishing a causal relationship between exchange rate expectations and firm's actions, I motivate my model with the literature on firm's inflation expectations (see Coibion et al., 2018; Candia et al., 2022; Coibion et al., 2019; McClure et al., 2025). The key takeaways from these papers include the causal relationship between inflation expectations and a firm's actions, as well as the joint formation of output and inflation expectations.

Most papers on behavioral macroeconomics focus on the closed economy framework, and the implications of behavioral biases for international macroeconomics questions remain less explored. One notable exception is the interest in exchange rate expectations in the literature on international finance, with such examples as Froot and Frankel (1989), Gourinchas and Tornell (2004), Bacchetta and Van Wincoop (2021), Molavi et al. (2024) and Valente et al. (2021). This line of research suggests that, according to the UIP, the exchange rate can be viewed as the sum of expected interest rate differentials, and investigates whether distorted expectations of macroeconomic fundamentals can explain UIP deviations. Several recent papers have examined this issue in general equilibrium framework, studying how behavioral expectations can lead the real shocks to account for UIP-related puzzles (see Candian and De Leo, 2025; Müller et al., 2024; Na and Xie, 2022; Kolasa et al., 2025). Candian and De Leo (2025) is closely related to my paper as it introduces the overextrapolation of real shocks in the general equilibrium model and can account for the Backus-Smith correlation and, partially, the excess volatility of the exchange rate. My model differs from their framework by focusing not on real shocks that generate UIP deviations, but on how the UIP shock transmits to the macroeconomy in a model calibrated using firm-level exchange rate expectations.

Another distinction of my paper is the use of Peruvian data, which contrasts with the prevailing focus on advanced economies. Exchange rate expectations may play different roles depending on the context. Kalemli-Ozcan and Varela (2021) show that consensus exchange rate forecasts explain the UIP deviations in advanced economies but not in emerging markets. This observation motivates the focus of my paper on a mechanism through which firms' beliefs about exchange rates can shape the transmission of exchange rate fluctuations, highlighting the relevance of expectations beyond explaining the UIP deviations.

The rest of the paper is organized as follows. In Section 2, I introduce the Monthly Survey of Macroeconomic Expectations and present empirical findings on exchange expectations and their implications for a firm's actions. Section 3 outlines the modeling framework and provides a simplified analytical example to illustrate how behavioral expectations affect the transmission of financial shock. Section 4 calibrates the model and presents quantitative findings. Section 5 concludes.

2 Exchange Rate Forecasts of Firms: Survey Evidence

In this section, I present a novel dataset collected by the Central Reserve Bank of Peru. The dataset is unique in that it presents monthly firm-level expectations of the exchange rate for a large sample of firms, along with other macroeconomic expectations. I study the exchange rate forecasts and conclude that the errors are sizable and predictable with past information, indicating the presence of a behavioral bias. Moreover, by looking at a cross-section of firms' responses, I conclude that expected depreciation is related to the expectation of economic slowdown both on aggregate and firm levels.

2.1 Firm-level Exchange Rate Forecast

Survey Data. The Monthly Survey of Macroeconomic Expectations (Central Reserve Bank of Peru (nd)) is a dataset collected by the Central Reserve Bank of Peru at the end of each month from 2009 to 2022. The respondents belong to a wide range of sectors (manufacturing, services, construction, retail, and mining) and represent all three major regions of the country. 1736 firms participated in the Survey at least once, resulting in on average 322 observations per month. The median number of responses per firm is 13, and 95% of the dataset is accounted for by firms who participated at least 10 times. However, the

	Exchange Rate (Δe)	Output Growth (Δy)	Inflation (π)
Median absolute error	3.79	0.97	0.90
Mean relative error	0.66	0.39	0.61
Median consensus error	3.64	0.48	0.58
Median disagreement	0.57	0.21	0.42

Table 1: Summary Statistics

Notes: The table presents descriptive statistics on six-month ahead forecast errors for exchange rate depreciation, output growth, and inflation. The forecast error for variable x_t is the difference between the realization and forecast, $x_t - E_{t-6}x_t$. The relative error is the absolute error normalized by the standard deviation of the annual change in the underlying variable, $mean(|x_t - x_{it}|)/\sigma(x_t)$. Consensus error is the median error for time t. Disagreement for time t is defined as $\sigma(x_t - x_{it})/\sigma(x_t)$, and the table presents the median disagreement across time. The data on realizations is taken from the Central Reserve Bank of Peru.

limitation of this dataset is the anonymity of the respondents. While the dataset reports firms' forecaster IDs, it does not contain such information as sector, size, or exporter status. Additionally, the Survey publishes the consensus forecasts of financial firms and economic analysts. No individual-level responses are available for these respondents.

The Survey asks the respondents to make quantitative forecasts and supplement them with qualitative answers regarding the firm's performance and the expected evolution of the aggregate economy. The firms report their beliefs about the exchange rate, GDP growth, and inflation at the end of the current year. This survey design does not provide a constant forecast horizon. Instead, it presents monthly revisions of the forecast for the same date, making the dataset particularly informative for studying how a firm incorporates new information into its beliefs. The qualitative questions regarding the beliefs about the state of the economy inquire about expected aggregate demand, wages, and employment in 3 and 12 months (e.g., 'Do you expect demand to increase or decrease in the next three months?'). Additionally, the respondents report how their firm's production, employment, and sales evolved compared to the previous month and how they are expected to evolve in the next 3 and 12 months (e.g., 'Have you increased or decreased output of your firm compared to the previous month?'). There are three possible answers to qualitative questions: an increase, a decrease, or no change.

Summary statistics. Firms tend to make sizable errors while predicting the nominal exchange rate. The median absolute error for the two-quarter-ahead forecast is 3.79%, while the average annual change in exchange rate is 6.1%. Moreover, 8.8% of respondents have absolute error over 10%. Appendix A.1 shows the distribution of the absolute errors.

Among the key macroeconomic variables, the exchange rate is the hardest to predict. Figure 1 compares the performance of exchange rate forecasts with forecasts of output growth and inflation by presenting a time series of firms' beliefs versus the realized values. While all three variables exhibit significant dispersion of the forecasts, as shown by the wide 90% central range, the realized exchange rate often lies outside of that interval or extremely close to one of the bounds. In those cases, 90% of firms have the same sign of the forecast error, over- or under-predicting the exchange rate. Table 1 supports the claim that exchange rate error is larger than output growth and inflation errors in absolute terms and relative to the volatility of the underlying variable.

The larger magnitude of the error results from both systematic and idiosyncratic components of the exchange rate forecast error. While the consensus error (representing the

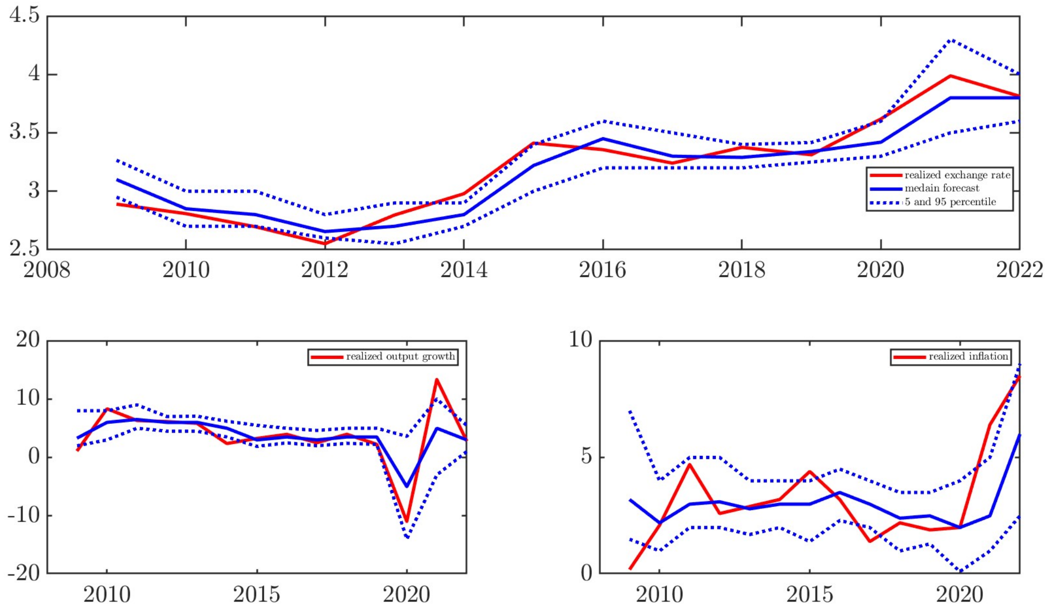

Figure 1: Realized and Forecasted Macroeconomic Variables

Notes: The figure illustrates the paths of realized (red) exchange rate at the end of the year, annual output growth, and inflation next to the 5-, 50- and 95-percentile of firms' six-month-ahead forecasts (blue) made in the end of June about the end of the year values. Appendix A.1 shows similar plots for other horizons. The data on realizations are taken from the Central Reserve Bank of Peru.

systematic error) may stem from the random-walk-like properties of the exchange rate, well-documented in the literature, it may also partially result from systematic deviation from rational expectations. High disagreement indicates substantial heterogeneity among firms and will be used to study how forecasts relate to their reported choices. Appendix A.1 demonstrates the descriptive statistics on forecast revisions. In contrast to errors, it shows similar properties of all three variables.

2.2 Systematic Deviations from Rational Expectations Hypothesis

This section shows that the systematic deviations of the firms' beliefs from the full-information rational expectations (FIRE) framework can account for a part of the exchange rate forecast error. The FIRE assumption implies that the agents use all the available information optimally, so their forecast errors cannot be predicted with the information published by the time of the forecast. However, I use the survey data to show that the exchange rate errors are systematically predictable.

First, I show that exchange rate errors are systematically related to publicly available information. Bordalo et al. (2018) (BGS) regression explores the relation between the forecast error and the current value of the variable:

$$e_{t+k} - \mathbb{E}_{i,t}e_{t+k} = \alpha_i + \beta_{BGS}e_t + \varepsilon_{it},$$

where $\mathbb{E}_{i,t}(\cdot)$ is the operator for forecast of firm i made at time t and e_t is the logarithm of

	(1)	(2)	(3)	(4)	(5)
β_{BGS}	-0.08	-0.15	-0.13	-0.10	-0.09
	(0.01)	(0.01)	(0.12)	(0.48)	(0.08)
β_{CG}	-0.32	-0.35	-0.34	-0.17	1.14
	(0.01)	(0.01)	(0.12)	(0.58)	(0.32)
	Panel	Panel	Panel by horizon	Individual	Aggregate
Fixed effect	No	Yes	Yes	No	No

Table 2: Predictable Errors

Notes: The table shows coefficients from BGS (forecast error on current exchange rate) and CG (forecast error on forecast revision) regressions. BGS regression uses the end-of-period nominal exchange rate from the Central Reserve Bank of Peru (interbank, average). Columns (1) and (2) show the coefficients from firm-level panel regressions with and without fixed effects. Column (3) shows the mean coefficients in fixed panel regressions with a fixed horizon of 1 to 11 months. Column (4) presents the mean coefficients of time series regressions for firms with more than 10 observations. Column (5) refers to the time series regression using consensus (median) forecast. The standard errors in Columns (1)-(3) are clustered by firms. Columns (3)-(4) show the standard deviation of the coefficients. For column (5), the standard errors are Newey-West. The time sample for BGS regression excludes years 2012 and 2021 due to high sensitivity, with details reported in Appendix A.2

the exchange rate. Under the rational expectations hypothesis, β_{BGS} must equal zero as the error is independent of the available information. In case $\beta_{BGS} < 0$, the agents are biased, and their beliefs exhibit the excessive persistence of current conditions. Depreciated current exchange rate e_t leads to the forecasted exchange rate $\mathbb{E}_{i,t}e_{t+k}$ being higher than the realized value as the agent anchors the forecast to the higher value. In other words, the data exhibit more mean reversion than expected. Similarly, underreaction ($\beta_{BGS} > 0$) would mean that a high value of e_t is associated with realized depreciation being higher than expected. Note that exchange rate data is publicly available, updated daily, and easily interpretable as the price of a dollar in terms of local currency. It is possibly the most widely-known macroeconomic variable for a small emerging economy. The survey responses are collected at the end of the month, so for my analysis, I use the end-of-month nominal exchange rate as the current value of e_t.

Second, I provide further evidence of overreaction bias with Coibion and Gorodnichenko (2015) (CG) regression. Instead of relying on publicly available information, it regresses forecast errors on forecast revisions — the change in the firm's expectations relative to the previous month, which should reflect any new information obtained during that time:

$$e_{t+k} - \mathbb{E}_{i,t}e_{t+k} = \alpha_i + \beta_{CG}(\mathbb{E}_{i,t}e_{t+k} - \mathbb{E}_{i,t-1}e_{t+k}) + \varepsilon_{it}.$$

Under rational expectations, the CG coefficient is zero, $\beta_{CG} = 0$, as any information received between $t-1$ and t is integrated optimally into the forecast at time t. The negative coefficient $\beta_{CG} < 0$ means overreaction to new information: as the agents learn the news indicative of expected depreciation, they revise their forecasts upwards too strongly, giving excessive weight to the latest information. Similarly, the reluctance to revise the forecast in response to the news would lead to the positive error and regression coefficient $\beta_{CG} > 0$.

Table 2 presents the evidence for error predictability. On the individual level (Columns (1) - (4)), the firms exhibit evidence of overreaction with both β_{BGS} and β_{CG} taking negative

	Expected (1)	**Expected (2)**	**Expected (3)**	**Realized**	$\beta_{\mathbf{BGS}}$
ρ^1_{Ee}	0.96	0.97	0.97	0.99	-0.03
	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)
ρ^2_{Ee}	0.99	1.00	0.98	0.97	-0.04
	(0.01)	(0.01)	(0.05)	(0.06)	(0.01)
ρ^3_{Ee}	1.01	1.02	1.03	0.95	-0.25
	(0.01)	(0.01)	(0.08)	(0.09)	(0.01)
	Panel	Panel	Aggregate	Aggregate	Panel
Fixed effect	No	Yes	No	No	Yes

Table 3: Expected and Realized Persistence of Exchange Rate

Notes: The table compares the empirical autoregression coefficients for the realized exchange rates and the expected persistence of the exchange rate estimated as the regression of forecast on the current observable value. I estimate the regressions on horizons from 1 to 12 months and report 3-month rolling window median for each quarterly estimate. Columns (1) and (2) present the results of panel regressions with and without fixed effects. Column (3) uses the consensus (median) forecast. Column (4) refers to the empirical estimate on related exchange rate data. I use end-of-month interbank exchange rates from the Central Reserve Bank of Peru for the period 2009–2022. The time sample for BGS regression excludes years 2012 and 2021 due to high sensitivity, with details reported in Appendix A.2. The standard errors are Newey-West.

values. The value $\beta_{BGS} = -0.15$ means that a 10% increase in the current exchange rate is associated with the end-of-year forecast exceeding the realized exchange rate by 1.5%. Similarly, $\beta_{CG} = -0.35$ indicates that a 10% upward revision of the forecast results in the end-of-year forecast overestimating the exchange rate by 3.5%. The consensus (median) forecast in Column (5) also shows the excessive persistence of the current conditions but underreacts to the news. While individual-level data on exchange rate forecasts is underexplored, these results are consistent with the studies of other macroeconomic and financial variables (see Bordalo et al. (2018), Bordalo et al. (2020)). The likely explanation of the negative β_{CG} for the consensus forecast is the individual-level overreaction combined with idiosyncratic noise (see Angeletos et al. (2021)). While Table 2 presents the estimates for the pooled horizon, Appendix A.2 estimates the BGS and CG regressions for varying horizons and shows they are robustly negative. It also demonstrates that the overreaction to current conditions is also present in the forecasts of financial firms and professional forecasters.

Table 3 compares the realized persistence of the nominal exchange rate with the expected persistence, ρ_{Ee}, estimated with the following panel regression:

$$\mathbb{E}_{i,t} e_{t+k} = \alpha_i + \rho^k_{Ee} e_t + \epsilon_{i,t}.$$

The overreaction bias appears as excessive persistence of the exchange rate. While the forecasts show non-stationarity, the realized values tend to revert to the mean. The difference is pronounced at the longer, three-quarters-ahead horizon, as the expected and realized trajectories of exchange rate diverge.

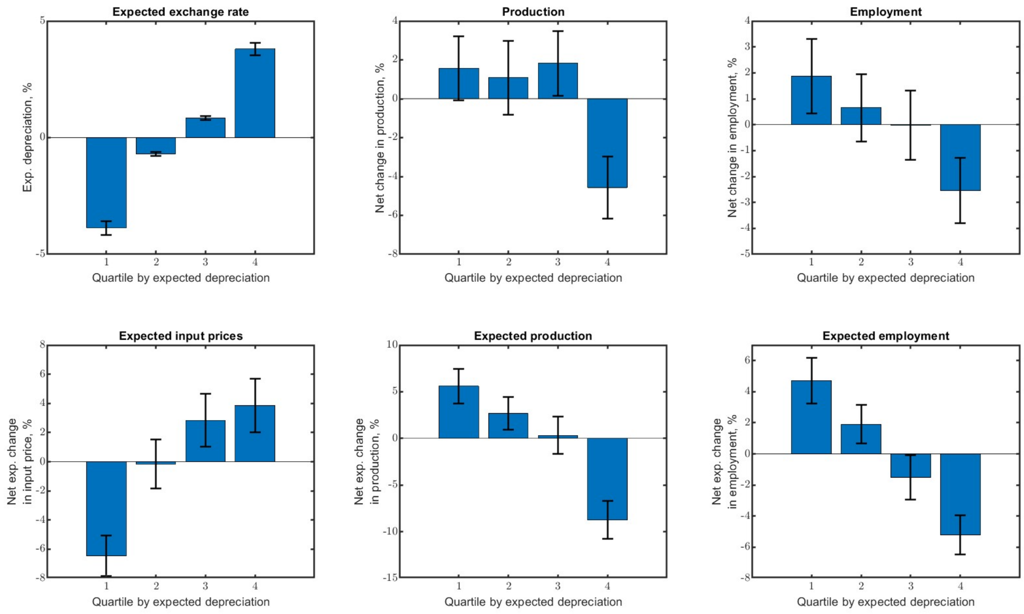

Figure 2: Recent and Expected Actions by Expected Depreciation

Notes: The Figure shows recent and expected actions of firms by expected depreciation quartiles. For every period t, exchange rate and action variables are residualized with respect to output and inflation forecast by running cross-section regressions. The observations are sorted into four quartiles by the expected exchange rate forecast, and the average is calculated for each quartile. The Figure reports the time series average. The responses for outcome variables can take values -1, 0, and 1, reflecting the direction of change. The net change of x% means that there are x% more firms reporting an increase in the variable than firms expecting a decrease. The 90% confidence intervals are estimated with a t-test.

2.3 Exchange Rate Forecasts, Beliefs about Economy and Firm's Actions

The following section explores the relationship between exchange rate forecasts and recent and intended actions of firms, as well as their beliefs about the economy. To do so, I exploit the heterogeneity in a firm's exchange rate forecasts. For each period, I divide the respondents into four quartiles by their expected exchange rate. Then, I report the average responses for each group, so that differences between quartiles reflect within-period heterogeneity and can be interpreted as deviations from the period mean. Both exchange rate forecasts and the outcome variables are residualized with respect to output growth and inflation forecasts. The responses on the exchange rate forecast are quantitative. Figure 2 shows that the first quartile of firms expects the annual depreciation to be approximately 8% lower than the fourth quartile. The outcome variables are qualitative, so the reported value represents the recent or expected net change, $\frac{I-D}{F} \cdot 100\%$, where I is the number of firms reporting an increase, D is the number of firms reporting a decrease, and F is the sample size. For example, the net change in employment of 2% means that the number of expanding firms exceeds the number of contracting firms by 2 percentage points.

Figure 2 shows that the firms expecting depreciation are more likely to report that their production and employment have decreased relative to the previous month. The difference

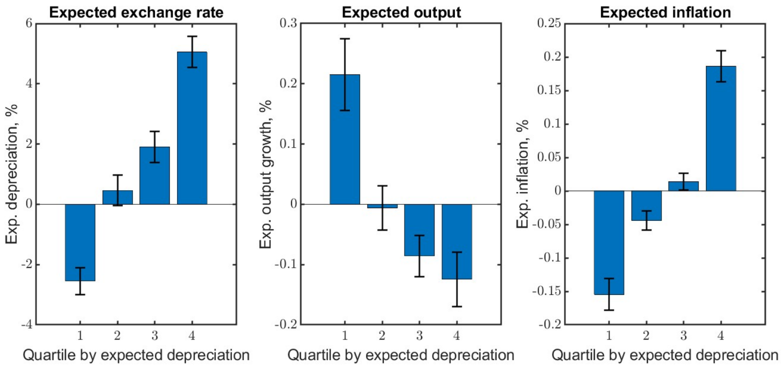

Figure 3: Expected Output and Inflation by Expected Depreciation

Notes: The Figure shows the inflation and output forecasts by expected depreciation quartiles. In each period t, observations are sorted into four groups based on the expected exchange rate. The forecasts are first averaged by quartile and then by time. The 90% confidence intervals are estimated with a t-test.

is the most pronounced for production, with the relative prevalence of expanding versus contracting firms being 6.1 percentage points higher in the first quartile (highest expected appreciation) than in the fourth quartile (highest expected depreciation). Moreover, the firms intend to continue contracting in the following three months, with the difference between the first and the fourth quartiles being 14.4 and 9.9 percentage points for expected production and employment, respectively. In addition, the firms associate depreciation with increasing input prices (10.3 percentage point difference). Appendix A.3 provides a short discussion of the validity of the data regarding actions, and Appendix A.4 shows robustness checks such as the non-residualized version of Figure 2 and control for fixed effects.

The heterogeneity in firms' exchange rate expectations is related not only to the firm's dynamics but also to the forecasts on the aggregate economy. Figure 3 shows that expected depreciation is associated with forecasting lower output growth and higher inflation. Figure 4 shows that exchange rate expectations are negatively related to expected aggregate demand, recruitment, and wages. In the fourth quartile, 11.8% more firms expect a fall in aggregate consumption compared to the first quartile. Appendix A.4 provides robustness checks.

To sum up, firms associate depreciation with declining economic activity both at the aggregate and individual levels. While these data do not allow for establishing that expectations cause firm-level slowdown, this interpretation is supported by the evidence from Candia et al. (2022), who conduct randomized trials to show that firms respond to the information about the future path of inflation by adjusting the expectations on other variables and, most importantly, by changing their employment and investment decisions. An alternative explanation not explored in this paper would rely on the pessimism of poorly performing firms that attribute their low productivity to misperceived aggregate conditions.

3 Model

In this section, I outline a general equilibrium model to study the implications of exchange rate expectations. First, I describe a small open economy New Keynesian model with segmented markets, where financial shock drives the exchange rate. Second, I introduce over-

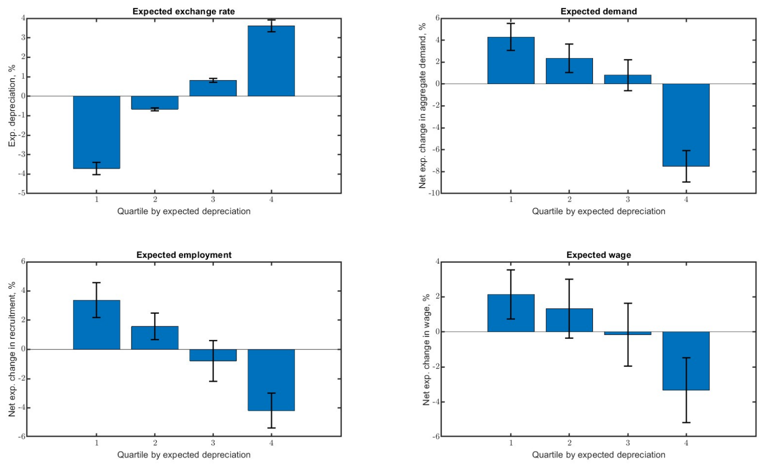

Figure 4: Beliefs on Aggregate Economy by Expected Depreciation

Notes: The Figure shows the beliefs on the evolution of the aggregate macroeconomic variables by expected depreciation quartiles. For every period t, both expected exchange rate and outcome variables are residualized with respect to output and inflation forecasts by running cross-section regressions. In each period t, observations are sorted into four groups based on the expected exchange rate. The mean outcomes by quartile are then averaged by time. The outcome variables can take values -1, 0, and 1 depending on the direction of change. Net change of x% means x% more firms reporting an increase in the variable than firms expecting a decrease. The 90% confidence intervals are estimated with a t-test.

reactive expectations. Finally, I simplify the model and solve it analytically to discuss how the expectations affect the macroeconomy.

3.1 Non-tradable Firms

The non-tradable sector is populated with monopolistically competitive firms owned by the households and maximizing the flow of their profit:

$$\mathbb{E}_t^f \sum_{k=0}^{\infty} \Theta^k \Pi_{NT,j,t+k},$$

where the operator $\mathbb{E}^f[\cdot]$ refers to the expectations of firms and Θ^t is the stochastic discount factor of the representative household.

A firm j has decreasing returns to scale and produce using labor $L_{NT,j,t}$ and imported inputs $M_{NT,j,t}$ with production function $Y_{NT,j,t} = A_{NT,t} L_{NT,j,t}^{\alpha} M_{NT,j,t}^{\alpha_M}$, where $A_{NT,t}$ refers to the sectoral productivity. The profit at time t is given by

$$\Pi_{NT,j,t} = P_{NT,j,t} Y_{NT,j,t} - W_t L_{NT,j,t} - \mathcal{E}_t P_{M,t}^* M_{NT,j,t},$$

where $P_{M,t}^*$ is the dollar price of imported inputs. The firm j faces CES demand for its variety of non-tradable goods, given by

$$Y_{NT,j,t} = \left(\frac{P_{NT,j,t}}{P_{NT,t}} \right)^{-\varepsilon} C_{NT,t},$$

where ε is the elasticity of substitution within the sector.

Given a price $p_{NT,j,t}$, the firm has to meet the demand for its variety of non-tradable goods. The static choice of a firm is the solution to the cost minimization problem,

$$\frac{M_{NT,j,t}}{L_{NT,j,t}} = \frac{\alpha_M}{\alpha}\frac{W_t}{\mathcal{E}_t P^*_{M,t}}.$$

The prices are sticky, and firms reset them according to the Calvo mechanism. With probability θ, the firm can't update the price for its variety at time t. Upon the opportunity to reset the price, the firm sets the optimal price according to

$$\bar{p}_{NT,j,t} = \mu + (1-\beta\theta)\mathbb{E}^f_t \sum_{k=0}^{\infty}(\beta\theta)^k(mc_{NT,j,t+k}),$$

where $\mu = \log(\frac{\varepsilon}{\varepsilon-1})$ is the steady-state markup, and $mc_{NT,j,t}$ is the log nominal marginal cost.

The marginal cost depends on the input prices W_t and $\mathcal{E}_t P^*_M$, sectoral productivity and the scale of production:

$$mc_{NT,t,j} = w_t(1-\alpha_M) + (1-\alpha-\alpha_M)l_{NT,j,t} - a_{NT,t} + \alpha_M(e_t + p^*_M).$$

Aggregating the result yields the forward-looking expression for non-tradable inflation $\pi_{NT,t}$:

$$\pi_{NT,t} = \lambda_a\left(mc_{NT,t} - p_{NT,t} + \mu\right) + \beta\mathbb{E}^f_t \pi_{NT,t+1},$$

where $mc_{NT,t} = w_t(1-\alpha_M)+(1-\alpha-\alpha_M)l_{NT,t} - a_{NT,t} + \alpha_M(e_t+p^*_M)$ becomes the aggregate nominal marginal cost and the parameter $\lambda_a = (1-\beta\theta)\frac{1-\theta}{\theta}\frac{\alpha+\alpha_M}{1+(1-\alpha-\alpha_M)(\varepsilon-1)}$ accounts for the decreasing returns to scale.

The exchange rate depreciation affects the cost of production directly due to the increasing relative price of imported inputs and indirectly through its impact on demand, nominal wage, and sectoral prices. The expected path of the exchange rate matters for price-setting decisions. As I show in the following sections, when the exchange rate is driven by financial shock, depreciation is associated with lower demand and higher nominal costs.

3.2 Tradable Firms

The problem of a tradable firm is identical to a non-tradable firm, except tradable firms produce both for domestic and international markets. Prices are set in local currency for the domestic market and in dollars for exports. Then, the profit of a tradable firm j becomes

$$\Pi_{T,j,t} = P_{HT,j,t}Y_{HT,j,t} + \mathcal{E}_t P^*_{X,j,t}X_{j,t} - W_t L_{T,j,t} - \mathcal{E}_t P^*_{M,t}M_{T,j,t},$$

where $P_{HT,j,t}$ and $Y_{HT,j,t}$ are price and sales of firm j on the domestic market, $X_{j,t}$ is the output exported by firm j, $P^*_{X,j,t}$ is its dollar-denominated price. The firm produces the output for both markets simultaneously, $Y_{H,T,j,t} + X_{j,t} = A_{T,t}L^{\alpha}_{T,j,t}M^{\alpha_M}_{T,j,t}$. The demand for variety j of tradable goods is given by

$$Y_{T,j,t} = \left(\frac{P_{HT,j,t}}{P_{HT,t}}\right)^{-\varepsilon} C_{H,T,t} + \left(\frac{P^*_{X,j,t}}{P_{X,t}}\right)^{-\varepsilon} X_t,$$

where I assume that the foreign household has the same demand and same elasticity of substitution ε as the domestic household, and X_t is aggregated according to the Dixit-Stiglitz function, $X_t = \left(\int_0^1 X_{j,t}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}}$. The demand for export from the Home country is CES

$$X_t = \left(\frac{P^*_{X,t}}{P^*_t}\right)^{-\eta} C^*,$$

where C^* and P^*_t refer to demand and price level in the rest of the world and are treated as parameters.

The paper assumes that dollar and local currency prices are sticky, and the firm resets them simultaneously. The only difference in price-setting is the denomination currency, with dollar marginal costs given by the following expression: $mc_{X,t} = (w_t - e_t)(1 - \alpha_M) + (1 - \alpha - \alpha_M)l_{T,j,t} - a_{T,t} + \alpha_M p^*_M$.

Due to the pricing-to-market assumption, the exchange rate has the opposite impact on demand and costs for exports and goods sold domestically. Depreciation makes exports more competitive compared to foreign goods by lowering the dollar cost of labor, which encourages firms to decrease the dollar price and expand exports. Dollar pricing is empirically relevant as a large share of international trade is priced in dollars. For instance, Gopinath (2015) show that for several Latin American economies, the share of exports invoiced in dollars exceeds 90%[1].

3.3 Households

The economy is inhabited by a representative household maximizing its lifetime utility

$$\mathbb{E}_t^{hh} \sum_{k=0}^{\infty} \beta^k u(C_{t+k}, N_{t+k}),$$

where C_t is the consumption of final good at period t, N_t is labor supply, parameter β is a discount factor and operator $\mathbb{E}_0^{hh}$ denotes the expectations of the representative household. The household has Greenwood–Hercowitz–Huffman (GHH) utility, $U_t(C_t, N_t) = \frac{1}{1-\sigma}\left(C_t - \varphi \frac{N_t^{1+\phi}}{1+\phi}\right)^{1-\sigma}$, where σ is a risk-aversion parameter, ϕ determines the Frisch elasticity of labor supply, and φ is a scale parameter.

The household receives labor income $W_t N_t$ and profits of tradable and non-tradable firms they own, $\Pi_{T,t}$ and $\Pi_{NT,t}$, as well as the profit of the financial sector $\Pi_{F,t}$. It consumes tradable and non-tradable goods ($C_{NT,t}$ and $C_{T,t}$) aggregated according to constant elasticity of substitution (CES) demand:

$$C_t = \left((1-a)^{\frac{1}{\eta}} C_{NT,t}^{\frac{\eta-1}{\eta}} + a^{\frac{1}{\eta}} C_{T,t}^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta-1}{\eta}},$$

where a is the share of tradable goods in consumption and η is the intersectoral elasticity of substitution. Tradable goods are similarly composed of domestic and imported goods, $C_{H,T,t}$ and $C_{F,t}$:

[1] In addition, it helps mitigate the excessive sensitivity of exports to exchange rate fluctuations. Under local currency pricing and price stickiness, the output of firms who cannot update price expands dramatically in response to depreciation.

$$C_{T,t} = \left((1-a^T)^{\frac{1}{\eta_F}} C_{HT,t}^{\frac{\eta_F - 1}{\eta_F}} + a^{T\frac{1}{\eta_F}} C_{F,t}^{\frac{\eta_F - 1}{\eta_F}} \right)^{\frac{\eta_F - 1}{\eta_F}},$$

where a_T is the measure of home bias and η_F is the elasticity of substitution between Home and Foreign tradable goods. $C_{NT,t}$, $C_{HT,t}$ and $C_{F,t}$ are composed of non-tradable, tradable, and imported varieties, aggregated following the Dixit-Stiglitz function:

$$C_{S,t} = \left(\int_0^1 C_{S,j,t}^{\frac{\varepsilon - 1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon - 1}},$$

where ε denotes the elasticity of substitution between varieties, and $S \in [NT, HT, F]$ denotes the type of good.

The household has access to incomplete financial markets and can trade non-state-contingent riskless bonds in both domestic and international markets. Domestic bond B_t earns interest rate R_t denominated in local currency. International bond B_t^* is denominated in dollars with effective interest rate $\tilde{R}_t^*$, which may differ from the foreign interest rate R^* due to the frictions in financial intermediation.

The budget constraint of a household is given by

$$P_t C_t + \mathcal{E}_t B_t^* + B_t = W_t N_t + \Pi_t + \frac{\mathcal{E}_t B_{t+1}^*}{\tilde{R}_t^*} + \frac{B_{t+1}}{R_t},$$

where $\mathcal{E}_t$ denotes the nominal exchange rate (an increase corresponds to the depreciation of local currency with respect to dollar), P_t is the consumer price index and $\Pi_t = \Pi_{NT,t} + \Pi_{T,t} + \Pi_{F,t}$ is the sum of profit from non-tradable and tradable firms, as well as from financial sector.

The solution to the static problem of the household is the labor supply function:

$$N_t^{\phi} = \varphi \frac{W_t}{P_t}.$$

Under GHH preferences, labor supply is determined by the real wage and is not affected by the household's wealth. This property makes this utility function a common assumption for the models exploring the impact of news and expectations (see Uribe and Schmitt-Grohé (2017); Jaimovich and Rebelo (2009)). In contrast, separable expectations permit a wealth effect: an anticipated negative productivity shock reduces expected income, increasing labor supply. A resulting expansion in economic activity is counterfactual.

Household demand for each type and variety of goods is characterized by the following equations:

$$C_{NT,t} = (1-a) \left(\frac{P_{NT,t}}{P_t} \right)^{-\eta} C_t, \quad C_{T,t} = a \left(\frac{P_{T,t}}{P_t} \right)^{-\eta} C_t,$$
$$C_{H,T,t} = (1-a^T) \left(\frac{P_{H,T,t}}{P_{T,t}} \right)^{-\eta_F} C_{T,t}, \quad C_{F,t} = a^T \left(\frac{P_{F,t}}{P_{T,t}} \right)^{-\eta_F} C_{T,t},$$

$$C_{S,j,t} = \left(\frac{P_{S,j,t}}{P_{S,t}}\right)^{-\varepsilon} C_{S,t}.$$

The solution to the intertemporal problem of the household is two Euler equations for international and domestic bonds. With $\Theta_t = \beta^{t-1}\frac{1}{P_t}\left(\frac{C_t - \varphi N_t^{1-\phi}}{(1-\phi)}\right)^{-\sigma}$ as the stochastic discount factor of the representative household, they are given by:

$$\frac{\Theta_t}{R_t} = \mathbb{E}_t^{hh}\Theta_{t+1},$$
$$\frac{\mathcal{E}_t\Theta_t}{\tilde{R}_t^*} = \mathbb{E}_t^{hh}\left(\mathcal{E}_{t+1}\Theta_{t+1}\right).$$

The exchange rate affects the static problem of the household by changing the relative prices: a depreciation makes imported goods expensive, so consumption switches to domestic goods. The expected exchange rate enters the Euler equation for international assets. Expected depreciation increases the return on dollar assets expressed in local currency and, therefore, stimulates saving and reduces consumption.

3.4 Financial Market

The financial block of the economy builds on Itskhoki and Mukhin (2021). Financial markets comprise two asset classes: local currency (LC) bonds and dollar-denominated bonds. They are traded by three groups of agents: households, noise traders, and financial intermediaries. LC assets cannot be traded internationally. Dollar bond demand is driven by the household and noise traders, neither of which has direct access to international financial markets. Financial intermediaries have to meet their demands while trading assets with the rest of the world.

Noise traders employ a zero-capital strategy so that their short position in dollar bonds is equal to their long position in LC bonds or vice versa. Their demand for dollar assets does not depend on macroeconomic fundamentals and can be viewed as motivated by liquidity needs. The dollar position of noise traders N_t^* is determined by exogenous process ψ_t:

$$\frac{N_t^*}{R^*} = n\left(e^{\psi_t} - 1\right),$$

where n is the measure of noise traders and R^* is the foreign interest rate, which is determined exogenously and assumed to be constant. Financial shock ψ_t is going to be the key driver of the model.

The measure m of arbitrageurs satisfies the demand of households and noise traders by engaging in carry trade with the rest of the world. However, the arbitrageurs are risk-averse and require a premium for exposing their balance sheet to exchange rate fluctuations. The arbitrageurs maximize CARA utility:

$$\max \mathbb{E}_t^{hh}\left(\frac{1}{\omega}\exp\left(-\omega\left[R^* - R_t\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}\right]\frac{d_{t+1}^*}{R^*}\right)\right),$$

where $\omega \geq 0$ is the measure of risk-aversion, and d_t^* is the dollar position of an individual intermediary. For simplicity, I assume that the arbitrageurs share the same expectations $\mathbb{E}_t^{hh}(\cdot)$ as the household.[2]

From market clearing in the financial market,

$$B_t^* + N_t^* = D_t^*,$$

where $D_t^* = md_t^*$ is the aggregate dollar position of the arbitrageurs. The profits of arbitrageurs and noise traders π_t^F are redistributed to the household as a lump-sum subsidy.

The reduced-form solution to the problem of the intermediary gives rise to the modified UIP condition:

$$r_t - r^* - \left(\mathbb{E}_t^{hh} e_{t+1} - e_t\right) = \psi_t + \psi_B B_t^*.$$

In a frictionless economy, the expected local currency return for international bonds equals the return on domestic bonds. The UIP equation becomes a no-arbitrage condition with the right-hand side equal to zero. However, in the presence of frictions, arbitrageurs require an excess return to absorb exchange rate risk. If the exogenous demand for dollar bonds by noise traders, ψ_t, increases, the arbitrageurs need to meet it by opening a short position in dollars and a long position on LC bonds. To compensate for currency risk, they require a higher return on domestic debt than on dollar debt and impose an additional premium when selling dollar assets. Since, in equilibrium, the household must be indifferent between the two types of assets, this premium, holding the domestic interest rate constant, implies that the local currency must appreciate in the future and depreciate today.

In this setting, intermediation between domestic households and the rest of the world is frictional, requiring households to pay an additional wedge when borrowing in dollars. The effective household interest rate $\tilde{r}_t^*$ depends on the financial shock:

$$\tilde{r}_t^* = r^* + \psi_t + \psi_B B_t^*.$$

Finally, note that the term $\psi_B B_t^*$, coming from the household's demand for dollar assets, is small. It serves to stabilize external debt and ensure the existence of equilibrium in a small open economy, as in Schmitt-Grohé and Uribe (2003).

3.5 Prices and Monetary Policy

The price indices for the three types of goods are

$$P_{S,t} = \left(\int_0^1 P_{S,j,t}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}.$$

The CPI price level and tradable price level are given by

$$P_t = \left[(1-a)P_{NT,t}^{1-\eta} + aP_{T,t}^{1-\eta}\right]^{\frac{1}{1-\eta}},$$
$$P_{T,t} = \left[(1-a^T)P_{HT,t}^{1-\eta_F} + a^T P_{FT,t}^{1-\eta_F}\right]^{\frac{1}{1-\eta_F}}.$$

[2] Since the solution for intermediaries is identical to the no-arbitrage condition for households, in the absence of this assumption, the financial market may not clear.

The real exchange rate (RER) is defined as $Q_t = \frac{\mathcal{E}_t P_t^*}{P_t}$, and an increase in Q_t denotes depreciation of the local currency. The international price P^* is assumed to be exogenous and constant. The imported goods are priced in dollars, and the law of one price holds, $P_{F,T,t} = \mathcal{E}_t P_F^*$.

The monetary policy follows an inflation-targeting regime, as is the case in Peru in the observed period. In particular, the monetary authority sets the nominal interest rate by the CPI-based Taylor rule:

$$r_t = \rho + \phi_\pi \pi_t,$$

where r_t is (log) nominal interest rate, π_t is CPI inflation, $\phi_\pi > 1$ is the parameter determining the tightness of monetary policy, and ρ is the steady-state level of the interest rate. The Foreign economy is not subject to shocks, so the analogous monetary rule results in $r^* = \rho$.

3.6 Market Clearing

In the goods market, consumption equals output for non-tradable and Home tradable goods, $C_{S,t} = Y_{S,t}$ for $S \in [NT, HT]$. The labor market clears, $L_t = N_t$. In addition, since domestic bonds are not traded internationally, their net supply equals zero, $B_t = 0$.

The country resource constraint is expressed in dollars and is derived from the household budget constraint and market clearing conditions in goods and financial markets:

$$P_{X,t}^* X_t + \frac{B_{t+1}^*}{R^*} = B_t^* + P_{F,t}^* C_{F,t} + P_{M,t}^* M_t.$$

The import includes both consumption goods and intermediate inputs. Note that international asset trade is conducted by financial arbitrageurs at the foreign interest rate R^*, rather than at the frictional rate $\tilde{R}^*$ faced by the domestic household.

3.7 Shocks and Beliefs

The key shock driving the economy is the financial shock to the dollar position of the noise traders. It follows an exogenous AR(1) process:

$$\psi_t = \rho_\psi \psi_{t-1} + \varepsilon_t^\psi, \quad \varepsilon_t^\psi \sim \mathcal{N}(0, \sigma_\psi),$$

where $\rho_\psi \in [0,1]$ and $\sigma_\psi \geq 0$ denote the persistence and volatility of the shock.

The households and firms don't know the true AR(1) process and mistakenly assume that the shock follows a process of persistence $\hat{\rho}^{hh}$ and $\hat{\rho}^f$, correspondingly. The agents don't learn the parameter ρ_ψ from observing the economy. Instead, they perceive their systematic errors as a part of financial shock innovation ε_t^ψ. As a positive innovation ϵ_t^ψ hits the economy, the agents overextrapolate it into the future and, compared to the rational benchmark, revise their forecast excessively, $\left(\mathbb{E}_t^i \psi_{t+1} - \mathbb{E}_{t-1}^i \psi_{t+1}\right) - \left(\mathbb{E}_t^{RE} \psi_{t+1} - \mathbb{E}_{t-1}^{RE} \psi_{t+1}\right) = (\hat{\rho} - \rho)(\varepsilon_t^\psi + \rho \psi_{t-1})$, where $i \in [hh, f]$ and $\mathbb{E}^{RE}(\cdot)$ denotes rational expectations. The systematic error for the financial wedge, defined as the difference between behavioral and rational expectations, increases in the current value of ψ_t as well as the gap between misspecified and true persistence: $(\psi_{t+1} - \mathbb{E}_t^i \psi_{t+1}) - \left(\psi_{t+1} - \mathbb{E}_t^{RE} \psi_{t+1}\right) = -(\hat{\rho} - \rho)\psi_t$. Both results are consistent with the empirical evidence of $\beta_{BGS} < 0$ and $\beta_{CG} < 0$. While the agents misspecify the process for financial shock and not for exchange rate directly, the financial wedge is the main driver of the exchange rate, so the exchange rate forecast shares these properties, as shown in the Appendix C.6.

The assumption of misspecified persistence of shocks is common in the literature on behavioral macroeconomics. Angeletos et al. (2021) employ it, in combination with idiosyncratic noise due to information rigidities, to reconcile the individual forecasts overreaction with both under- and overreaction in aggregate forecasts in terms of β_{CG} and β_{BGS}, respectively. Bordalo et al. (2018) propose an alternative way to model overreaction by introducing diagnostic expectations, where agents place excessive weight on recent information due to representativeness bias. Bordalo et al. (2020) show that this approach can also account for underreaction to news in aggregate forecasts; however, they don't simultaneously match the aggregate overreaction pattern. Although I don't introduce informational rigidities in this paper, I choose my approach to modeling overreaction such that it would preserve both individual-level $\beta_{CG} < 0$ and aggregate-level $\beta_{BGS} < 0$ under their addition.

3.8 Simplified Analytical Model

In this section, I discuss the intuition behind the impact of behavioral overreaction on aggregate dynamics. I impose several simplifying assumptions to allow for an analytical solution to the model and examine the effects of a financial shock on the economy. I demonstrate that behavioral expectations increase exchange rate volatility and, in the presence of nominal rigidities, may influence the sign of the output response to a financial shock.

Simplifying Assumptions. For this section, I assume that households and firms share the same beliefs about the persistence of financial shock, $\hat{\rho} = \hat{\rho}^{hh} = \hat{\rho}^{f}$, resulting in $\mathbb{E}_t^{hh}(\cdot) = \mathbb{E}_t^{f}(\cdot) = \mathbb{E}_t(\cdot)$.

Both tradable and non-tradable firms produce with one factor of production — labor. Non-tradable firms have a constant return to scale production function given by $Y_{NT,t} = AL_{NT,t}$. Expressed in deviations from the steady state, their price-setting condition becomes:

$$p_{NT,t} = (1-\beta\theta)\mathbb{E}_t \sum_{k=t}^{\infty} \beta^{k-t}\theta^{k-t} w_{t+k}. \tag{1}$$

Tradable firms are price-takers in international markets, so the price for exported goods is fixed in dollars. They don't produce for the domestic market and have a decreasing returns production function, $Y_{T,t} = AL_{T,t}^{\alpha}$. The problem of a tradable firm becomes

$$\max_{L_{T,t}} = \mathcal{E}_t P_F^* A L_{T,t}^{\alpha} - W_t L_{T,t},$$

with loglinearized solution $l_{T,t} = \frac{1}{1-\alpha}(e_t - w_t)$.

The household consumes non-tradables and imports only, and the demand for Home tradable goods is set to zero. Additionally, I impose several parameter restrictions on the elasticities of substitution and labor: $\eta = \sigma = 1$ and $\phi = 2$. With GHH preferences, labor supply equals real wage, $n_t = w_t - p_t$, giving rise to the labor market clearing condition:

$$w_t - p_t = a\frac{1}{1-\alpha}(e_t - w_t) + (1-a)(c_t - p_{NT,t} + p_t), \tag{2}$$

where a denotes the share of exports, $1-a$ is the share of non-tradables, and the non-tradable output is given by $y_{NT,t} = c_{NT,t} = c_t - p_{NT,t} + p_t$.

The modified UIP condition is simplified by omitting the household asset demand term $\psi_B B$, and the Euler equation for international assets becomes

$$\mathbb{E}_t(c_{t+1} + p_{t+1}) = c_t + p_t + r^* + \psi_t - e_t + \mathbb{E}_t e_{t+1}, \tag{3}$$

while the modified UIP condition is

$$r_t = r^* + \psi_t - e_t + \mathbb{E}_t e_{t+1}. \tag{4}$$

I close the model by introducing the country resource constraint, stating that the discounted sum of net exports must equal zero:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\alpha}{1-\alpha}(e_{t+k} - w_{t+k}) - a(c_{t+k} - e_{t+k} + p_{t+k}) \right) = 0, \tag{5}$$

with the last term denoting the demand for imports, $c_{F,t} = c_t - e_t + p_t$.

The monetary policy rule remains unchanged,

$$r_t = \rho + \phi_\pi \pi_t. \tag{6}$$

Financial Shock and Exchange Rate. To show how expectations affect the current exchange rate, I substitute the modified UIP equation (4) forward:

$$e_t = \mathbb{E}_t \sum_{k=0}^{\infty} \psi_{t+k} - \mathbb{E}_t \sum_{k=0}^{\infty} (r_{t+k} - r^*) + \bar{e} = \mathbb{E}_t \sum_{k=0}^{\infty} \psi_{t+k} - \mathbb{E}_t \sum_{k=0}^{\infty} \phi_\pi \pi_{t+k} + \bar{e} = \frac{\psi_t}{1-\hat{\rho}} - (\phi_\pi - 1)\,\bar{p},$$

where I impose $p_{t-1} = 0$, denote the expected long-run nominal level of exchange rate and prices as $\bar{e}$ and $\bar{p}$ correspondingly, and assume that in the long run, the real variables return to the steady state, so $\bar{e} - \bar{p} = 0$.

Overextrapolating expectations with $\hat{\rho} > \rho$ amplifies the impact of the financial shock and, other things being equal, requires a stronger depreciation of the exchange rate. To offset the financial wedge and equalize the expected returns on international and domestic assets, the real exchange rate must depreciate on impact and gradually return to its steady state. A more persistent financial shock requires a longer period of expected appreciation, thus leading to a stronger immediate depreciation. While in this section, I assume that firms and households have identical expectations, it's worth noting that the amplification originates in the UIP condition, so the bias refers to the expectations of households and the financial sector.

The second term on the right-hand side denotes the expected path of the domestic interest rate or, using the Taylor rule, inflation. If this term increases, the no-arbitrage condition is partially restored by a higher domestic interest rate instead of the expected appreciation, so the response of the current exchange rate is dampened. As I will show in the next section, the overextrapolative expectations $\hat{\rho} > \rho$ can lead to a stronger response of prices and, therefore, interest rates.

Financial Shock and Prices. For tractability, I impose the additional assumption that non-tradable firms reset their prices only at time $t = 0$ when the economy is hit by the shock, keeping prices constant thereafter; that is, $\theta = 0$ at impact t and $\theta = 1$ for $k > t$. In that case, we can see that p_{NT} is forward-looking and increasing in the path of the exchange rate:

$$p_{NT} = (1-\beta)\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k w_{t+k} = \frac{(1-\beta)}{a}\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left(w_{t+k}^r + a e_{t+k}\right),$$

where $w_t^r = w_t - p_t$ denotes real wage, and the price index can be written as $p_t = ae_t + (1-a)p_{NT}$.

The impact of the real exchange rate on the real wage is ambiguous. The labor demand from the export sector increases as depreciation makes Home goods more competitive on the international market; however, the labor demand from the non-tradable sector decreases due to the fall in aggregate consumption.

However, when the monetary policy is not overly strict, $\phi_\pi < \frac{a+\frac{\alpha}{1-\alpha}}{\beta a^2}$, the depreciation offsets a potential decrease in the real wage. Using the country resource constraint (5) to express the discounted sum of nominal wages, p_{NT} can be written as a function of the financial shock ψ:

$$p_{NT} = \frac{\psi_t}{(1-\hat{\rho})(1-\beta\hat{\rho})} \frac{(a+\Lambda)}{\phi_\pi \Lambda},$$

where $\Lambda = \frac{\alpha}{1-\alpha}\frac{1}{1-\beta\phi_\pi a}$ (see the derivation in Appendix B.1). Then, if the monetary policy is not too aggressive[3], the financial shock causes an increase in the prices of non-tradables.

Moreover, the price of non-tradables is highly sensitive to the parameter $\hat{\rho}$. It enters the expression twice: first, as an amplification of the current exchange rate coming from the modified UIP expression and generated by the beliefs of households and the financial sector; second, as the result of the expected path of the exchange rate, raising the discounted sum of nominal marginal costs driven by firms' expectations.

Financial Shock and Aggregate Demand. To discuss the impact of financial shock on domestic demand, I substitute forward the international Euler equation:

$$c_t = -\frac{\psi_t}{1-\hat{\rho}} + e_t - p_t.$$

In the absence of financial frictions, consumption comoves with the real exchange rate: a real depreciation means that Home goods become cheap in terms of dollars, and households borrow internationally to consume at lower prices. However, financial shock disrupts the risk-sharing channel and dampens consumption due to increasing borrowing costs.

Using the expressions for c_t and e_t derived above, I write the aggregate demand for non-tradable goods as

$$c_{NT,t} = c_t - p_{NT,t} + p_t = -p_{NT,t} + \bar{p} - \mathbb{E}_t \sum_{k=0}^{\infty} r_{t+k} = -p_{NT,t} - (\phi_\pi - 1)\bar{p} = -\phi_\pi p_{NT}.$$

The demand for non-tradables decreases in their current nominal price as well as in the long-run price level or, equivalently, the expected path of interest rates. The financial shock raises the prices, triggering a contractionary monetary policy response and suppressing domestic demand. Notice that while the expected path of interest rates refers to household expectations, the firms' expectations also matter by influencing price-setting behavior given

[3] Aggressive monetary policy aims to stabilize CPI inflation p_t, and to offset imported inflation, must lead to deflation in the non-tradable sector, achieved through a sharp suppression of domestic demand with high interest rates.

the current state of the economy.

Finally, the aggregate consumption is given by

$$c_t = -\underbrace{a\psi_t/(1-\hat{\rho})}_{\text{imports}} - \underbrace{(1-a)\left[p_{NT,t} + (\phi_\pi - 1)\bar{p}\right]}_{\text{non-tradables}},$$

where imports decrease in financial shock due to both depreciation and fall in aggregate demand, $c_{F,t} = c_t - e_t + p_t = -\psi_t/(1-\hat{\rho})$.

Financial Shock and Output. The financial shock can affect output through two opposing channels:

$$y_t = \underbrace{a\alpha(1-a)/(1-\alpha+a)\cdot\psi_t/(1-\hat{\rho})}_{\text{expenditure switching}} - \underbrace{(1-a)\phi_\pi p_{NT}}_{\text{domestic demand}}.$$

The first term shows that output is increasing due to the expenditure switching[4]: depreciation makes domestic goods more competitive compared to foreign goods. The second term, however, reflects lower demand for non-tradables.

In terms of the shock, the output can be expressed as

$$y_t = (1-a)\frac{\psi_t}{1-\hat{\rho}}\left(\underbrace{\frac{a\alpha}{1-\alpha+a}}_{\text{static}} - \underbrace{\frac{1}{(1-\beta\hat{\rho})}\frac{a+\Lambda}{\Lambda}}_{\text{forward-looking}}\right).$$

The parameter $\hat{\rho}$ enters this expression twice. First, coming from the modified UIP condition, it appears in the term before the bracket, amplifying the change in output due to stronger depreciation. Second, it determines the sign of the response by affecting the relative importance of the two channels. Since aggregate demand for non-tradable goods depends on the expected path of forward-looking prices, while tradable goods production is static and relies only on current variables[5], the aggregate demand channel is more forward-looking and more sensitive to changes in the perceived persistence of financial shocks. Therefore, a model with behavioral overreaction, $\hat{\rho} > \rho$ becomes more likely to contract in response to the depreciation induced by the financial shock.

4 Quantitative Analysis

The section presents the main results of the paper. First, I calibrate the model and evaluate its performance by comparing it to unconditional macroeconomic moments. Second, I show that expectations driven by financial shock are consistent with cross-sectional empirical evidence from the Survey, unlike those driven by other domestic shocks. Third, I explain how behavioral bias affects the economy's response to a financial shock by amplifying exchange rate fluctuations and generating contractionary depreciation. Finally, I discuss the roles of

[4]The first term denotes the expansion in export. The second term contains expenditure switching from imports to non-tradables; however, it is fully offset by the fall in demand.

[5]In the full model, exporters set forward-looking dollar prices. However, there is no feedback loop from price-setting to external demand, and an increase in export prices is not amplified by the response in monetary policy and decline in foreign consumption.

Notation	Parameter	Value	Source
σ	Risk-aversion coefficient	2	Itskhoki and Mukhin (2021)
$1/\phi$	Frisch labor supply elasticity	1	Itskhoki and Mukhin (2021)
η	Sectoral elasticity of substitution	0.5	Uribe and Schmitt-Grohé (2017)
η_F	Elasticity of substitution by country of origin	1.5	Feenstra et al. (2018)
ε	Within sector elasticity of substitution	6	Galí and Monacelli (2005)
$1-(\alpha+\alpha_M)$	Decreasing returns to scale	0.1	Jaimovich and Rebelo (2009)
θ	Calvo probability of price adjustment	0.75	Galí (2015)
ψ_π	Monetary policy coefficient	1.5	Galí (2015)

Table 4: Standard Parameter Values

the expectations of firms and households in shaping that response.

4.1 Calibration

A subset of the calibrated parameters matches empirical moments estimated from Peruvian data, while others are chosen based on conventional values in the international macro literature.

This paper follows Itskhoki and Mukhin (2021) in using conventional values for risk-aversion coefficient $\sigma = 2$ and Frisch labor supply elasticity $1/\psi = 1$. For the elasticity of substitution between tradable and non-tradable sectors, I use the standard parameter from Uribe and Schmitt-Grohé (2017) of $\eta = 0.5$. The elasticity of substitution between Home and Foreign tradable goods $\eta_F = 1.5$ follows the estimates by Feenstra et al. (2018). Within-sector elasticity between varieties $\varepsilon = 6$ comes from Galí and Monacelli (2005). The decreasing return to scale is $1 - \alpha - \alpha_M = 0.1$ as in Jaimovich and Rebelo (2009). The measure of price stickiness $\theta = 0.75$ is standard for New Keynesian models (see Galí (2015)) and imposes that the prices are reset on average once a year. Finally, the monetary policy coefficient ϕ_π is set to 1.5, also following Galí (2015). The non-targeted parameters are summarized in Table 4.

Table 5 lists the parameters calibrated by targeting the empirical moments. The values of $a = 0.3$ and $a_F = 0.7$ are chosen to match the share of employment in the service sector (55.7%) and trade openness (50%), respectively, both calculated as averages for 2009–2022 using annual data from the World Bank. The external demand parameter $C_F = 0.022$ targets the PPP exchange rate. Those parameters help to capture the relative importance of the sectors for the aggregate dynamics, since tradable and non-tradable firms have different degrees of exposure to the exchange rate. Under the standard assumption of $\rho = 1/\beta - 1$, the quarterly discount factor $\beta = 0.992$ is chosen to target the annual interest rate, estimated as the average reference interest rate according to data from the Central Reserve Bank of Peru. The GHH preference constant $\phi_l = 0.25$ suggests that the household spends 20% of time on labor as in Schmitt-Grohé and Uribe (2012). Finally, the production function parameter $\alpha_M = 0.15$ matches the share of imported inputs to the labor expenditure. For the empirical counterpart, I use the estimates of Gopinath and Neiman (2014), who gather the data from OECD input-output tables for Argentina. In the steady state, international debt $\bar{B}$ is set to zero, ensuring balanced trade. I normalize the price level in the rest of the world, P_F^*, and the dollar price of imported inputs, P_M^*, to 1. The value of $\psi_B = 0.1$ targets

Parameter	Value	Target	Data	Model
β	0.992	Annual interest rate	3.24%	3.27%
φ	0.25	Time spent on labor	0.20	0.22
a	0.3	Employment share in service sector	55.7%	53.9%
a_F	0.7	Trade openness	50%	52%
C_F	0.022	PPP exchange rate	1.77	1.70
α_M	0.15	Imported inputs expenditure relative to labor expenditure	18%	17%
ψ_B	0.1	Persistence of external position	0.98	0.99
$\hat{\rho}_\psi$	0.94	Expected persistence of exchange rate, 3 q. ahead	1.02	1.02
ρ_ψ	0.78	Overreaction to current conditions	-0.03	-0.03

Table 5: Targeted Moments

Notes: The table presents the calibrated model parameters. The target moments are calculated as averages for 2009–2022 using data from the Central Reserve Bank of Peru and the World Bank. The share of imported inputs expenditure is taken from Gopinath and Neiman (2014) and time spend on labor is from Schmitt-Grohé and Uribe (2012). I estimate the expected persistence of the exchange rate and overreaction to current conditions on survey data as panel regressions with fixed effects. The model estimates are the median across 100 simulations of the model. The simulation covers 1,200 periods, with the first 200 omitted.

the empirical persistence of the external debt-to-GDP ratio reported by the Central Reserve Bank of Peru.

The bottom part of Table 5 assigns the values to the true and perceived persistence of financial shock, $\rho_\psi = 0.78$ and $\rho_\psi = 0.94$. They are chosen to match the moments estimated on the survey data: the one-quarter-ahead overreaction coefficient β_{BGS} and the expected three-quarter-ahead persistence of exchange rate ρ_{Ee}. The volatility of financial shock innovation is normalized to 1.

Figure 5 provides more detail on the joint identification of $\hat{\rho}_\psi$ and ρ_ψ. First, the expected persistence of the exchange rate is increasing monotonically in the parameter $\hat{\rho}_\psi$ for different values of the true shock persistence ρ_ψ. The lower ρ_ψ results in a steeper slope. When the true shock process is persistent, backward-looking variables (e.g., prices, external debt) deviate further from the steady state and can play a larger role in determining the equilibrium. Low ρ_ψ is required to generate the expected persistence of exchange rate slightly above one, as in the data. Second, the overreaction coefficient β_{BGS} depends on the gap between the true and behavioral parameter and is negative for $\hat{\rho}_\psi > \rho_\psi$. With the behavioral parameter fixed at $\hat{\rho}_\psi = 0.94$, the coefficient is increasing with ρ_ψ.

The model is solved at first order, with control variables evolving according to high-persistence laws of motion and the shocks following the true, low-persistence laws of motion. Appendix C.1 provides details on how the transition matrices are constructed. In the baseline model, firms and households share the same behavioral bias, but I relax this assumption in a later extension.

4.2 Non-Targeted Moments

In this section, I study non-targeted moments in the BE model and compare its performance with the RE models of varying persistence. I show that financial shock generates several exchange rate disconnect moments across all specifications. However, the perceived per-

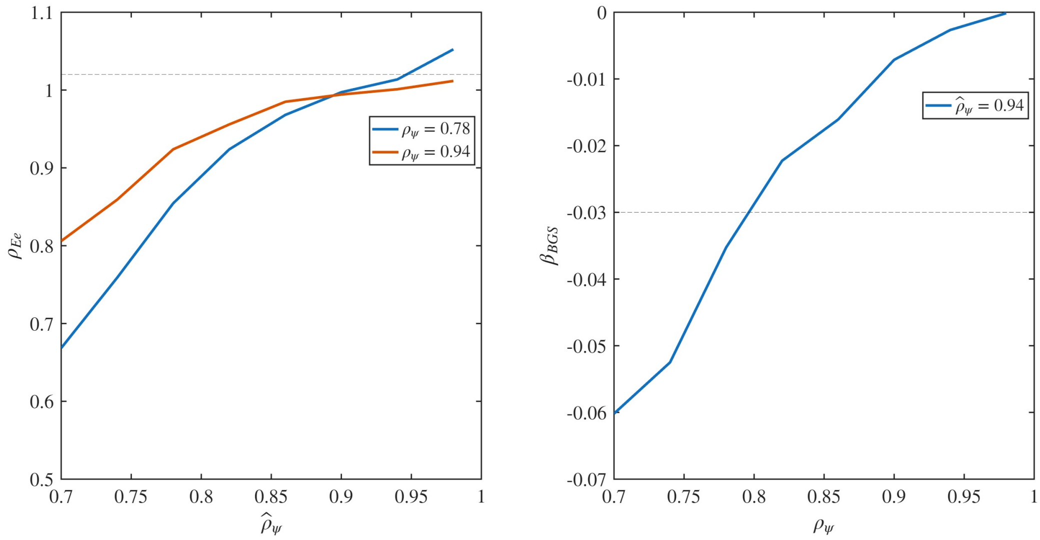

Figure 5: Identification of $\hat{\rho}_\psi$ and ρ_ψ

Notes: The plot on the left shows the identification of the perceived persistence of financial shock, $\hat{\rho}_\psi$. The dashed line presents the empirical estimate — the regression coefficient for (log) three-quarter-ahead forecast dependence on (log) current exchange rate. The blue and red lines represent the model estimates under the assumption of true persistence $\rho_\psi = 0.78$ and $\rho_\psi = 0.94$, correspondingly. The plot on the right shows the identification of ρ_ψ, with the target value (dashed line) being the empirical estimate of the one-quarter-ahead overreaction coefficient β_{BGS}, and the model counterpart is calculated under assumption $\hat{\rho}_\psi = 0.94$. The model estimates are the median across 100 simulations of the model. A simulation spans 1200 periods, with the first 200 omitted.

sistence of the shock strongly affects the degree of excess exchange rate volatility and its comovement with output. This sharply distinguishes between the BE and the transitory RE model, which shares its true but not perceived persistence. I also show that, based on contemporaneous aggregate data moments, the BE model cannot be differentiated from the persistent RE model, which shares its perceived but not true persistence. Then, I compare their dynamic moments. I demonstrate that the empirical persistence of UIP deviations and nominal exchange rate, as well as the pace of exchange rate pass-through into consumer prices offer support to the BE model.

Contemporaneous moments. As in Itskhoki and Mukhin (2021), in all specifications, financial shock can explain the Backus-Smith puzzle (the negative correlation between the real exchange rate and Home consumption relative to Foreign) and the excess volatility of the exchange rate compared to macro variables. In conventional international macro models, households borrow internationally to finance production when the exchange rate is high and domestic goods are cheap. However, financial shock disrupts the risk-sharing condition by raising the borrowing costs. Consumption falls due to the combination of higher borrowing costs and increasing consumer prices. Moreover, the home bias limits the impact of expenditure switching on consumption and output, resulting in real variables being less volatile than the exchange rate.

Figure 6 shows the unconditional moments for behavioral economies with fixed true persistence ρ_ψ and different perceived persistence $\hat{\rho}_\psi$. The excess volatility of exchange rate moments (the volatility of the exchange rate relative to consumption and output) and the

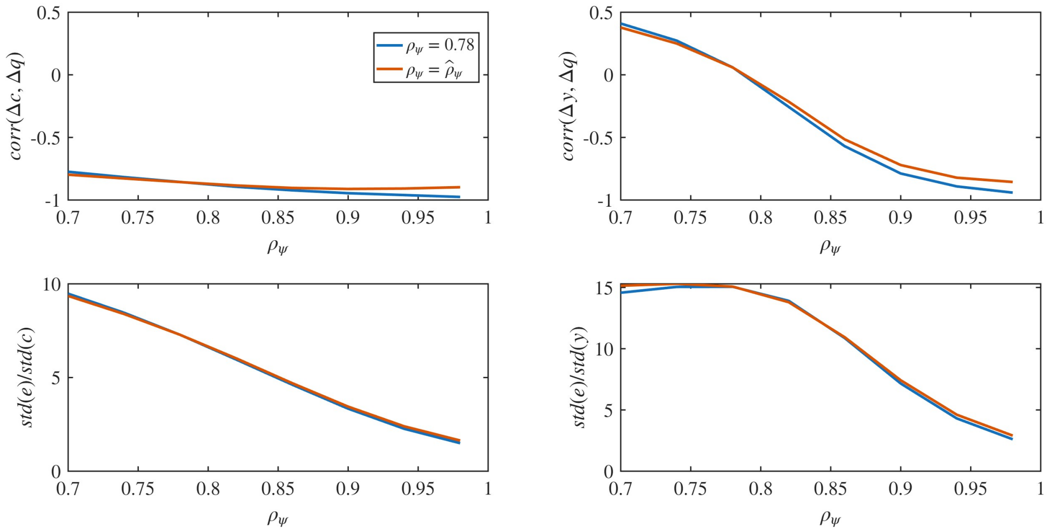

Figure 6: Exchange Rate Disconnect Moments

Notes: The plot shows how the exchange rate unconditional moments depend on the expected persistence of financial shock $\hat{\rho}_\psi$. The blue line refers to the behavioral model, in which the true persistence is fixed at $\rho_\psi = 0.78$. The red line depicts the rational expectations model where the true and perceived persistence values change together, $\rho_\psi = \hat{\rho}_\psi$. The model estimates are the median across 100 simulations of the model. A simulation spans 1200 periods, with the first 200 omitted.

negative Backus-Smith correlation[6] are present for any value of $\hat{\rho}_\psi$. When the agents believe the shock to be temporary, the excess volatility becomes more pronounced. That happens because the real variables don't respond strongly to temporary shocks: consumption is smooth due to the small amount of change to the permanent income of the households, while firms don't adjust prices strongly due to their stickiness. If the shock is believed to be permanent, however, both households and firms adjust. For the same reason, the Backus-Smith correlation becomes more negative under persistent expectations.

The correlation between output and the real exchange rate, in contrast, changes qualitatively with the perceived persistence of the financial shock: depreciation is expansionary for transitory shocks but contractionary for permanent shocks. As mentioned in the previous section, the sign reversal stems from the trade-off between expansionary expenditure switching and the contractionary decline in aggregate demand. Since the demand channel is more forward-looking, greater persistence causes it to dominate the expenditure-switching channel.

Additionally, Figure 6 demonstrates that the aggregate disconnect moments cannot identify the true persistence of the financial shock. The Figure compares the behavioral expectations (BE) model with the true persistence fixed at $\rho_\psi = 0.78$ (blue) with the rational expectations (RE) model where the true persistence varies with beliefs, $\rho_\psi = \hat{\rho}_\psi$ (red). The moments are similar for the two specifications. The comovement of exchange rate and real variables is determined by the forward-looking decisions on optimal pricing and consumption. The initial conditions don't affect the choice of the agents as much as their expectations.

[6] As the current model is SOE, the Backus-Smith correlation of the RER and relative consumption is equivalent to the correlation of the RER and domestic consumption.

	Data	BE	RE, $\rho_\psi = 0.78$	RE, $\rho_\psi = 0.94$
β_{BGS}	-0.03	-0.03	-0.01[a]	0.00
$\rho_3(Ee)$	1.02	1.02	0.86	1.00
β_{CG}	-0.35	-0.09	0.00	0.00
ρ_e	-0.99	0.98	0.94	1.00
$\sigma(\Delta e)/\sigma(\Delta c)$	3.50	2.26	7.26	2.40
$\sigma(\Delta e)/\sigma(\Delta y)$	3.32	4.30	15.08	4.63
corr$(\Delta c, \Delta q)$	-0.12	-0.98	-0.86	-0.98
corr$(\Delta y, \Delta q)$	-0.06	-0.92	0.06	-0.90
corr$(\Delta c - \Delta c^*, \Delta q)$	-0.25	-0.98	-0.86	-0.98
corr$(\Delta y - \Delta y^*, \Delta q)$	-0.09	-0.92	0.06	-0.90

Table 6: Non-Targeted Moments

Notes: The table presents the non-targeted moments. The empirical unconditional macro moments are calculated with the Central Reserve Bank of Peru data for 2009-2022. The second column refers to the one-shock behavioral model with $\rho_\psi = 0.78$ and $\hat{\rho}_\psi = 0.94$. The third and fourth columns refer to the rational models with persistence values of 0.78 and 0.94, respectively. The business cycle moments are the median across 100 simulations of the model. A simulation spans 1200 periods, with the first 200 omitted.

[a] The estimate is not significant with the standard error of 0.01

Table 6 reiterates these points by comparing three models: the BE model with $\rho_\psi = 0.78$ and $\hat{\rho}_\psi = 0.94$ and RE models with the persistence of $\rho_\psi = 0.78$ and $\rho_\psi = 0.94$. The former is the RE model where true persistence is the same as in the BE model, but the agents don't have the overextrapolating bias. The latter can be seen as the RE model recalibrated to match the persistence of exchange rate expectations. The exchange rate disconnect moments are very similar for the BE and the recalibrated RE model, with excess volatility slightly lower for the BE model and correlations almost identical. However, by construction, only the BE model matches the overreaction coefficient β_{BGS} while also generating the overreaction to news β_{CG} as an untargeted moment. At the same time, the RE model generates a low expected persistence of the exchange rate, $\rho_{Ee} = 0.86$ at the three-quarter horizon, and implies a weak response of macro variables to exchange rate fluctuations. As shown in Appendix C.3, in the two-shock model, the RE model with low persistence cannot generate a negative Backus-Smith correlation on its own due to the low impact of financial shock on consumption.

Dynamic moments. Despite the similarity in contemporaneous unconditional moments, the BE model and the RE model with $\rho = \hat{\rho} = 0.94$ differ in the implied persistence of the variables. First, the true parameter ρ has direct implications for the persistence of ex-ante UIP deviations. Figure 7 compares AR(1) coefficients for the UIP deviations in the two models and the data. The BE model fits the empirical estimates closely on all horizons from 1 to 8 quarters, while the RE model exhibits high persistence with coefficients lying above the empirical 90% confidence intervals.

Second, the two models contrast in the dynamics of the exchange rate. To compare them against the data, I estimate the local projections:

$$\Delta_h ER_{t+h} = \alpha_h + \beta_h \Delta ER_t + \gamma_h X_t + \varepsilon_{h,t},$$

where Δ_h refers to the cumulative change from period $t-1$ to period $t+h$, $\Delta_h x_{t+h} =$

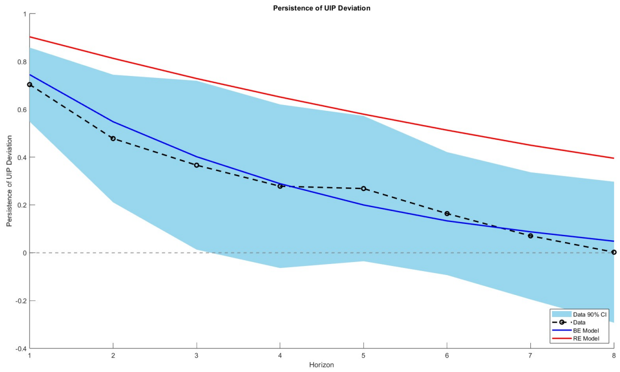

Figure 7: Persistence of UIP Deviations

Notes: The plot compares the persistence of UIP deviations on horizons from 1 to 8 quarters in the data and the two models: BE with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and RE with $\rho = \hat{\rho} = 0.94$. I estimate the empirical persistence at the quarterly frequency using monthly data. The ex-ante UIP deviations are measured using annualized deposit interest rates for Peru and the US, sourced from the Central Reserve Bank of Peru and the Federal Reserve, respectively, and spanning the period from 2009 to 2022. The 12-month-ahead exchange rate expectations are measured as the weighted average of consensus professional forecasts for the end of the current and following year, based on a survey by the Central Reserve Bank of Peru. The blue area refers to the 90% confidence interval for empirical estimates. The model moments are the median across 100 simulations. A simulation spans 1200 periods, with the first 200 omitted.

$x_{t+h} - x_{t-1}$, ER_t refers to the logarithm of either the real or nominal exchange rates, and X_t is the matrix of control variables, including the own lag, the US interest rate and the log difference in commodity price index. The model counterparts do not include any controls apart from the lag of the dependent variable since the model is driven by domestic shocks only.

Figure 8 presents the results. Empirical estimates indicate that both nominal and real exchange rate fluctuations have a cumulative effect of nearly one on short horizons (from 1 to 6 quarters), which decreases gradually over longer horizons. For all horizons, the dynamics of nominal and real exchange rates remain very similar. The upper panel shows that the BE model successfully replicates the close comovement between the nominal and real exchange rates, as well as their transitory dynamics on long horizons. However, it slightly underestimates the persistence of the exchange rate in the short run. In contrast, the RE model on the lower panel captures the cumulative response of near unity on short horizons for the real exchange rate, but implies a strong non-stationarity of the nominal exchange rate and a sharp divergence between the nominal and real exchange rates. This pattern arises from equalizing the true ρ to the behavioral parameter $\hat{\rho}$, calibrated to the Survey expectations data, where firms overstate the persistence in the realized macroeconomic data and expect the exchange rate to have persistence above one. Overall, the comparison indicates that the BE model performs better against the data and implies a sharp difference in the long-run exchange rate pass-through (ERPT).

Next, I examine the ERPT into consumer prices across different horizons. The response of prices to the exchange rate, while playing a central role in linking overextrapolative expectations with recessionary depreciations, helps to distinguish between the BE and RE models through its dynamics. On one hand, the BE and RE models have identical immediate ERPT.

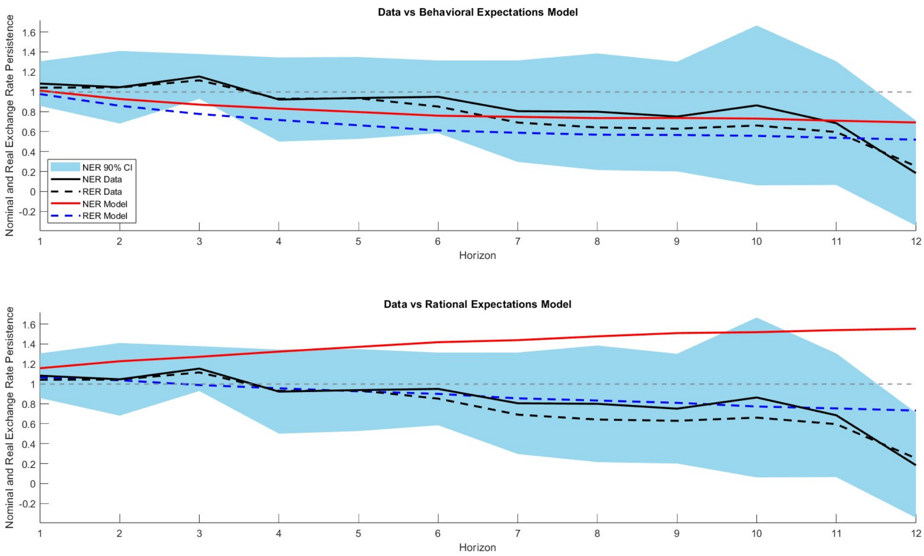

Figure 8: Persistence of Real and Nominal Exchange Rates

Notes: The figure compares the empirical exchange rate persistence on horizons from 1 to 12 quarters with the counterparts in two models: BE with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and RE with $\rho = \hat{\rho} = 0.94$. I estimate the cumulative response of nominal (solid) and real (dashed) exchange rates to their change using local projections. The empirical persistence is estimated at the quarterly frequency using monthly data on the exchange rate from the Central Reserve Bank of Peru for 2009-2020. The controls include the own lag, log difference in commodity prices (from the World Bank Commodity Price data), and the US interest rate (from the Federal Reserve Bank of St. Louis database). The blue area shows the 90% confidence interval for nominal exchange rate persistence. The model moments are the median across 100 simulations. A simulation spans 1200 periods, with the first 200 omitted.

At $h = 0$, when depreciation occurs, price-optimizing firms in both economies share the same beliefs about the persistence of the financial shock and set the same prices. However, the two models diverge drastically in the long-run ERPT. In the periods following the shock, the firms in the BE economy face exchange rate realizations inconsistent with their expectations, which gradually dampens the price response. ERPT becomes frontloaded compared to the RE model, where ERPT increases slowly due to price stickiness, leading to higher overall pass-though and a flatter trajectory.

I start the comparison by estimating the local projections of the nominal exchange rate into consumer prices, where controls include the lag of change in domestic demand, the own lag, and US export prices as a proxy for international prices. Appendix C.2 reports the estimates of cumulative and quarterly changes in CPI, core CPI, and import price index. Next, I assess how long an exchange rate fluctuation affects consumer prices. To do so, I examine the duration over which the ERPT into quarterly changes in the CPI remains statistically significant. For instance, a duration of 5 means that the ERPT is significant up to $h = 4$. Table 7 shows that the BE model is able to account for the fast pass-though of the exchange rate, while the RE model significantly overstates it. In Appendix C.2, I provide the details on the empirical estimates of the ERPT as well as the alternative comparison based on a different measure of its front-loadedness.

Apart from differentiating between the models, the ERPT frontloading is noteworthy on

	Financial shock	Financial and TFP shocks
Data, CPI	5	5
Data, core CPI	5	5
BE Model, median	6	6
BE Model, 90% CI	[4,9]	[4,9]
RE Model, median	11	11
RE Model, 90% CI	[7,13]	[6, 13]

Table 7: Duration of Exchange Rate Pass-Through

Notes: The table compares the number of periods for which ERPT remains significant in the data and in the two models: BE with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and RE with $\rho = \hat{\rho} = 0.94$. I estimate the quarterly response of prices to a 1% depreciation of the nominal exchange rate using local projections and examine which coefficients are significant at the 90% level of confidence. The duration includes the immediate impact at $h = 0$, so a duration of 5 means that the ERPT is significant up to $h = 4$. The model moments are 5-, 50-, and 95 percentiles across 100 simulations. A simulation spans 1200 periods, with the first 200 omitted. The results are reported for two specifications of models: with financial shock only and with both financial and TFP shocks. The calibration of the volatility of the TFP shock is reported in the Appendix C.3, and the details about the empirical estimates are reported in the Appendix C.2.

its own. First, a behavioral model with overreacting expectations and nominal rigidities can offer an alternative explanation of why exchange rate pass-through is incomplete even at long horizons, augmenting standard mechanisms such as strategic complementarities and a low-inflation environment. With exchange rate dynamics more transitory than expected by firms, the price hikes decay fast following a depreciation episode. Second, although, to my knowledge, the literature doesn't discuss frontloading in ERPT explicitly, it implicitly assumes the ERPT trajectory when estimating long-run ERPT. Typically, it is defined as the pass-through a year or two after the shock (see Burstein and Gopinath, 2014; Campa and Goldberg, 2006). At the same time, a rational expectations model with Calvo pricing and a random-walk-like exchange rate features a slower ERPT. To illustrate, for a standard parameter of $\theta = 0.75$, when only a quarter of firms can adjust prices in a given period, 24% of the firms still haven't had the chance to reset their prices 4 quarters after the shock. Then, assuming depreciation doesn't cause the real marginal costs to overshoot in the short run, ERPT cannot exceed 76% of its long-run value and is further reduced by pricing complementarities with firms that have not reset their prices. Even two years after the shock, at quarter 7, the ERPT remains below its long-run value, reaching at most 90%. This observation contradicts the empirical estimates discussed above and the implicit assumptions common in the literature. A behavioral model bridges this gap by generating a more frontloaded ERPT.

4.3 Consistency with Cross-sectional Data: Financial Shock

The following section shows that the expectations generated by the news of a financial shock are consistent with the pattern documented in the empirical section of the paper. When financial shock is the main driver of the exchange rate, firms are more likely to associate expected depreciation with a slowdown in their own and aggregate economic activity.

I generate the variation in expectations by assuming that a small firm i of measure 0, which cannot affect the aggregate conditions in the economy, receives the news of the shock hitting the economy in the next period. I assume that the firm expects the shock to follow

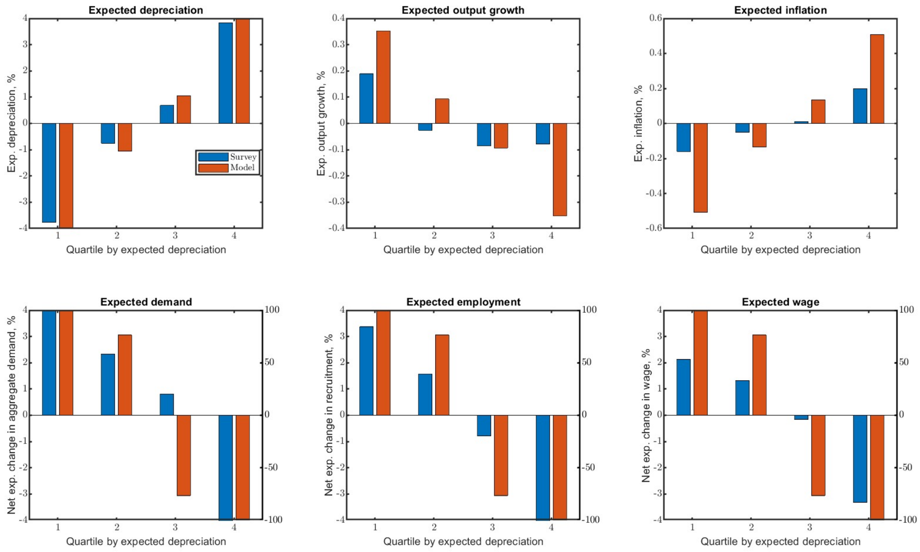

Figure 9: Beliefs about Aggregate Economy by Expected Depreciation: Data and Model

Notes: The figure compares the beliefs on the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms that receive news about the financial shock in the next period. The forecast horizon is one quarter for aggregate demand, employment, and real wage and two quarters for other variables due to the different types of corresponding survey questions. The model estimates of expected wage refer to the real wage. The empirical estimates of the end-of-year expectations on the exchange rate, output, and inflation are quantitative, while the expected demand, wage, and employment refer to the percent point difference between firms expecting an expansion and contraction in the next three months.

the AR(1) process with a persistence of 0.94. The shocks come from a discretized normal distribution with 11 possible values. I study how macroeconomic expectations and current actions of a firm i vary depending on its expectation of financial shock. I sort the responses by expected depreciation and average them by quartile. For expected exchange rate, output, and inflation, I use two-quarter-ahead forecasts to match the average horizon in the Survey. To match the questions that only have qualitative responses in the Survey, I calculate the difference between the fractions of firms reporting an expansion versus contraction. To measure the model counterpart of the responses of firms about their own actions, I model it separately for price-updating and non-updating firms in both tradable and non-tradable sectors and report the weighted average.

Figure 9 shows the beliefs of the firms about the aggregate state of the economy by their exchange rate expectation while plotting it against the empirical counterparts. In the model, agents expecting depreciation tend to forecast low output growth and demand, accompanied by high inflation, with variance of exchange rate expectations noticeably exceeding the variance of other quantitative expectations. Also, firms expect declining aggregate employment and real wages. Although the survey estimates reflect unconditional moments that may result from various shocks, the financial shock as the main driver of exchange rate expectations aligns well with observed data patterns. However, accounting for only a single shock leads to an overestimation of the comovement between most expected macroeconomic variables and exchange rate forecasts.

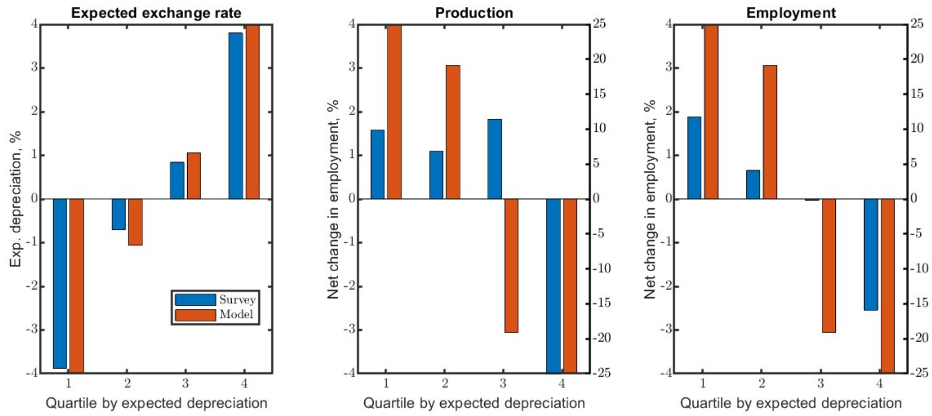

Figure 10: Firm's Actions by Expected Depreciation: Data and Model

Notes: The figure compares the recent actions by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms that receive news about financial shock in the next period. The graph shows the weighted average by sector and price-updating status. The forecast horizon for the exchange rate is two quarters. The empirical estimates refer to the expected percent change in the variable by the end of the year, while the survey responses on actions refer to the percent point difference between firms expecting an expansion and contraction in the next three months.

Moreover, the model correctly predicts the contraction in output and employment of a firm that expects depreciation. Figure 10 shows the variation in firms' actions by exchange rate expectations as a weighted average by sector and price optimization status. In response to depreciation driven by financial shock, firms that reset their prices increase them in response to future inflation, which leads to lower demand for their variety of goods. Appendix C.4 shows the response by sector. Non-tradable firms account for most of the contraction, but tradable firms also shrink due to the domestic share of their sales.

A shortcoming of modeling the variance of expectations with shocks is that this version doesn't generate the expected contraction in the firm's output as recorded in the survey. Instead, firms that optimize their prices expect a partial recovery, anticipating that others in their sector will respond to depreciation by raising prices, which will improve the firm's market share. However, Appendix C.4 shows that expected individual-level contraction can be generated if the variation in expectations is modeled as the differing expected persistence of financial shock. Moreover, this result is supported in Appendix C.9, which studies an extension with half of the firms having rational expectations while the other half has behavioral ones. Both current and expected contraction are consistent with the model.

In sum, the model driven by financial shocks successfully captures the regularities in the relationship between exchange rate forecasts, aggregate beliefs, and firm behavior.

4.4 Consistency with Cross-Sectional Data: Other Shocks

This section shows that, in contrast to financial shock, other standard domestic shocks — TFP, demand, and monetary policy — don't generate cross-section responses consistent with the survey data. The TFP shock is defined as a productivity shock common to both the tradable and non-tradable sectors. Demand shock is the shock to discount factor, while monetary policy shock enters the Taylor rule equation. I repeat the approach outlined in the

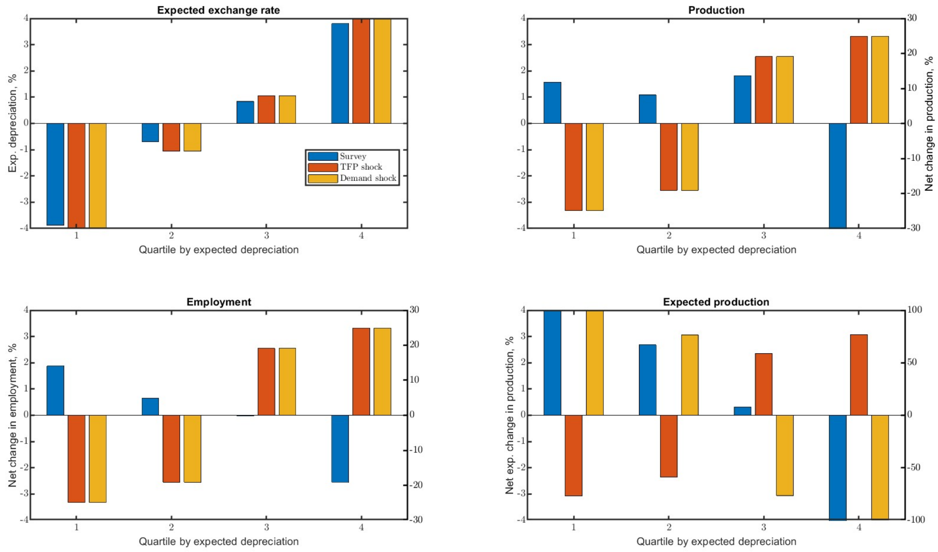

Figure 11: Expected and Recent Firm's Actions by Expected Depreciation: TFP and Demand Shocks

Notes: The figure compares the recent and expected firms' actions by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms receiving news about the TFP (red) and demand (yellow) shock in the next period. The graphs show the weighted average by sector and price-updating status. The forecast horizon for the exchange rate is two quarters. The empirical estimates refer to the expected percent change in the variable by the end of the year, while the survey responses on actions refer to the percent point difference between firms expecting an expansion or contraction in the next three months.

previous section, examining changes in beliefs and actions of measure-0 firms that receive news about shocks expected to hit the economy in the next period.

The real shocks — TFP and demand shocks — are not consistent with firms that expect depreciation contracting their current output. Since the exchange rate is determined by the UIP condition, a non-financial shock that causes depreciation must also lead to a decline in the domestic interest rate. Under a real shock, the decreasing nominal rate is the response of monetary policy to deflation. If firms expect low interest rates and deflation in the next period, they lower their prices today, anticipating that they may not be able to adjust them later. Lower prices increase demand for their variety of goods, leading to higher production and employment. Figure 11 shows that under TFP and demand shocks, firms' actions have the opposite comovement with exchange rate expectations compared to the data. The same argument would hold for other non-monetary and non-financial shocks that may be driving the business cycle and affecting the UIP condition through the domestic interest rate, including terms-of-trade and commodity shocks. Appendix C.5 provides more details by showing the impulse responses to TFP and demand shocks and demonstrating the expectations of the aggregate variables.

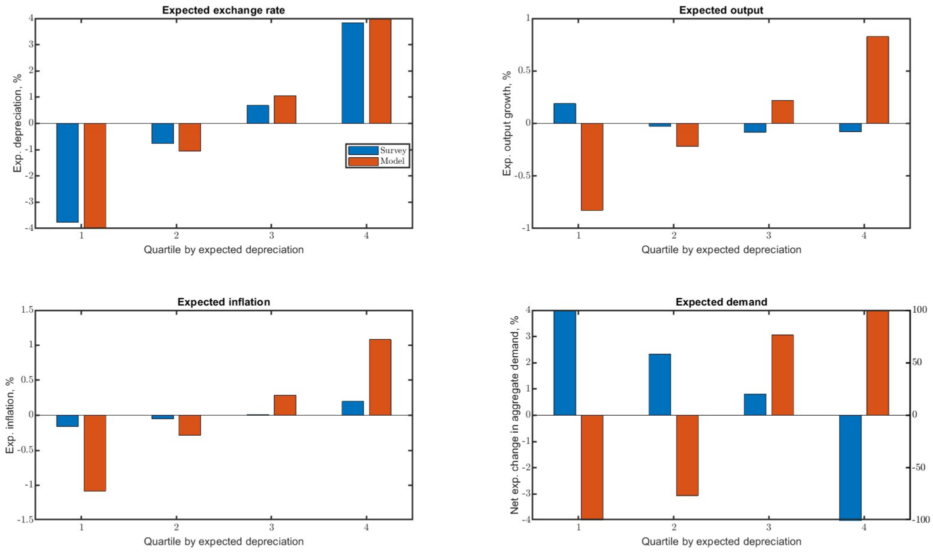

Figure 12: Beliefs about Aggregate Economy by Expected Depreciation: Monetary Shock

Notes: The figure compares the beliefs about the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms receiving news about a monetary policy shock in the next period. The forecast horizon is one quarter for aggregate demand and two quarters for other variables due to the different types of corresponding survey questions. The empirical estimates of the end-of-year expectations on the exchange rate, output, and inflation are quantitative, while the expected demand refers to the percent point difference between firms expecting an expansion or contraction in the next three months.

A monetary shock can generate individual-level contraction of firms that expect depreciation, but it is not consistent with the expected aggregate slowdown. Now, depreciation and a declining interest rate occur due to expansionary monetary policy, which stimulates demand and output. Figure 12 shows that firms expecting high exchange rates due to the news of monetary easing would also expect a boom in demand and output. Appendix C.5 provides further details on the impulse responses to monetary policy shocks and firm-level responses by expected depreciation.

Therefore, financial shock is the only domestic shock that is consistent with both macro- and micro-level contraction.

4.5 Impulse Response to Financial Shock

I study the impulse response to 1% positive financial shock. I first outline how the financial shock affects the rational expectations economy and then show how the behavioral bias changes the aggregate response by amplifying exchange rate volatility and magnifying the contractionary impact of the aggregate demand channel. In this section, I assume both firms and households have behavioral expectations.

Figure 13 shows the response of the rational expectations economy (red line) to the shock. From the modified UIP condition, any change in the expected path of the financial wedge for international bonds $\mathbb{E}_t\{\psi_{t+k}\}_{k=0}^{\infty}$ must be offset either by current depreciation or increase in the expected path of the domestic interest rate. Both effects are present

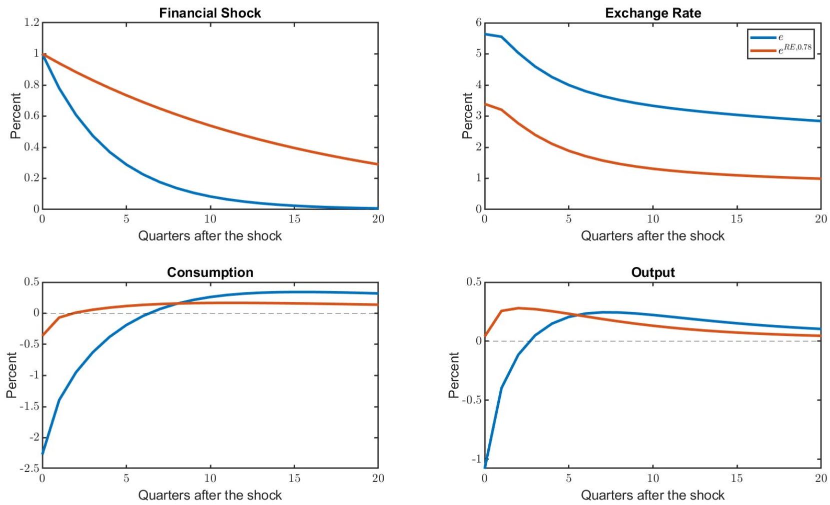

Figure 13: Macroeconomic Response to a Financial Shock

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark.

in this economy. An increase in the exchange rate transmits to inflation through import prices. In the long run, real variables return to their steady state, while nominal values, such as prices and the nominal exchange rate, may permanently change their levels. Domestic firms raise local currency prices due to expected inflation, monetary policy responds with an interest rate hike, and households react to the change in the current and expected path of interest rates by decreasing their consumption. Both tradable and non-tradable firms face a decline in domestic demand. As Figure 14 (red) shows, the combination of low demand and high prices leads to a small decline in output in the non-tradable sector, even despite the expenditure-switching effect. The tradable sector, in contrast, expands. As the labor costs are denominated in local currency but the exported goods are priced in dollars, the depreciation allows the tradable firms to lower their dollar prices and increase the external demand for their variety of tradable goods. Under rational expectations, despite the fall in domestic demand, the export channel dominates, and the aggregate output expands.

The overreacting beliefs change the response of macroeconomic variables. As shown in Figure 13 (blue) and explained in the analytic example in the previous section, the response of the exchange rate is amplified due to the expectation of financial shock affecting the path of the exchange rate for a longer period. The firms respond with stronger price changes, the interest rate increases to curb inflation, and domestic consumption drops by more than in the RE model. Figure 14 shows that behavioral expectations magnify the drop in non-tradable output. The tradable sector faces a trade-off between higher competitiveness in the external sector and a drop in domestic demand, both of which increase when depreciation is expected. However, in contrast to external demand, domestic demand responds not only to the current prices but also to the expected path of the interest rate, which is sensitive to overreacting expectations. In the BE model, the tradable sector expands, but less than in the RE model. As a result, under the persistent beliefs, the aggregate output contracts.

Appendix C.7 provides additional insights by showing a high-persistence RE model, which corresponds to the expected evolution of the economy according to the beliefs of behav-

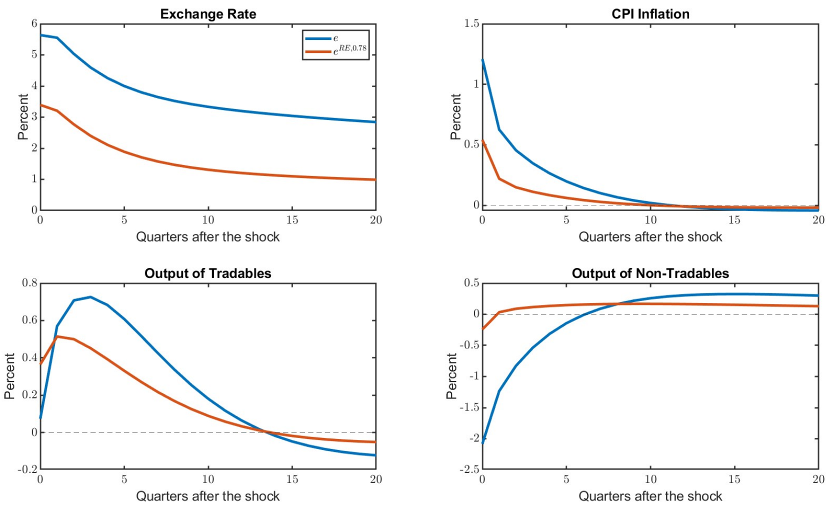

Figure 14: Sectoral Response to a Financial Shock

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model. and the red line is the rational expectation benchmark.

ioral agents. Appendix C.8 discusses the role of price rigidities in shaping the result. Since the domestic demand channel's sensitivity to expectations depends on firms' price-setting choices, in a flexible price model, behavioral expectations don't affect its relative importance. However, they still amplify the response of the exchange rate and the macroeconomy. Appendix C.10 confirms that the empirical data on Peru indeed feature deprecations that are associated with contractions in output and demand, an expansion in export, and a fall in non-tradable output.

4.6 The Role of Firms' and Households' Expectations

The baseline behavioral model relies on the assumption that households and firms have the same bias in forming the expectations for the financial shock, $\hat{\rho}^f_\psi = \hat{\rho}^h_\psi$. However, there is no available data on households' expectations. The following section separates firms' and households' expectations to examine their roles. Figure 15 compares four versions of the model: the RE model (blue), the baseline BE model (purple), the model where only firms are behavioral (red), and the model where firms are rational but households are behavioral (yellow). It shows that the firms' expectations can generate a recessionary depreciation even when households are rational. However, the households' expectations amplify the impact of the shock on the exchange rate and make the recession quantitatively significant.

Compared to the rational benchmark, households' overreaction, even when firms are rational, increases exchange rate volatility by influencing the modified UIP condition. However, expenditure switching still dominates the fall in domestic demand, so output expands, resulting in amplification without contraction.

In contrast, under behavioral firms and rational households, the exchange rate response is close to the fully rational model since firms' expectations don't directly affect the UIP condition. However, behavioral firms still anticipate prolonged depreciation and increase local currency prices excessively. As monetary authorities respond to the price changes,

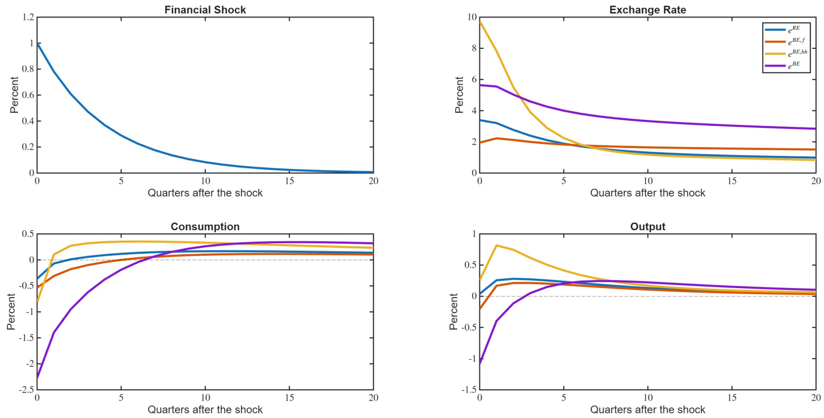

Figure 15: Impact of Behavioral Beliefs by the Type of Agents

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the rational benchmark model. The red line is the model with behavioral firms and rational households. The yellow line is the model with behavioral households and rational firms, while the purple line denotes the model where all agents are behavioral.

households correctly anticipate that in this economy, a depreciation of a similar magnitude corresponds to a stronger increase in the domestic interest rate path. Therefore, rational households contract their demand in response to the current and expected actions of behavioral firms. Households' forward-looking decision-making amplifies firms' behavioral bias, strengthening the demand channel relative to the expenditure-switching channel, which leads to a contraction without amplification.

For the decline in output to be quantitatively significant (both in absolute terms and relative to the exchange rate depreciation), the model requires behavioral bias to be present both in firm and household expectations. According to the behavioral macro literature, this can be a reasonable assumption. Candia et al. (2022) show that firm inflation expectations differ from those of both households and professional forecasters, generally falling between the two and often aligning more closely with household expectations. A plausible assumption may be that small firms form expectations similarly to households while larger firms tend to be closer to the professionals. In a recent paper, McClure et al. (2025) show that the output inflation expectations of low- and middle-rank managers closely approximate those of households.

5 Conclusion

In this paper, I study the exchange rate expectations of firms and their impact on the economy. Using individual-level survey data, I document two facts. First, firms' forecasts of exchange rates systematically depart from the rational expectation benchmark by overreacting to news and anchoring to the current exchange rate. Second, firms associate depreciation with an economic slowdown and tend to reduce their own economic activity when they expect a higher exchange rate.

I introduce overreactive expectations into a small open economy model, disciplining the agents' beliefs with the empirical evidence, and show that exchange rate expectations driven by financial shocks are consistent with the micro- and macro-level contractions documented empirically. I discuss the implications of behavioral beliefs for aggregate dynamics, showing that the overreactive expectations of households amplify exchange rate volatility, while firms' expectations make financial-shock-driven depreciations more contractionary.

One application of this work is the conduct of communication policy, particularly in the context of large devaluations and foreign exchange interventions. Communicating the drivers and expected persistence of exchange rate fluctuations can potentially help anchor expectations, stabilize the exchange rate, and mitigate recessionary effects. Another avenue for future research is to further explore the heterogeneity in firms' expectations and its implications for misallocation, as well as sectoral and aggregate responses to depreciations. Finally, an important extension would be to establish causal links through randomized controlled trials, assessing how information about exchange rates influences economic beliefs and decision-making among firms, households, and the financial system.

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A Empirical Analysis

A.1 Descriptive Statistics on Forecast Errors and Revisions

Forecast errors. Figures A.1 and A.2 show the time series of the realized exchange rates, output growth, and inflation compared to the firms' 3- and 9-month-ahead forecasts of those variables. On a 3-month horizon, the realized value of the exchange rate is more likely to lie inside the 90% confidence interval than on 6- or 9-month horizons, showing that the forecast becomes more precise on shorter horizons.

Table A.1 suppoerts the findings by reporting the magnitude of forecast errors on different horizons. The difference between the one- and three-quarter-ahead forecast is especially strong for the exchange rate but weak for inflation. Exchange rates remain the hardest-to-predict variable on every horizon.

Forecast revisions. Forecast revisions of the exchange rate show similar properties to output and inflation. As shown in Table A.2, the share of non-revisions for the exchange rate is high (46%) and close to the non-revision share for output and inflation (47% and 52% correspondingly) despite the publicly available daily updates on exchange rate dynamics. In 24% of cases, the respondent does not update any of the three forecasts. All three variables exhibit significant disagreement between forecasters, as measured by the standard deviation of the forecasts normalized by the underlying value volatility. Despite revisions of exchange rate forecasts being larger in magnitudes and exhibiting stronger disagreement, the three variables show similar properties.

This finding aligns with a model where new information about the exchange rate, output, and inflation is processed similarly. Specifically, it supports the hypothesis that all three variables respond to the same shocks, with agents adjusting their macroeconomic expectations based on beliefs about the future trajectory of those shocks.

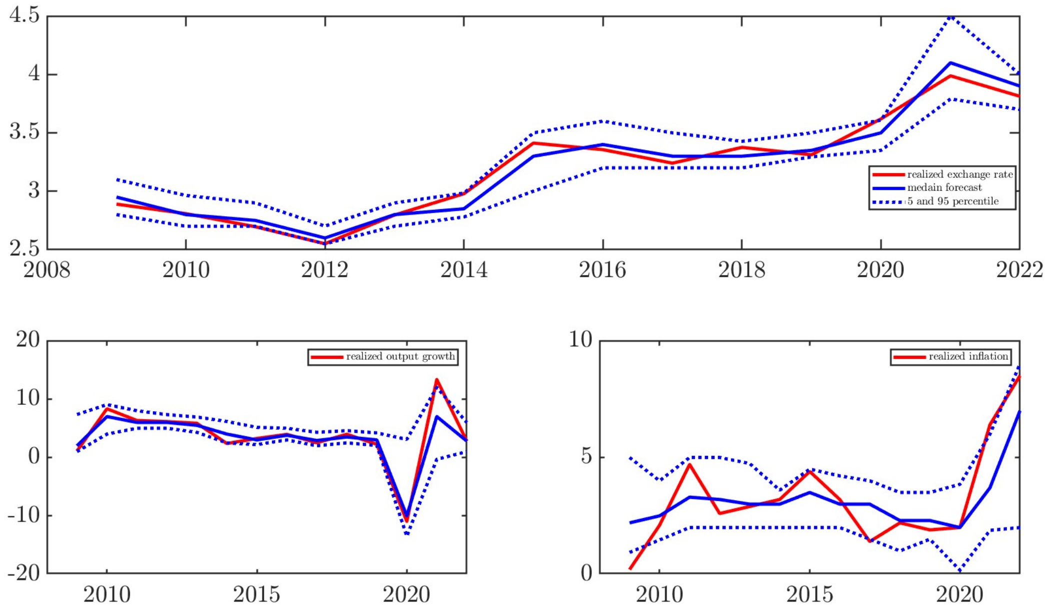

Figure A.1: Realized Variables and 3-months-ahead Forecasts

Notes: The figure illustrates the paths of the realized (red) exchange rate at the end of the year, annual output growth, and inflation next to the 5-, 50- and 95-percentile of firms' nine-month-ahead forecasts (blue). The data on realizations are taken from the Central Reserve Bank of Peru.

Forecast Horizon	**Exchange Rate (Δe)**	**Output Growth (Δy)**	**Inflation (π)**
One-quarter ahead	2.27	0.76	0.90
Two-quarters ahead	3.79	0.97	0.90
Three-quarters ahead	4.81	1.26	1.10
Four-quarters ahead	6.26	1.49	1.00

Table A.1: Summary Statistics: Magnitude of Absolute Error by Forecast Horizon

Notes: The table presents the median absolute error on forecast errors about exchange rate depreciation, output growth, and inflation on different horizons. The forecast error for variable x_t is the difference between the realized and forecasted value, $x_t - E_{t-h}x_t$, where h is the forecast horizon.

A.2 Robustness of Overreaction Bias

Robustness by forecast and revision horizon. Since the structure of the survey provides monthly forecasts of the exchange rate at the end of the year, the baseline results are estimated on the dataset with a pooled horizon ranging from 1 to 12 months ahead. In this section, I estimate the BGS and CG coefficients while controlling for the forecast horizon. Figure A.3 shows that both coefficients are robustly negative, independent of the forecast horizon. For the calibration of the quantitative model, I match one-quarter-ahead BGS coefficient. However, the BGS coefficients are sensitive to the inclusion of specific years. This sensitivity reflects the mechanical link between the contemporaneous exchange rate and the end-of-year realization, which amplifies the influence of non-typical periods. In Peru,

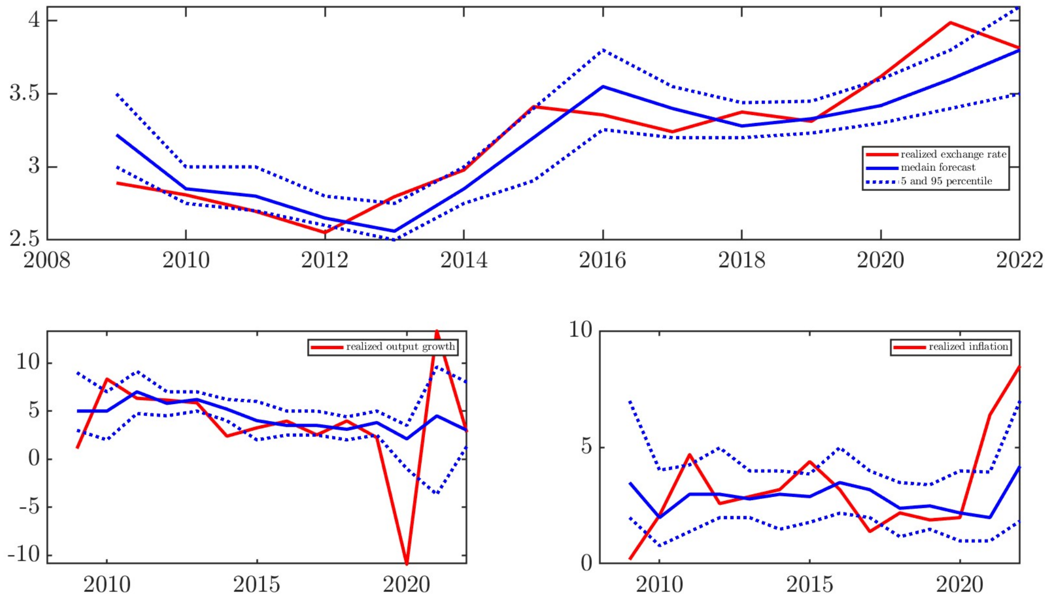

Figure A.2: Realized Variables and 9-months-ahead Forecasts

Notes: The figure illustrates the paths of the realized (red) exchange rate at the end of the year, annual output growth, and inflation next to the 5-, 50- and 95-percentile of firms' nine-month-ahead forecasts (blue). The data on realizations are taken from the Central Reserve Bank of Peru.

	Exchange Rate (Δe)	**Output Growth (Δy)**	**Inflation (π)**
Non-revision share	0.46	0.47	0.52
Mean absolute revision	1.79	0.69	0.36
Mean relative revision	0.27	0.13	0.16
Mean relative SD of revisions	0.56	0.24	0.31

Table A.2: Summary Statistics: Forecast Revisions

Notes: Revision is defined as $E_{t-h}x_t - E_{t-h-1}x_t$, where h is the forecast horizon. Non-revisions refer to instances when the respondent provides the same forecast at time t and $t+1$, i.e., $E_{t-h}x_t - E_{t-h-1}x_t = 0$. As the data is rounded to 0.01 percentage point, the share of non-revisions may also include forecasts updated by smaller amounts. Relative revision and standard deviation of revisions are normalized by the standard deviation of annual depreciation, output growth, and inflation, respectively.

2012 and 2021 are the two years with the largest leverage in the panel. The two years are also the years with the strongest exchange rate interventions in the sample (US$ 12 billion net purchases in 2012 and US$ 1.6 billion net sales in 2021). Excluding these years yields estimates that better reflect the underlying relationship. Figure A.4 shows the BGS coefficients with and without these observations.

Figure A.5 provides the robustness check on the pooled-horizon estimate of CG regression, controlling for different horizons of forecast revision. In the baseline regression, revision is defined as a change in the forecast compared to the previous month. Here, I allow for varying time gaps in between forecast revisions, $\mathbb{E}_{i,t-h}x_t - \mathbb{E}_{i,t-h-k}x_t$, with h taking values

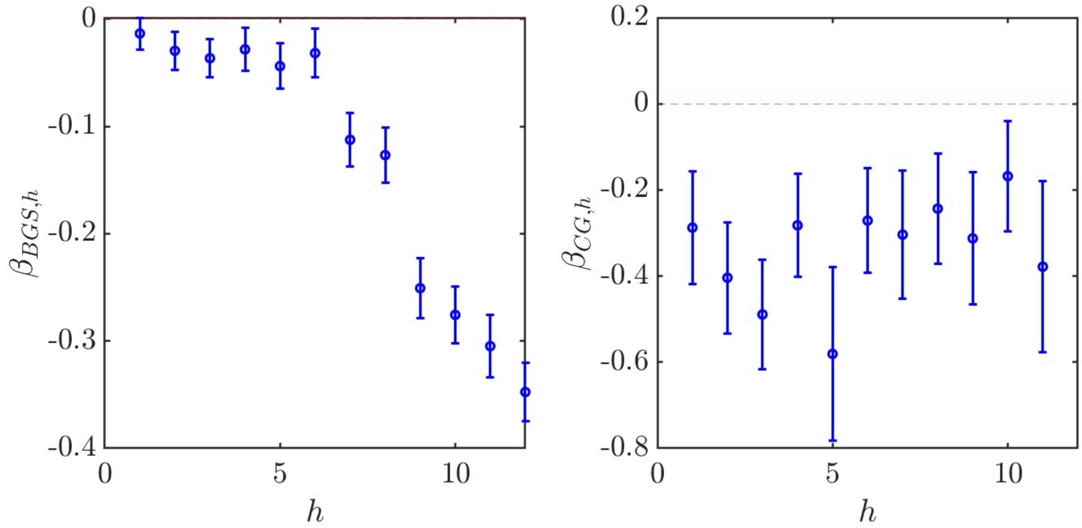

Figure A.3: BGS and CG Regressions for h-month-ahead Forecast

Notes: The figure displays the coefficients and 90% confidence intervals from BGS and CG panel regressions with fixed effects, estimated across different forecast horizons h, where h denotes the forecast horizon. The time sample for BGS regression excludes years 2012 and 2021 due to high sensitivity.

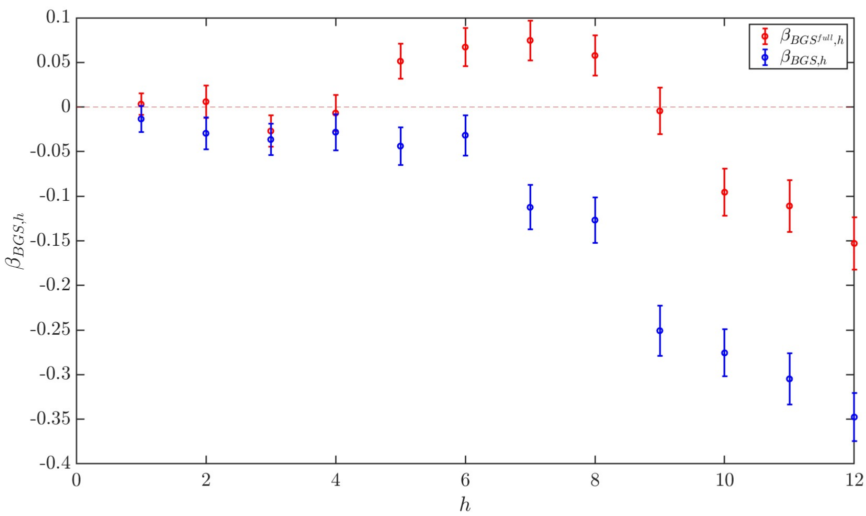

Figure A.4: BGS Regressions for h-month-ahead Forecast: Sensitivity

Notes: The figure displays the coefficients and 90% confidence intervals from BGS and CG panel regressions with fixed effects, estimated across different forecast horizons h, where h denotes the forecast horizon. The full sample estimates are shown in red, while the baseline specification excluding years 2012 and 2021 is shown in blue.

from 1 to 11 months. The sign of the overreaction is robust across different definitions of a revision, while magnitude decreases on longer horizons, possibly due to added noise.

Robustness by type of respondent. The persistence of current conditions seems robust among different types of respondents. Table A.3 compares the β_{BGS} regression coefficients

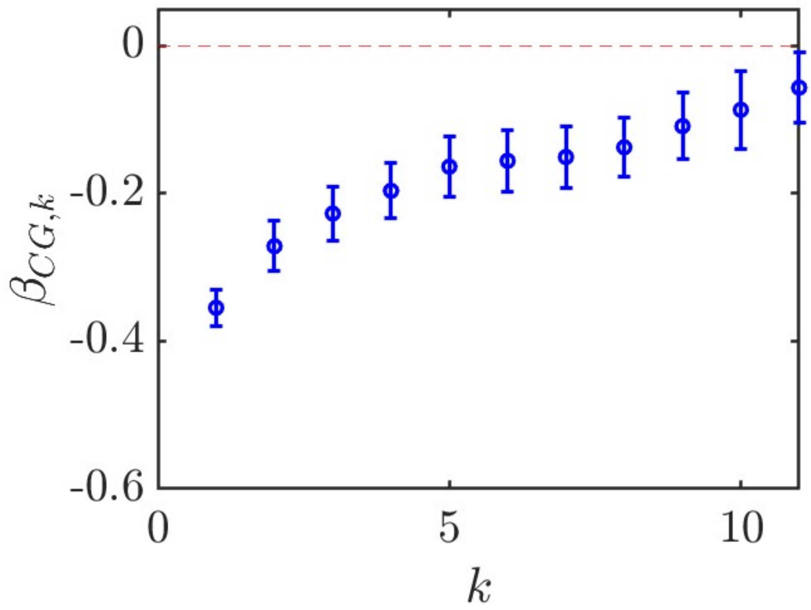

Figure A.5: CG Regressions for k-month Revisions

Notes: The figure displays the coefficients and 90% confidence intervals from CG panel regressions with fixed effects, estimated across different revision horizons h, where k denotes the revision horizon, $\mathbb{E}_{i,t}x_{t+h} - \mathbb{E}_{i,t-k}x_{t+h}$.

	Firms (Non-financial)	**Financial System**	**Professional Forecasters**
β_{BGS}	-0.19	-0.21	-0.21
	(0.09)	(0.08)	(0.08)

Table A.3: Predictable Errors by Type of Respondent

Notes: The table presents estimation results from the BGS regression using consensus forecasts of professional forecasters, financial system participants, and non-financial firms from March 2002 to August 2022. Standard errors are Newey–West. The time sample for BGS regression excludes years 2012 and 2021 due to high sensitivity.

for non-financial and financial firms and professional forecasters. In all three cases, the forecasts deviate from FIRE with $\beta_{BGS} < 0$, indicating that the overreactive beliefs are not specific to firms. This observation serves as a rationale for assuming the presence of overreactive expectations for all economic agents in the baseline model despite studying the roles of firms' expectations separately in its extension.

Expectation	Realized Production			Realized Sales			Realized Employment		
	Incr.	Const.	Decr.	Incr.	Const.	Decr.	Incr.	Const.	Decr.
Increase	46%	39%	15%	49%	36%	16%	30%	63%	6%
Constant	13%	74%	14%	13%	71%	16%	4%	89%	7%
Decrease	10%	24%	66%	11%	26%	63%	3%	47%	50%

Table A.4: Consistency between Expected and Realized Actions

Notes: The table shows the distribution of realized changes in production, sales, and employment in month t relative to the previous month $t-1$, conditional on expectations reported at $t-1$. The expectations refer to the expected change in the next three months starting the date of the survey.

A.3 Data Validity Discussion

As the survey does not include identifying information on the responding firms, it is not possible to directly verify the accuracy of their reported actions or determine whether expectations align with actual decisions using a supplementary data source. One concern is that the survey may be completed by employees who are not directly involved in decisions about production or employment, raising the question of whether the survey reflects the realized dynamics of the firm.

However, the data allow us to assess the consistency of a firm's responses by examining whether expected expansions or contractions are followed by their self-reported implementation. Specifically, I compare a firm's three-month-ahead expectations for output, sales, and employment reported in month $t-1$ with the month t answers on their realized change relative to month $t-1$. Table A.4 presents the frequencies of recent self-reported changes, conditional on the expectations reported a month earlier. Although alignment is not perfect, firms are most likely to follow through with their intentions. The share of firms whose actions align with prior expectations is 62.1% for output, 61.1% for sales, and 74.8% for employment. This evidence suggests that assuming the accuracy of self-reported outcomes, the expectations captured in the survey are informative about the firm's subsequent actions.

A.4 Exchange Rate Forecasts, Beliefs about Economy and Firm's Actions: Robustness

In this section, I discuss the robustness of the connections among exchange rate forecasts, beliefs about the macroeconomy, and the firm's actions by presenting non-residualized plots and regression results.

Beliefs about the economy. Figures A.6 and A.7 show non-residualized plots that link exchange rate forecasts with expectations about the rest of the economy. As in the main section, for every period, I sort observations by expected depreciation and divide them into quartiles. Then, I average the mean for each quartile by time. Consistent with the main section's results, expected depreciation is linked to high inflation and an economic slowdown, reflected in declining output, demand, wages, and employment.

Table A.5 presents regression results linking exchange rate expectations to expectations for other macroeconomic variables, controlling for forecasted output and inflation, as well as log exchange rate at the beginning of the year. To interpret the coefficients, consider that firms expecting an increase in demand tend to anticipate annual depreciation that is 0.6 and

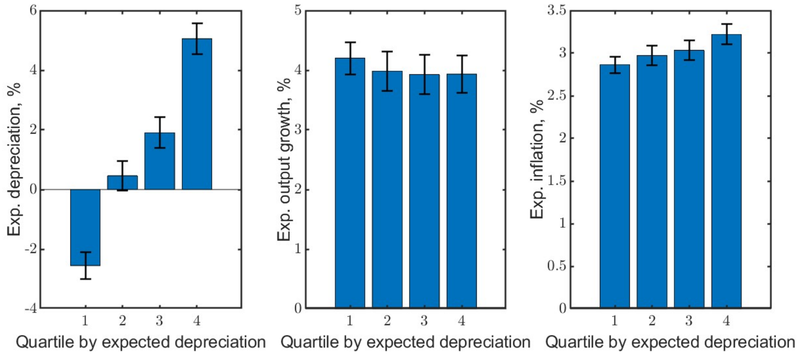

Figure A.6: Expected Output and Inflation by Expected Depreciation: Non-Residualized

Notes: The figure shows the inflation and output forecasts by expected depreciation quartiles. For every period t, observations are sorted into four groups by expected exchange rate. The forecasts are first averaged by quartile and then by time. The 90% confidence intervals are estimated with a t-test.

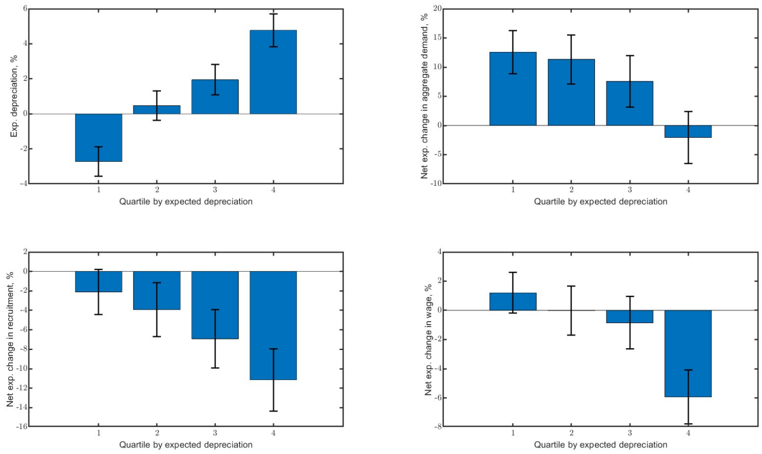

Figure A.7: Beliefs about Aggregate Economy by Expected Depreciation: Non-Residualized

Notes: The figure shows the beliefs about the evolution of the aggregate macroeconomic variables by expected depreciation quartiles. The observations are sorted into four groups by expected exchange rate forecast. The mean outcomes by quartile are then averaged by time. The outcome variables take values of –1, 0, or 1, depending on the sign of the change. Net change of x% means x% more firms reporting an increase in the variable than firms expecting a decrease. The 90% confidence intervals are estimated with a t-test.

1.2 percentage points lower than firms expecting stable or decreasing demand, respectively.

Firm's actions. Figure A.8 shows non-residualized plots that connect exchange rate forecasts with firms' expected and recent actions. I demonstrate that the results presented in the main sections are not driven by expected inflation or output. Firms that expect depreciation are more likely to contract their production and employment currently and in the next three months. In addition, they associate depreciation with higher input costs. In addition to the variables discussed in the main section, I examine recent and expected changes in sales, as well as the expected change in price. The results on sales closely resemble those on production. I don't document a link between the expected depreciation and the fraction

	(1)	(2)	(3)
Expected demand	-0.59		
	(0.07)		
Expected recruitment		-0.82	
		(0.09)	
Expected wages			-1.59
			(0.18)
Expected output growth	-0.25	-0.24	-0.03
	(0.02)	(0.02)	(0.01)
Expected inflation	0.29	0.29	0.28
	(0.04)	(0.04)	(0.06)

Table A.5: Macroeconomic Beliefs and Exchange Rate Forecast

Notes: The table reports coefficients from panel regressions with firm fixed effects. The dependent variable is the expected annual depreciation. Each column includes a different belief variable of interest: expected demand, recruitment, or wages. All models control for expected output growth and inflation. Data on expected demand and recruitment span the whole sample, but the data on wages starts in October 2017. Standard errors are clustered at the firm level.

of firms that intend to raise prices.

Table A.6 supports these findings by regressing exchange rate expectations on the action variables, controlling for the forecasted output and inflation, as well as log exchange rate at the beginning of the year. For example, a firm that has recently hired new employees expects, on average, annual depreciation to be 0.75% lower compared to a firm that kept its employment constant or 1.50% lower depreciation compared to a firm that has reduced its workforce.

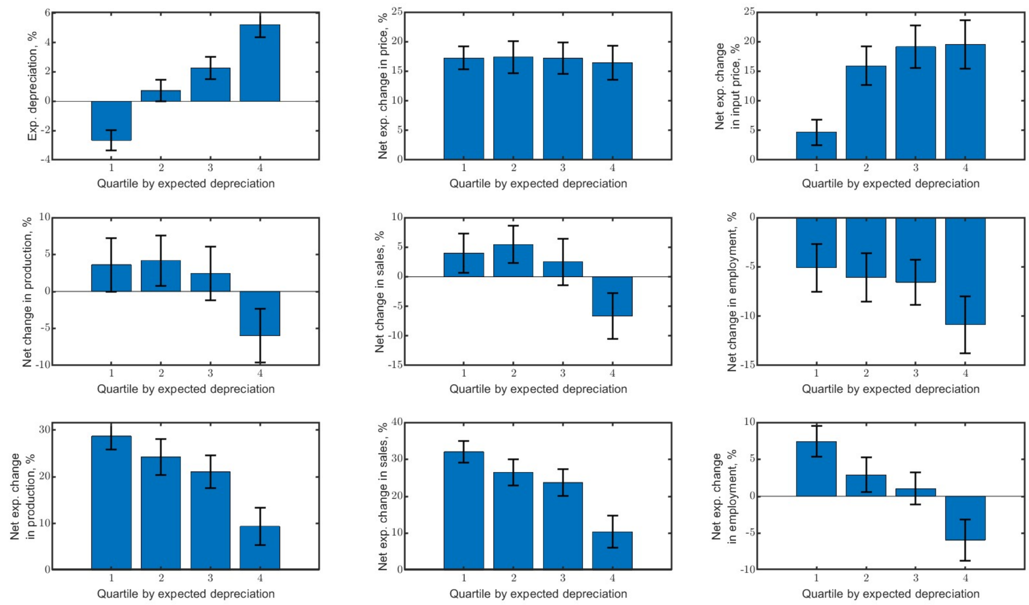

Figure A.8: Recent and Expected Actions by Expected Depreciation: Non-Residualized

Notes: The Figure shows the recent and expected actions of firms by expected depreciation quartiles. The observations are sorted into four quartiles by expected exchange rate forecast, and the average is calculated for each quartile. The Figure reports the time series average. The responses for outcome variables can take values -1, 0, and 1 depending on the sign of change. The net change of x% means that there are x% more firms reporting an increase in the variable than firms expecting a decrease. The 90% confidence intervals are estimated with a t-test.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Production	-0.27							
	(0.06)							
Sales		-0.37						
		(0.05)						
Employment			-0.75					
			(0.09)					
Expected production				-0.59				
				(0.10)				
Expected sales					-0.67			
					(0.08)			
Expected employment						-0.64		
						(0.10)		
Expected price							-0.07	
							(0.09)	
Expected input price								0.14
								(0.09)
Expected output growth	-0.26	-0.26	-0.25	-0.06	-0.06	-0.05	-0.25	-0.28
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Expected inflation	0.32	0.27	0.24	0.39	0.36	0.60	0.30	0.30
	(0.06)	(0.04)	(0.04)	(0.07)	(0.06)	(0.05)	(0.04)	(0.05)

Table A.6: Actions and Exchange Rate Forecast

Notes: The table presents coefficients from panel regressions with firm fixed effects. The dependent variable is the expected annual depreciation. Columns (1)–(3) include realized actions (production, sales, employment); columns (4)–(6) include expectations of those variables. Columns (7)–(8) include expected price and input price changes. Data for expected production, sales, and employment are available from 2015 onward; all other variables span from 2009–2022. Standard errors are clustered at the firm level.

B Model

B.1 Analytical Example: Derivation of the Price of Non-Tradables

To derive the price of non-tradables p_{NT} set at period t and kept constant forever, I use the price-setting equation

$$p_{NT} = (1-\beta)\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k w_{t+k}$$

and plug it into the country resource constraint:

$$\mathbb{E}_t \sum_{k=t}^{\infty} \beta^t \left(\frac{\alpha}{1-\alpha}(e_t - w_t) - a(c_t - e_t + p_t) \right) = 0.$$

This transformation allows rewriting p_{NT} as a function of the expected discounted sum of the expression depending on consumption, prices, and exchange rate:

$$\frac{\alpha}{1-\alpha}\frac{p_{NT}}{1-\beta} = \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\alpha}{1-\alpha} e_{t+k} - a(c_{t+k} - e_{t+k} + p_{t+k}) \right).$$

Using the result for consumption derived in the main section, I write imports as a function of the expected path of financial shock, $m_t = c_t - e_t + p_t = -\frac{\psi_t}{1-\hat{\rho}}$. Then, the expression becomes

$$\frac{\alpha}{1-\alpha}\frac{p_{NT}}{1-\beta} = \frac{a\psi_t}{(1-\hat{\rho})(1-\beta\hat{\rho})} + \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\alpha}{1-\alpha} e_{t+k} \right),$$

where I use the fact that the financial shock ψ_t is expected to evolve according to the AR(1) process with persistence $\hat{\rho}$.

To simplify the discounted sum of exchange rates, I use the expression for exchange rates as a function of financial shock and CPI prices derived in the main section, $e_t = \frac{\psi_{t+k}}{1-\rho} - (\phi_\pi - 1)\,\bar{p} + \phi_\pi p_{t+k-1}$. Then, it can be written in the following way:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k e_{t+k} = \frac{\psi_t}{(1-\hat{\rho})(1-\beta\hat{\rho})} + \frac{(1-\phi_\pi)p_{NT}}{1-\beta} + \beta\phi_\pi \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k p_{t+k}.$$

For the second term, I use the fact that since non-tradable prices cannot be reset in the future and real variables converge to the steady state, the long-run deviation of the aggregate price level must equal the deviation in non-tradable prices, $\bar{p} = p_{NT}$.

As for the discounted sum of prices, I write it as a function of the current price of non-tradables and the discounted sum of the exchange rate:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k p_{t+k} = \frac{(1-a)p_{NT}}{1-\beta} + a \sum_{k=0}^{\infty} \beta^k e_{t+k}.$$

Plugging this expression back into the expected discounted sum of the exchange rates, I get

$$\sum_{k=0}^{\infty} \beta^k e_{t+k} = \frac{1}{1-\beta\phi_\pi a}\left(\frac{\psi_t}{(1-\hat{\rho})(1-\beta\hat{\rho})} + \frac{(1-\phi_\pi)p_{NT}}{1-\beta} + \beta\psi_\pi(1-a)\frac{p_{NT}}{1-\beta}\right).$$

Finally, I substitute it into the expression for the price of non-tradables and express it as a function of financial shock:

$$p_{NT} = \frac{\psi_t}{(1-\hat{\rho})(1-\beta\hat{\rho})}\frac{a+\Lambda}{\Lambda\phi_\pi},$$

where $\Lambda = \frac{\alpha}{1-\alpha}\frac{1}{1-\beta\phi_\pi a}$.

C Quantitative Model

C.1 Model Solution

Baseline Behavioral Model. The model is solved as a standard first-order DSGE model modified to account for the behavioral expectations of firms and households, where all economic agents have identical beliefs. I solve the behavioral model by estimating two rational expectation models with true and behavioral parameters ρ and $\hat{\rho}$ and using them to construct the law of motion of the behavioral economy. The forward-looking decisions are based on observable states and behavioral expectations, while the backward-looking variables evolve according to the true shock process.

I consider a state-space representation

$$s_t = As_{t-1} + Bu_t,$$

$$x_t = \Phi s_t,$$

where s_t is a vector of control variables, x_t is a vector of control variables, and u_t is a vector of exogenous shocks. A and B are matrices describing the law of motion of the economy, and Φ is a policy function matrix. Under rational expectations, both $A(\cdot)$ and $B(\cdot)$ are functions of the persistence of the shocks. Moreover, $A(\rho)$ and $B(\rho)$ only differ from $A(\hat{\rho})$ and $B(\hat{\rho})$ in the column referring to ψ and ε_ψ correspondingly. The two models are identical except for the persistence of the financial wedge, its impact on other variables, and the impact of the innovation ε_ψ.

A behavioral model with true persistence ρ and perceived persistence $\hat{\rho}$ should satisfy the following properties:

1. The economic agents know the current state of the economy but misspecify its future trajectory. Given the true state vector s_t, the controls should evolve as in the $\hat{\rho}$ model,

$$x_t = \Phi(\hat{\rho})s_t$$

2. The shocks evolve according to the true laws of motion, $\psi_t = A(\rho)^{(\psi)}\psi_{t-1} + B(\rho)^{(\psi)}u_t$.

3. The rest of the states evolve according to the law of motion under perceived persistence $\hat{\rho}$ and misspecified innovation $\hat{u}_t$. Upon seeing the realization of the shock ψ_t, the agents don't use it to learn its true process. Instead, they interpret the predictable error $\rho\psi_{t-1} - \hat{\rho}\psi_{t-1}$ as a part of the innovation to the shock, $\hat{\varepsilon}_t^\psi$. Therefore, the states evolve as follows:

$$s_t^{(-\psi)} = A^{(-\psi)}(\hat{\rho})s_{t-1} + B^{(-\psi)}(\hat{\rho})\hat{u}_t =$$
$$A^{(-\psi)}(\hat{\rho})s_{t-1} + B^{(-\psi)}(\hat{\rho})u_t + B^{(-\psi)}(\hat{\rho})\left(A(\rho) - A(\hat{\rho})\right)s_{t-1},$$

where $\hat{u}_t$ refers to the misinterpreted innovation.

Notice that for the rows referring to shocks, $B^\psi(\cdot)$ only has one non-zero entry. It is equal to one and refers to the impact of the innovation ε^ψ. Therefore, the expression in property 3 can include the financial wedge ψ while still satisfying property 2, which results in the law of motion of the economy of the following form:

$$s_t = A(\hat{\rho})s_{t-1} + B(\hat{\rho})u_t + B(\hat{\rho})\left(A(\rho) - A(\hat{\rho})\right)s_{t-1}.$$

To solve the model, I estimate rational expectation models with parameters ρ and $\hat{\rho}$. Then, I modify the latter by replacing the transition matrix $A(\hat{\rho})$ with $A(\hat{\rho}) + B(\hat{\rho})\left(A(\rho) - A(\hat{\rho})\right)$. I record the behavioral expectations of the agents as separate variables. However, those expectations contain systematic errors and are not consistent with the future trajectory of the economy.

Behavioral Model with $\hat{\rho}^{hh} \neq \hat{\rho}^{f}$. Next, I outline the model solution when the perceived persistence of shocks differs for households and firms, with one type of agent being behavioral and the other being rational. The approach is based on approximating the long-run expectations of households entering international and domestic Euler equations.

After forward substitution, the international Euler equation can be expressed as

$$\frac{\mathcal{E}_t}{P_t}\Theta_t = \beta R^* e^{\psi_t} e^{\psi_B B_{t+1}} \mathbb{E}_t^{hh}\left(\frac{\mathcal{E}_{t+1}}{P_{t+1}}\Theta_{t+1}\right) = \mathbb{E}_t^{hh}\Pi_{k=0}^{\infty} e^{\psi_{t+k}} e^{\psi_B B^*_{t+1+k}} \frac{\bar{\mathcal{E}}}{\bar{P}}\bar{\Theta},$$

where $\Theta_t = \left(\frac{C_t - \varphi N_t^{1-\phi}}{1-\phi}\right)^{-\sigma}$, and $\bar{X}$ refers to the expected long-run value of a variable X.

As the financial shock is exogenous, I rewrite the first term as $\mathbb{E}_t^{hh}\Pi_{k=0}^{\infty} e^{\psi_{t+k}} = e^{\frac{\psi_t}{1-\hat{\rho}^{hh}}}$. Moreover, if the economy converges to a steady state, the long-run ratio of the nominal exchange rate and CPI is not affected by short-term dynamics. The expected path of external debt is approximated using the policy functions[7], $B^*_{t+k+1} \sim f(B_{t+k}, \psi_{t+k})$.

Similarly, by substituting the domestic Euler equation forward and using the Taylor rule, I get

$$\frac{\Theta_t}{P_t} = \mathbb{E}_t^{hh}\left(e^{\psi_\pi\left(\frac{\bar{P}}{P_{t-1}}-1\right)}\frac{\bar{\Theta}}{\bar{P}}\right).$$

I assume that households change their long-run expectations in response to the latest perceived innovation to the financial wedge, $\mathbb{E}_t^{hh}\bar{p} = \mathbb{E}_{t-1}^{hh}\bar{p} + \delta(\psi_t - \mathbb{E}_{t-1}^{hh}\psi_t)$. If the households are rational, they only respond to the true innovation ε_t^{ψ}. However, if they are behavioral, they also adjust their expectations in response to the systematic forecast error, $\hat{\varepsilon}_t^{\psi} = \varepsilon_t^{\psi} + (\rho - \hat{\rho})\psi_{t-1}$. The parameter δ is estimated with the guess-and-verify procedure. To verify a guess of the parameter δ, I compare the long-run expectations of households $\mathbb{E}_t^{hh}\bar{p}$ with the realized long-run prices according to the impulse response to a financial shock in a model where true persistence is equal to the households' beliefs, $\rho = \hat{\rho}^{\psi}$.

An important consideration is that the long-run prices and, consequently, parameter δ depend not only on the expectations of households but also on the expectations of firms. I consider three possible cases.

Case 1: Rational households and rational firms. Since the expectations are rational, the long-run price level $\bar{p}$ is updated only once in response to the initial shock. The parameter δ^{RE} corresponds to the responses of firms with perceived persistence ρ and matches the baseline rational expectations model.

Case 2: Rational households and behavioral firms. The approach is based on estimating the behavioral model where the law of motion follows the true persistence ρ, while behavioral firms set prices under the perceived persistence $\hat{\rho}$, and households' expectations are approximated to be consistent with the model's realizations. I follow a three-step process similar to the one for the baseline behavioral model.

First, a rational model with persistence ρ is estimated using the parameter δ^{RE}. Second,

[7] I use policy functions from a RE model with $\rho = \hat{\rho}^{hh}$. The results are not sensitive to updating the policy functions for the versions of the model constructed below.

I guess a parameter $\delta^{BE} \neq \delta^{RE}$ and estimate a rational expectations model with persistence $\hat{\rho}$. Then, I use the two estimated models and the parameter δ^{BE} to construct a behavioral model with approximated expectations of rational households. If the guess on δ^{BE} is correct, the rational households should be able to correctly predict the long-run price level $\bar{p}$ while accounting for the true shock process and the price-setting rule of behavioral firms. In this model, the expectations of firms and households differ, but each types of agent can understand the decision-making of the other type.

Case 3: Rational households and behavioral firms. In this case, I estimate the δ^{BE} parameter using the approach from Case 2. Then, I return to the model estimated in the second stage. It refers to the case when firms' expectations are consistent with the true law of motion, and household expectations are behavioral since they would be consistent with an economy under a different persistence.

Heterogeneous Firms. I use a similar approach to solve the model extension with two types of firms. In this extension, households and half of the firms are behavioral, while the other half of the firms are rational. The setting is described in detail in C.9.

I modify the model by approximating the expectations of rational firms and verifying them by showing consistency with the model realizations.

I express the beliefs of the rational firms as a function of the behavioral firms' expectations and their systematic bias:

$$\beta \mathbb{E}_t^{RE} \pi_{S,t+1}^{RE} = \omega_S(\hat{\rho} - \rho)\psi_t + \beta \mathbb{E}_t^{BE} \pi_{S,t+1}^{RE},$$

where $S \in [NT, HT, X]$ is the sector of the firm, x^{BE} and x^{RE} denote the variables referring to behavioral and rational firms correspondingly, and ω_S is a parameter that I guess and verify. The Phillips curves are expressed as

$$\pi_{S,t}^{RE} = \omega_S(\hat{\rho} - \rho)\psi_t + \beta \mathbb{E}_t^{BE} \pi_{S,t+1}^{RE} + \lambda_a(mc_{S,t}^{RE} - p_{S,t}^{RE}),$$

I estimate a behavioral model where households and a measure 0.5 of firms expect the economy to evolve according to the persistence $\hat{\rho}$ while the true law of motion is ρ. I verify the guess of the parameters ω_S by estimating the impulse response to financial shock and comparing the expected inflation for rational firms $\mathbb{E}_t^{RE} \pi_{S,t+1}^{RE}$ with their approximated expectations.

C.2 Exchange Rate Pass-Trough Frontloading: Details and Robustness

In this appendix, I report additional information and robustness checks on ERPT frontloading in the data and models. I present the empirical estimates, provide comparative statistics for the performance of the BE and RE models, and report peak timings as an alternative measure of frontloading, robust to the choice of normalization.

Figure C.1 and Figure C.2 illustrate the empirical cumulative and quarterly local projection estimates for import prices, the CPI, and the core CPI. Due to the availability of the monthly data, the analysis uses the CPI for the Lima Metropolitan area rather than a national series. The ERPT into import prices is nearly complete on impact, but decreases on the longer horizons. The high short-run pass-through stems from the dominance of dollar pricing and justifies the assumption of the law of one price in the theoretical model. The pass-through into CPI and core CPI increases in the first 4 quarters after the shock but declines slightly afterwards. The hump-shaped ERPT may be attributed to the persistent

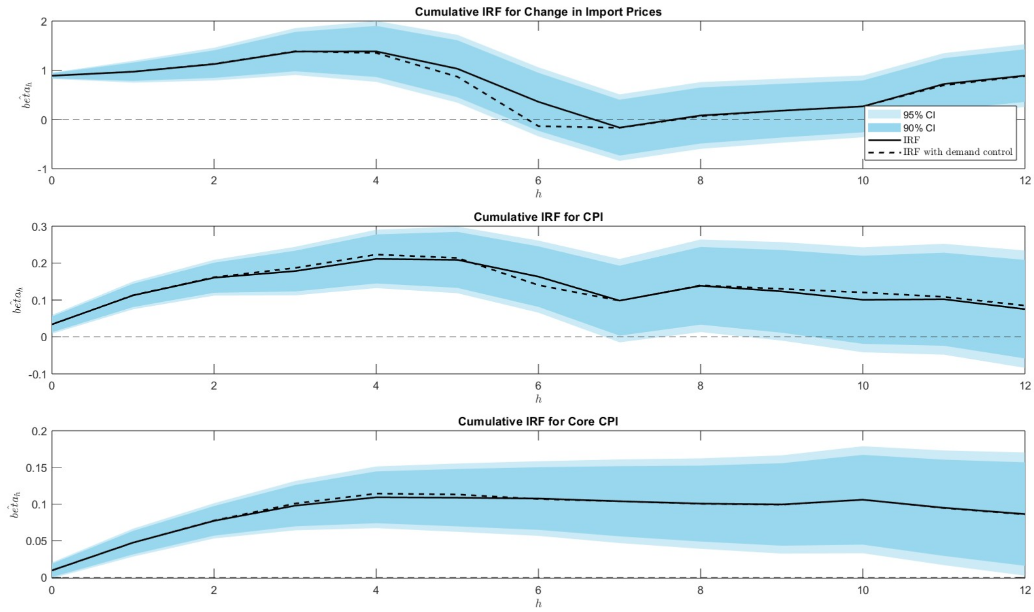

Figure C.1: Local Projections for Cumulative Exchange Rate Pass-Through

Notes: The figure shows the cumulative response of import prices, CPI, and core CPI to a 1% depreciation of the nominal exchange rate. The local projections are estimated at quarterly frequency using monthly data from the Central Reserve Bank of Peru for 2009-2021. Both dependent and independent variables are in log differences. The controls include the log difference in US export prices (sourced from the US Bureau of Economic Analysis) and the lags of the dependent variable and the log difference in demand (dotted line only). Blue and light blue areas denote 90% and 95% confidence intervals, respectively, with Newey-West standard errors. Price and demand indices are deseasoned.

decline in demand following a depreciation, as shown in Appendix C.10, or high immediate pass-through into dollarized inputs followed by pricing-to-market. My estimates on the ERPT into CPI are consistent with a study by Rodriguez et al. (2024), who use time-varying parameter VAR to estimate ERPT in Peru, both in magnitude and shape.

Figure C.3 and table C.1 complement the comparison between the BE and RE models with additional statistics. Figure C.3 compares the ERPT frontloading in the BE and RE models (blue and red, respectively) against the empirical estimates on core CPI (black). I calculate the frontloading coefficient FC_h for horizons h from 0 to 8 as $FC_h = \beta_h/\beta^{LR}$, where β_h is an estimated coefficient for cumulative local projection and β^{LR} is the long-run ERPT defined as the average cumulative ERPT on horizons h from 9 to 12, $\beta^{LR} = 1/4\sum_{j=9}^{12}\beta_j$. In the data, ERPT is slightly hump-shaped, peaking at 4 quarters after the impact and gradually declining to its long-run level by quarter 8[8]. The immediate response of prices is small, only 10% of the long-run level. Neither the BE nor the RE model captures the hump, and both overshoot the immediate impact. However, they differ in how long it takes for the ERPT to approximate its long-run level. Both models underestimate the pace of the ERPT, however, the empirical ERPT frontloading lies within 90% confidence interval of the BE model for most periods, while dramatically exceeding the estimates in the RE model.

[8] A possible explanation for the slight decline in ERPT on longer horizons is the delayed drop in demand, as documented in Appendix C.10.

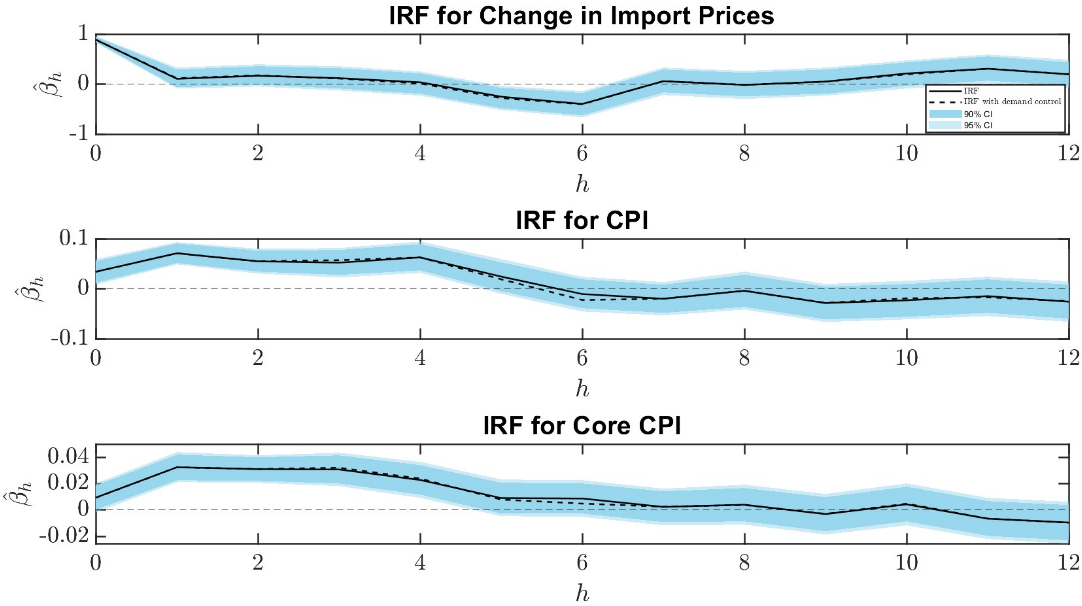

Figure C.2: Local Projections for Quarterly Exchange Rate Pass-Through

Notes: The figure shows the quarterly response of import prices, CPI, and core CPI to a 1% depreciation of the nominal exchange rate. The local projections are estimated at quarterly frequency using monthly data from the Central Reserve Bank of Peru for 2009-2021. Both dependent and independent variables are in log differences. The controls include the log difference in US export prices (sourced from the US Bureau of Economic Analysis) and the lags of the dependent variable and the log difference in demand (dotted line only). Blue and light blue areas denote 90% and 95% confidence intervals, respectively, with Newey-West standard errors. Price and demand indices are deseasoned.

Table C.1 compares the pace of exchange rate transmission into prices by reporting the quarter when the cumulative ERPT reaches 50%, 75%, 90%, and 95% of its long-run value. The empirical estimates are provided for both the CPI and the core CPI. For the theoretical models, I present the median and 90% confidence interval for every threshold. The table confirms that the BE model fits the data better than the RE model.

C.3 Unconditional Moments for Multi-shock Economy

This section studies the unconditional moments in a two-shock economy and shows that the BE model can match the exchange rate disconnect moments as well as the RE model with beliefs of the same persistence. I show that augmenting the model with an additional shock doesn't change the conclusions outlined in the main section.

As the second shock, I introduce a shock to the total factor productivity (TFP) that affects both tradable and non-tradable firms. I assume that the true and perceived persistence for this shock is the same as for financial shock, $\rho_a = \rho_\psi$ and $\hat{\rho}_a = \hat{\rho}_\psi$. Appendix C.5 discusses the impulse response to a 1% TFP shock under both rational and behavioral beliefs.

Table C.2 reports the unconditional moments for BE and RE models. The volatility of the TFP shock $\frac{\sigma e_a}{\sigma e_\psi}$ matches the volatility of the exchange rate relative to output, $\sigma(\Delta e)/\sigma(\Delta y)$. I calibrate every model specification separately since both the true and perceived persistences

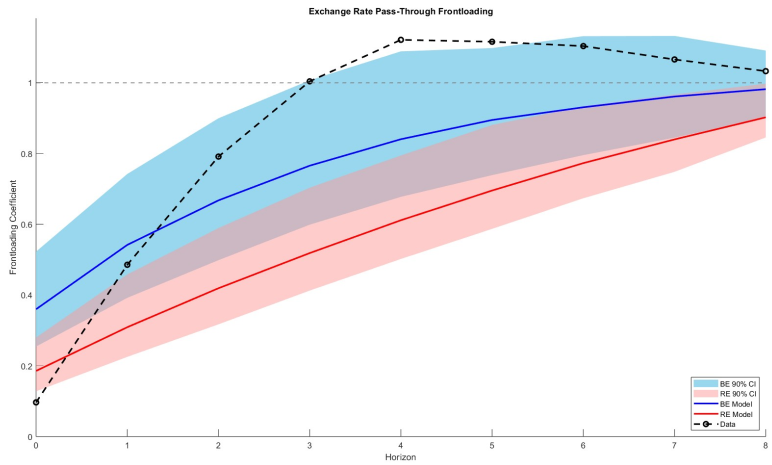

Figure C.3: Frontloading in Exchange Rate Pass-Through

Notes: The plot compares the empirical ERPT frontloading on horizons from 0 to 8 quarters with the counterparts in two models: BE with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and RE with $\rho = \hat{\rho} = 0.94$. I estimate the empirical cumulative ERPT at the quarterly frequency using monthly data on exchange rate and core CPI from the Central Reserve Bank of Peru for 2009-2022. I control for the lag of the dependent variable and the log difference in US export prices, sourced from the U.S. Bureau of Economic Analysis. The CPI index is deseasoned. The blue and red areas refer to the 90% confidence intervals for the RE and BE models, respectively. The solid lines represent the median across 100 simulations. A simulation spans 1200 periods, with the first 200 omitted.

	50% LR ERPT	**75% LR ERPT**	**90% LR ERPT**	**95% LR ERPT**
Data, core CPI	2	2	3	3
Data, CPI	1	2	4	4
BE Model, median	1	4	6	7
BE Model, 90% CI	[0, 3]	[2, 6]	[3, 8]	[3, 10]
RE Model, median	4	6	9	9
RE Model, 90% CI	[2,4]	[4, 7]	[6, 9]	[7, 10]

Table C.1: Frontloading in Cumulative Exchange Rate Pass-Through to CPI

Notes: The table compares the empirical frontloading in the exchange rate pass-through with its counterparts in two models: BE with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and RE with $\rho = \hat{\rho} = 0.94$. I define the long-run pass-through (LR ERPT) as the mean pass-through at horizon from 9 to 12, $\beta^{LR} = 1/4 \sum_{j=9}^{12} \beta_j$, and report the horizon h at which the cumulative ERPT reaches 50%, 75%, 90%, and 95% of LR ERPT. The model moments are the median and 90% confidence intervals across 100 simulations. A simulation spans 1200 periods, with the first 200 omitted.

of the shocks affect the volatility of the two variables.

The BE model with $\rho = 0.78$ and $\hat{\rho} = 0.94$ and the persistent RE model with $\rho = \hat{\rho} = 0.94$ result in similar comovement patterns between real exchange rate, output, and consumption, capturing the excess volatility of the exchange rate and the negative correlation with output and consumption. The persistence of the exchange rate is also similar in the two models. However, by construction, only the behavioral model generates the biased forecast with the significant $\beta_{BGS} < 0$ and $\beta_{CG} < 0$.

	Data	**BE**	**RE,** $\rho = 0.78$	**RE,** $\rho = 0.94$
$\sigma(\Delta e)/\sigma(\Delta y)$	3.32	3.29	3.27	3.28
$\rho_3(Ee)$	1.02	1.01	0.98	1.00
β_{BGS}	-0.03	-0.03	0.00	0.00
β_{CG}	-0.35	-0.10	-0.01	-0.01
$\rho(e)$	0.99	0.98	0.99	1.00
$\sigma(\Delta e)/\sigma(\Delta c)$	3.50	2.07	3.09	2.14
corr$(\Delta c, \Delta q)$	-0.12	-0.68	0.12	-0.61
corr$(\Delta y, \Delta q)$	-0.06	-0.44	0.45	-0.33
corr$(\Delta c - \Delta c^*, \Delta q)$	-0.25	-0.68	0.12	-0.61
corr$(\Delta y - \Delta y^*, \Delta q)$	-0.09	-0.44	0.45	-0.33
$\sigma e_a/\sigma e_\psi$		1.2	2.25	1.35

Table C.2: Non-Targeted Moments: Financial and TFP Shocks

Notes: The table presents the non-targeted moments. The empirical unconditional macro moments are calculated using data from the Central Reserve Bank of Peru for the period 2009–2022. The second column refers to the one-shock behavioral model with $\rho_\psi = 0.78$ and $\hat{\rho}_\psi = 0.94$. The third and fourth columns refer to the rational expectations model with persistence of 0.78 and 0.94, respectively. The relative magnitude of financial and TFP shocks for every model specification matches the empirical volatility of the exchange rate relative to output, $\sigma(\Delta e)/\sigma(\Delta y)$. The business cycle moments are the median across 100 simulations of the model. A simulation spans 1200 periods, with the first 200 omitted.

The transitory RE model with $\rho = \hat{\rho} = 0.78$ doesn't generate a negative correlation between real exchange rate and relative consumption or output: the response of the real variables to financial shock is weak and insufficient to offset the positive correlation between exchange rate and consumption due to TFP shock.

C.4 Consistency with Cross-Sectional Data: Robustness

In this section, I conduct two robustness checks on the comparison between the firm's response to expected depreciation in the model and in the data. First, I discuss sectoral responses to the news about the financial shock. Second, I explore an alternative approach to generating differences in financial shock expectations and discuss the resulting responses in expected actions.

Sectoral Response to Financial Shock News. Figure C.4 shows that both tradable and non-tradable sectors show the propensity to contract when they receive the news of financial-shock-driven depreciation. Both sectors increase the local currency prices, and domestic demand for their product falls. At the same time, tradable firms decrease their dollar prices and increase their export. However, the prices in the domestic market are more sensitive: nominal wages are expected to increase, rising local price costs and partially offsetting the increase in export competitiveness due to depreciation. Thus, even for the tradable firms, the contractionary effect dominates. Tradable firms show contraction of lower magnitude than non-tradable firms, yet the direction of change is similar for both sectors.

Varying beliefs about financial shock persistence. This robustness check shows an alternative way to model the disagreement about the expected financial wedge and the exchange rate. Here, the firms are exposed to the same shock at period $t = 0$ but expect it to have different persistence, which closely resembles the behavioral bias in the baseline model.

A small firm i, which cannot affect the aggregate conditions in the economy, disagrees with other firms and households on the persistence of the financial shock, $\hat{\rho}^i_\psi \neq \hat{\rho}_\psi$. Firm i knows the macro behavioral parameter $\hat{\rho}_\psi$. The individual parameter $\hat{\rho}^i_\psi$ may be behavioral or rational.

I study an impulse response of the economy to 1% financial shock and how macroeconomic expectations and current and expected actions of a firm i vary depending on its individual expected persistence of financial shock $\hat{\rho}^i \in [0.3, 1.0] \neq \hat{\rho}$, which can take eight possible values. For symmetry, I run impulse responses to positive and negative financial shocks. For each, I sort the responses by expected depreciation, divide them into four groups, and estimate the average for every quartile. For the expected exchange rate, output, and inflation, I use two-quarter-ahead forecasts. For variables with qualitative survey responses, I construct an index based on the difference between the shares of expanding and contracting firms to ensure consistency with the data. While working with the firms' own actions, I calculate them separately for price-updating and non-updating firms in both sectors and report the weighted average. Additionally, I add noise[9] by assuming a small firm also expects a TFP shock in the next period. I set the true persistence to be the same for the two shocks, $\rho_a = \rho_\psi = 0.78$, and calibrate their relative standard deviation σ_a/σ_ψ to match the relative standard deviations of the expected exchange rate and output, $\sigma(\mathbb{E}_{i,t}e_{t+1})/\sigma(\mathbb{E}_{i,t}y_{t+1}) = 3.3$.

Figure C.5 shows the recent and expected actions of firms by their exchange rate expectations. Similarly to the baseline specification, where differences in beliefs are generated by news, firms contract their current economic activity when they expect a higher exchange rate. In addition, this version of the model captures the expected decline in output. In the main specification, the decline is offset by the market share recovery of firm i: upon learning the news, the firm raises its prices, causing a sharp drop in demand for its variety, but when the shock hits the economy, the aggregate inflation restores the share of the firm i. In this specification, however, this effect is smaller since all price-adjusting firms respond to the shock at $t = 0$. With the market share effect being smaller, firms that expect more prolonged depreciation anticipate having to decrease their output due to the fall in aggregate demand and the possibility of their price optimization.

A limitation of this specification is the lack of association between expected depreciation and expected fall in employment and wages. The response of these variables to a financial shock is small, and their volatility is explained by TFP shock, resulting in expected depreciation associated with higher wages and employment.

C.5 Non-financial Shocks

In this section, I supplement the discussion about why non-financial shocks fail to capture both firm-level and aggregate contraction in response to expected depreciation by presenting impulse responses and additional cross-sectional firm responses by exchange rate forecast.

Figure C.6 shows the response of the economy to a positive TFP shock. As with financial shock, the red line denotes rational expectations with $\rho = 0.78$, while the blue line refers to a behavioral model with $\rho = 0.78$ and $\hat{\rho} = 0.94$. A positive TFP shock lowers marginal costs, allowing firms to reduce prices, which in turn boosts output and domestic consumption. Due

[9] Noise is necessary to avoid the cases when all firms update the expectation of the variable in the same direction and only differ in magnitude. In such cases, the index won't reflect the heterogeneity by expectations.

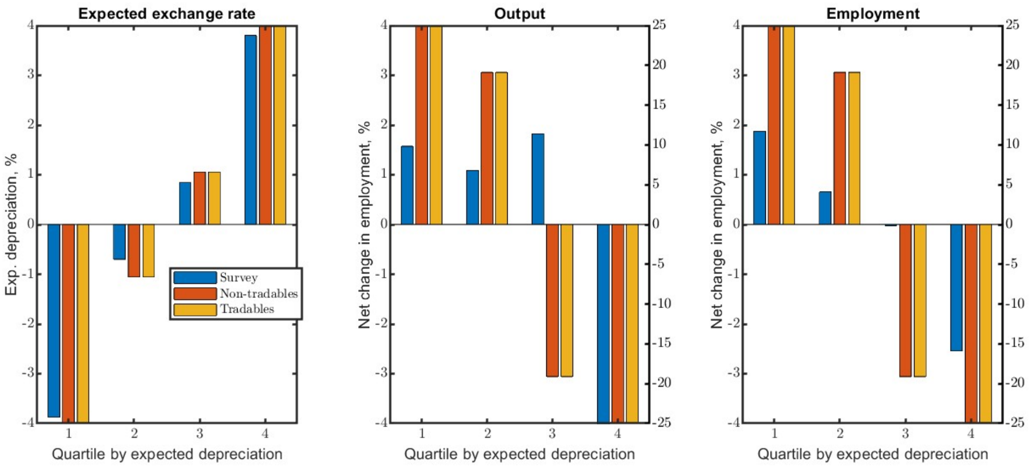

Figure C.4: Firms' Actions by Expected Depreciation: Tradable and Non-tradable Sectors

Notes: The figure compares the recent actions of firms in the tradable and non-tradable sectors by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms that receive news about financial shock in the next period. The figure shows the weighted average by price-updating status. The forecast horizon is two quarters for the exchange rate and one quarter for the other variables. The exchange rate survey estimates reflect the expected percentage change in the variable, while the other survey responses indicate the net share of agents reporting or expecting an increase.

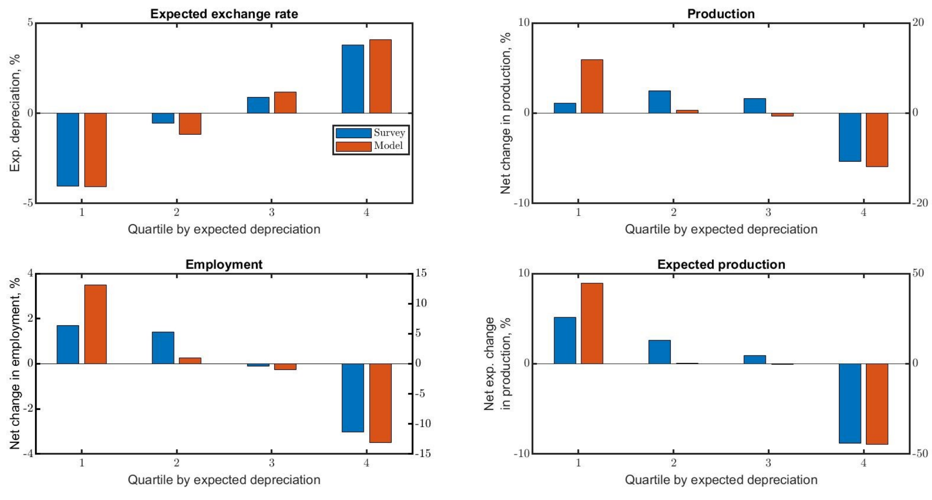

Figure C.5: Expected and Recent Actions by Expected Depreciation: Varying $\hat{\rho}^i_\psi$

Notes: The figure compares the recent and expected actions by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of a measure-0 firm with varying parameter $\hat{\rho}^i_\psi$ in response to the financial shock. The graph shows the weighted average by sector and price-updating status. The forecast horizon is two quarters for the exchange rate and one quarter for the other variables. The exchange rate survey estimates reflect the expected percentage change in the variable, while the other survey responses indicate the net share of agents reporting or expecting an increase.

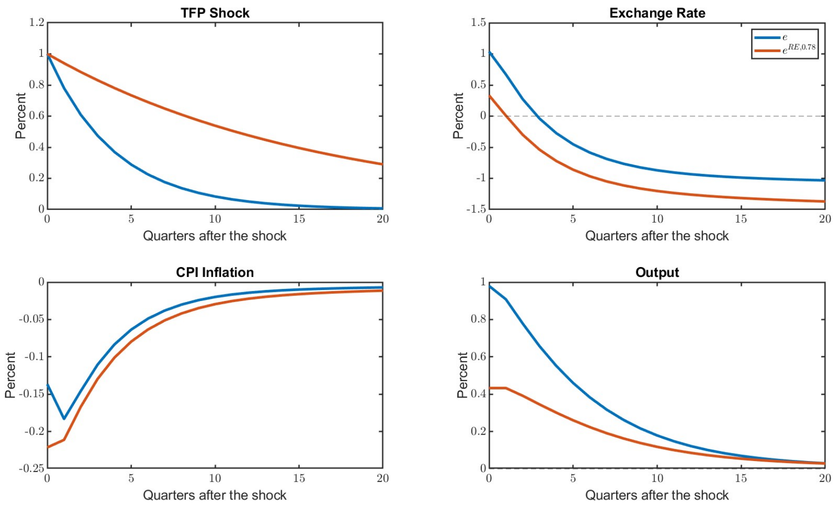

Figure C.6: Aggregate Response to a TFP Shock

Notes: The figure depicts theoretical impulse responses to a 1% TFP shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark.

to the monetary policy rule, deflation results in a decrease in nominal interest rate as monetary authorities stimulate the economy to help it achieve the potential output. As implied by the UIP condition, this leads to a current depreciation so that the resulting expected appreciation ensures no arbitrage between domestic and international assets. Therefore, exchange rate depreciation is expansionary.

Figure C.7 describes the response to a negative demand shock, which encourages households to save more and consume less. Output falls, the real wage declines due to reduced labor demand, and firms lower their prices in response to changes in labor costs and production scale. As with a TFP shock, this leads to a lower domestic interest rate and exchange rate depreciation.

Figure C.8 shows the cross-section of beliefs about the expected evolution of the economy by expected exchange rate changes explained by the two real shocks. The TFP shock fails to account for the contractionary economic environment. Demand shock is consistent with a decline in output and consumption but not with increasing prices. Moreover, as discussed in the paper, neither demand nor TFP shock can account for a firm contracting its output and employment in response to expected depreciation.

Figure C.9 discusses monetary policy shock. As the interest rate spikes, households increase their savings, leading to lower output and falling prices, similar to a demand shock. The exchange rate, however, appreciates in response to the higher domestic interest rate. Figure C.10 shows that the news about depreciation caused by monetary shock, similar to financial shock, can encourage firms to cut their economic activity. However, as shown in the main body of the paper, this shock is not consistent with the association between expected depreciation and contraction in output and demand.

In addition, none of these shocks can account for the combination of contractionary depreciation and volatile exchange rate. Demand shock can generate an economic downturn during depreciation, but the exchange rate becomes less volatile than output. Monetary shocks generate a strong exchange rate response, as interest rate changes directly affect

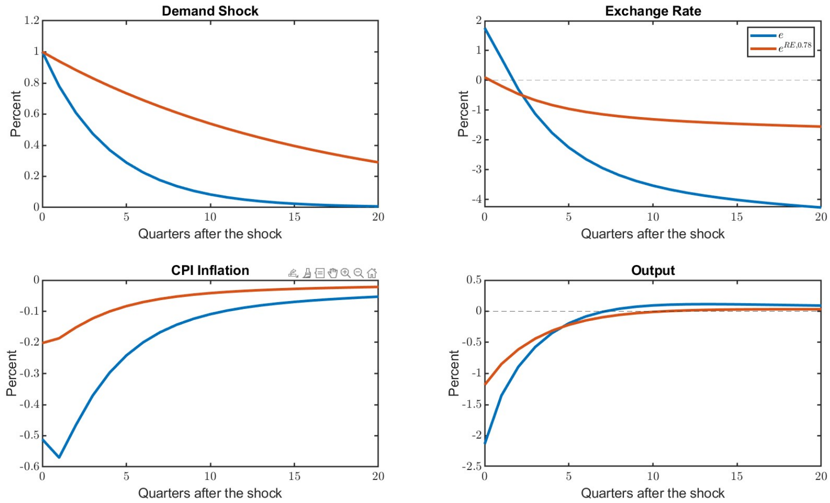

Figure C.7: Aggregate Response to a Demand Shock

Notes: The figure depicts theoretical impulse responses to a 1% demand shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark.

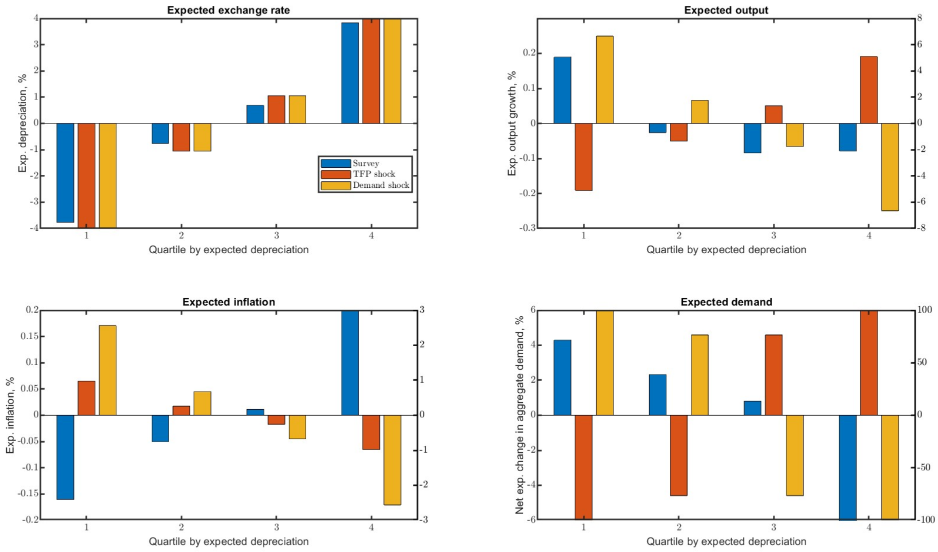

Figure C.8: Beliefs about Aggregate Economy by Expected Depreciation: TFP and Demand Shock

Notes: The figure compares the beliefs about the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of measure-0 firms receiving news about the next period TFP (red) or demand (yellow) shock. The forecast horizon is one quarter for aggregate demand and two quarters for other variables, with the difference originating from different types of survey questions. Expectations of the exchange rate, output, and inflation are quantitative, while expected demand is measured as the percentage-point difference between firms expecting expansion and those expecting contraction.

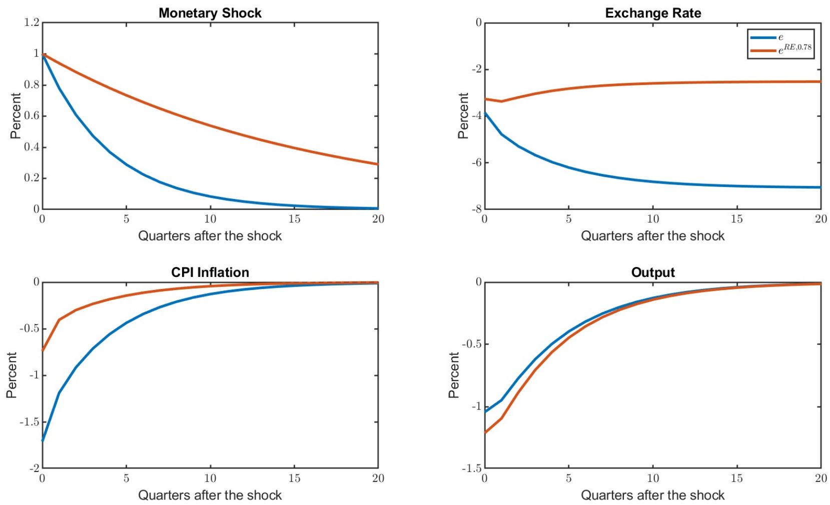

Figure C.9: Aggregate Response to a Monetary Shock

Notes: The figure depicts theoretical impulse responses to a 1% monetary policy shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark.

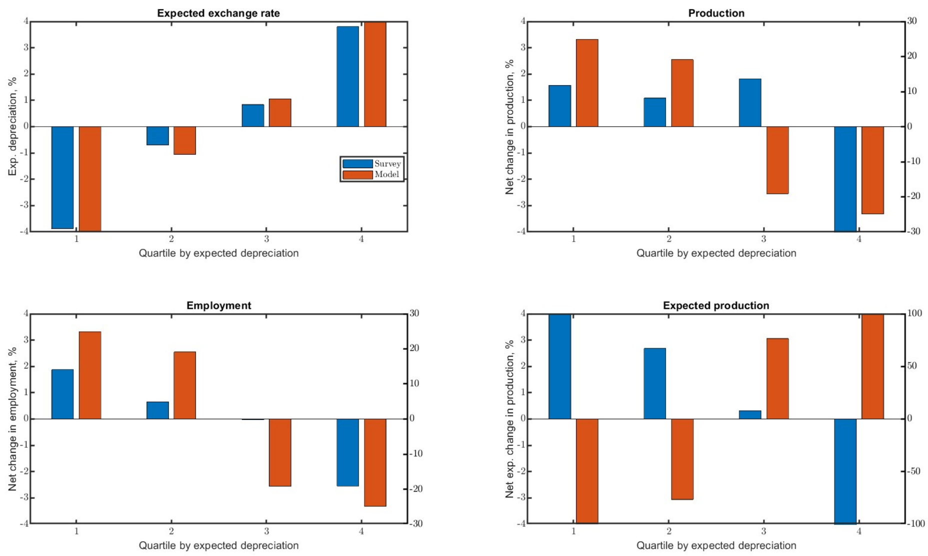

Figure C.10: Expected and Recent Actions by Expected Depreciation: Monetary Shock

Notes: The figure compares the recent and expected actions of a firm by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of a measure-0 firm in response to news about a monetary shock. The figure shows the weighted average by sector and price-updating status. The forecast horizon is two quarters for the exchange rate and one quarter for the other variables. The exchange rate survey estimates reflect the expected percentage change in the variable, while the other survey responses indicate the net share of agents reporting or expecting an increase.

the UIP condition. However, depreciations are expansionary as they are associated with monetary loosening. The TFP shock fails in both dimensions.

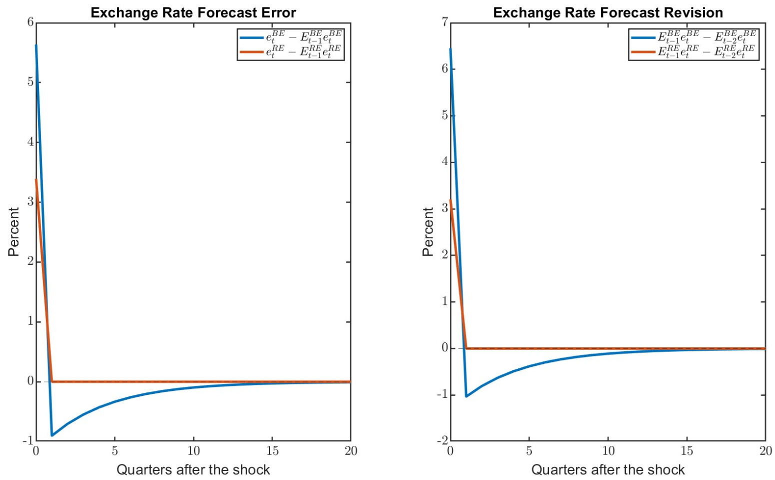

Figure C.11: Forecast Errors and Revisions in Response to a Financial Shock

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark.

Note that behavioral expectations amplify the response of the economy but do not change the direction of change.

C.6 Errors and Revisions of the Exchange Rate Expectations

To study the implications of misspecified beliefs, I show how the overestimated persistence of the financial shock, $\hat{\rho}_\psi > \rho_\psi$, translates into the systematic exchange rate error.

Figure C.11 shows the response of exchange rate error $e_t - \mathbb{E}_{t-1}e_t$ (left panel) and exchange rate forecast revision $\mathbb{E}_t e_{t+1} - \mathbb{E}_{t-1}e_{t+1}$ (right panel) to an unanticipated financial shock. On impact, both rational (red) and behavioral (blue) agents underpredict the exchange rate as it depreciates unexpectedly. Both revise their forecasts for the next quarter upwards. The difference between the models is driven only by the magnitude of the exchange rate response to the same shock.

However, starting $t = 1$ and assuming no additional shocks, the rational agents predict the exchange rate path accurately with zero error and make no revisions. In contrast, behavioral agents expect the exchange rate to stay depreciated, which leads to a negative forecast error as the exchange rate realizations start reverting to the mean. As the agents see the true realizations of the shock and the exchange rate, they gradually revise their forecasts downwards.

C.7 Rational Expectation Models with Low and High Persistence

This appendix augments the comparison of the BE and RE models' impulse responses with the analysis of the RE model of high persistence equal to the behavioral parameter. The goal is to clarify the roles of true versus perceived persistence and, additionally, to demonstrate how behavioral agents expect the economy to evolve after being hit by a shock.

Figure C.12 shows that at $t = 0$, the persistent RE economy with financial shock parameter of $\hat{\rho} = 0.94$ (yellow) responds identically to the BE model (blue) since the responses of the economies are shaped by the actions of agents who have identical expectations. However, starting at $t = 1$, the two specifications diverge. While the BE model generates exchange rate overshooting, with initial depreciation exceeding the long-run change in the exchange rate, in the persistent RE model, the exchange rate depreciates until it reaches the new nominal price level, which is high due to the strong response of firms. This dynamic provides additional insight into the causes of aggregate demand falling under behavioral expectations. Since the household expects the exchange rate to depreciate further after the initial impact, the cost of borrowing increases by more than the financial wedge ψ_t, resulting in a sharp drop in domestic demand. Another difference is that output recovers faster in the behavioral model, as agents eventually correct their expectations.

Figure C.13 provides additional details on the sectoral responses. The persistent RE model implies slow recovery in the non-tradable sector and amplifies the hump-shaped response of the tradables.

C.8 The Role of Price Stickiness

In this appendix, I discuss the role of price stickiness in the results of the paper. The flexible price model differs qualitatively from the baseline model, as firms now face a static problem, and their behavioral expectations no longer affect pricing decisions. Moreover, I use the model with a low degree of price stickiness that approximates flexible prices to gain insight into the mechanisms driving price increases during depreciations.

I compare the baseline model with $\theta = 0.75$, where only a quarter of firms can reoptimize their prices in a specific quarter, with a flexible price model approximated by setting $\theta = 0.05$, such that 95% of firms can adjust prices in a given period. I choose to work with the approximation to examine nominal variables and comment on the channels behind the inflationary impact of depreciation.

Sticky and flexible prices in RE model. First, I compare the response of the sticky and flexible price models to financial shock under rational expectations. Figure C.14 (red) depicts the impulse response of the exchange rate, output, and consumption to a positive financial shock under flexible prices. Compared to the baseline model, the response of exchange rates is slightly dampened, while consumption falls by more. Most importantly, under flexible prices, even the rational expectations model generates a recession.

The reason behind a sharper contraction is that the aggregate demand channel is stronger under flexible prices, and expenditure-switching dominates under price stickiness. Figures C.15 and C.16 show the response of the real exchange rate and real interest rates, defined as $rr_t = r_t - \mathbb{E}_t^{hh}\pi_{t+1}$, under flexible and sticky prices correspondingly. The sticky price model features a strong real exchange rate response that stimulates exports alongside a muted real interest rate response, which dampens the aggregate demand channel. Therefore, depreciation is expansionary. In contrast, under flexible prices, the real exchange rate is less volatile, and the contractionary demand channel dominates.

The reason for the relative importance of the two channels is the response of prices. The flexible price model generates stronger immediate inflation since all firms in the economy can reset their prices. That mutes the connection between nominal and real exchange rates, reduces expected inflation since the firms don't have to postpone price adjustment, and drives up the nominal interest rate. All these factors contribute to the real interest rate

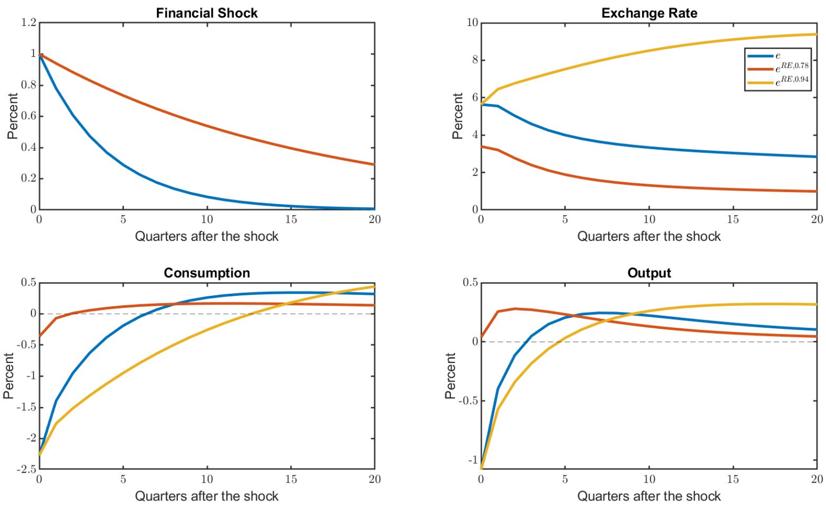

Figure C.12: Aggregate Response to a Financial Shock

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark. The yellow line represents the response of the persistent rational expectations economy with $\rho_\psi = 0.94$.

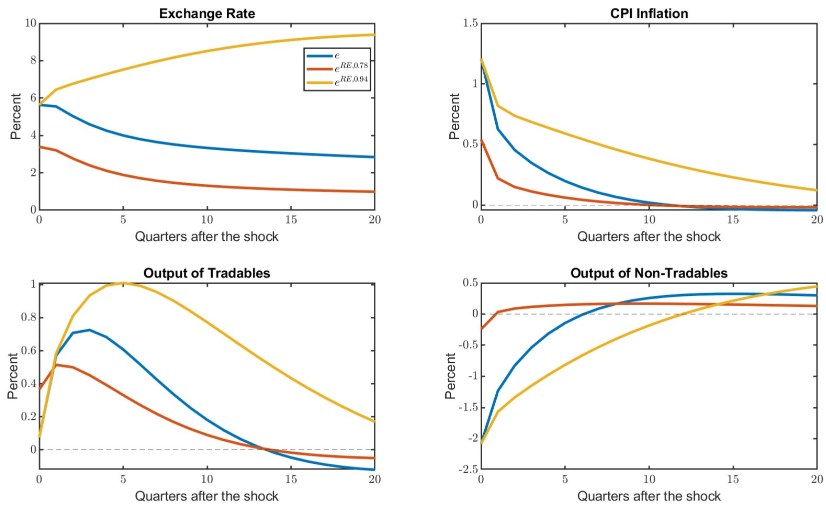

Figure C.13: Sectoral Response to a Financial Shock

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark. The yellow line represents the response of the persistent rational expectations economy with $\rho_\psi = 0.94$.

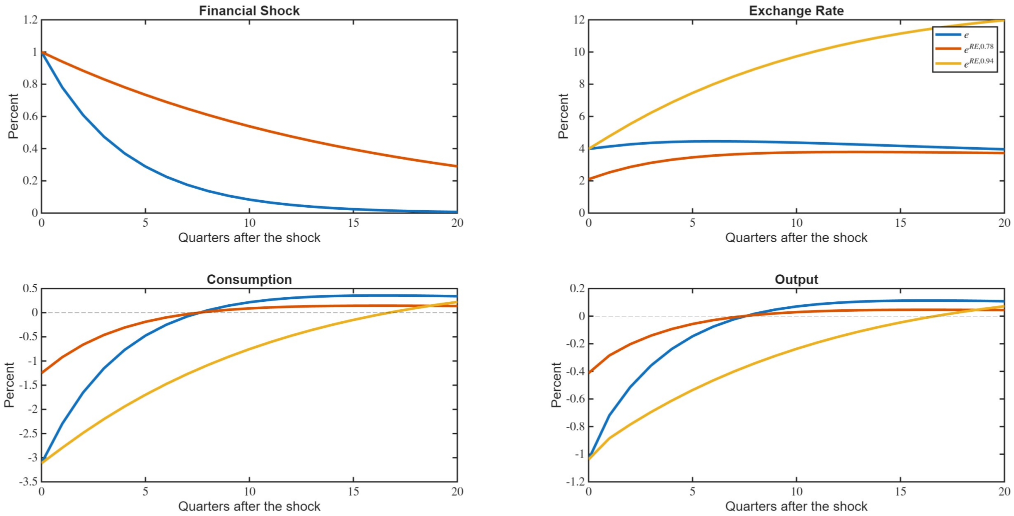

Figure C.14: Aggregate Response to a Financial Shock: Flexible Prices

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark. The yellow line represents the response of the persistent rational expectations economy with $\rho_\psi = 0.94$.

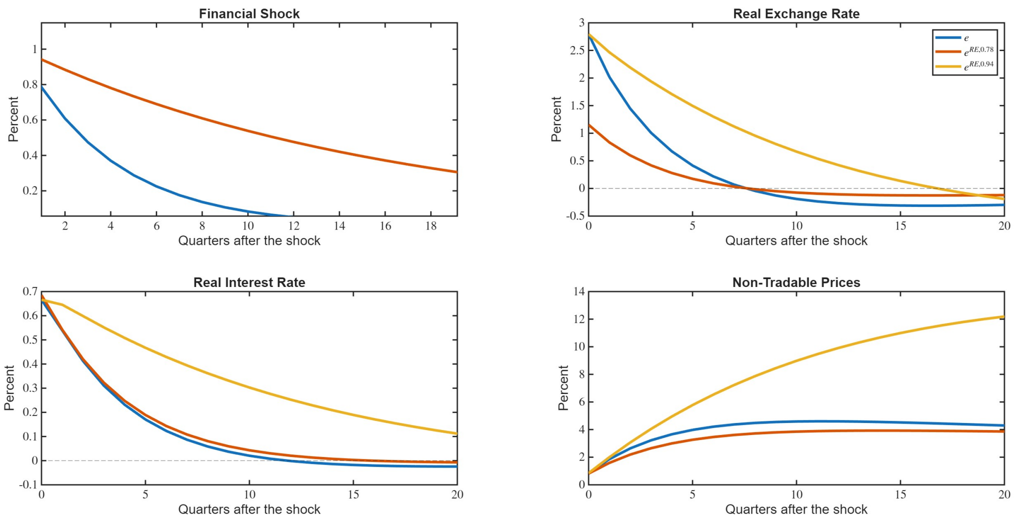

Figure C.15: Prices and Real Interest Rate Response to a Financial Shock: Flexible Prices

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark. The yellow line represents the response of the persistent rational expectations economy with $\rho_\psi = 0.94$.

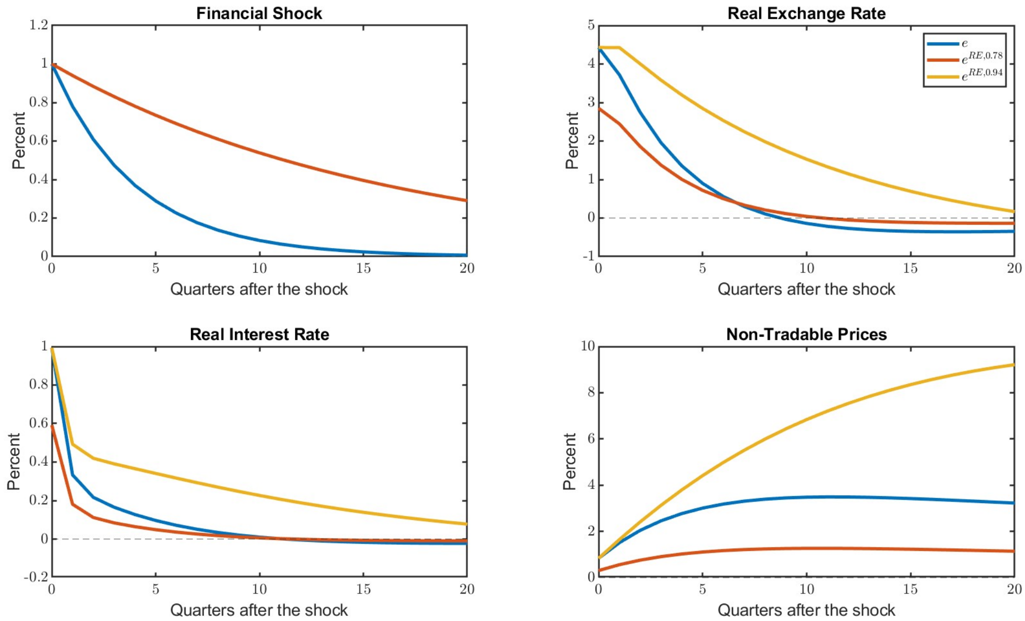

Figure C.16: Prices and Real Interest Rate Response to a Financial Shock: Sticky Prices

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the behavioral model, and the red line is the rational expectation benchmark. The yellow line represents the response of the persistent rational expectations economy with $\rho_\psi = 0.94$.

responding more strongly compared to the real exchange rate.

Finally, when price stickiness is low, inflation remains high despite expectations having a limited influence on price-setting. The two drivers of inflation are the price of imported inputs and an increase in nominal wage due to imported inflation. As the costs of living rise, workers demand higher nominal wages to supply the same demand for labor.

RE and BE models under flexible prices. Next, I study the role of behavioral expectations under low price stickiness. In this setting, dynamic considerations have minimal impact on firms' decisions, resulting in similar price responses under both the BE (blue) and RE (red) models and yielding nearly identical paths for realized prices and interest rates. Firms' behavioral beliefs do not reinforce the contractionary effects of the demand channel.

However, the beliefs of households still matter for the UIP condition and exchange rate. The BE model generates a volatile exchange rate and amplifies the response of real variables to the shock. The immediate response of the real exchange rate is stronger than in the RE model. The expected path of the real interest rate (yellow) also lies above its realization (blue).

To conclude, the presence of price stickiness matters for the relative importance of expenditure-switching and aggregate demand channels, as well as for the role of behavioral beliefs. Nominal rigidities are necessary for firms' expectations to matter for the sign of the economy's response to a depreciation. However, the amplification of the shock by the household's beliefs is independent of price rigidities.

C.9 Heterogeneous Firms

This section presents an alternative approach to assessing the model's consistency with cross-sectional survey evidence. I assume that a fraction of the firms have rational expectations and compare their responses with the behavioral firms. In contrast to the small price-taking firm in the previous section, the difference in the expectations can have an aggregate impact.

Both tradable and non-tradable sectors consist of a measure 1/2 of rational ($\hat{\rho}^{RE} = \rho = 0.78$) firms and a measure 1/2 of behavioral ($\hat{\rho}^{BE} = 0.94$, $\rho = 0.78$) firms. The two types of firms only differ from each other in their beliefs. They are aware of the disagreement and know each other's expectations. The households are assumed to be behavioral.

Rational and behavioral firms in the same sector (assuming non-tradables for simplicity) differ in their optimal price-setting. The aggregate inflation for non-tradables is given by $\pi_{NT,t} = 1/2\left(\pi^{RE}_{NT,t} + \pi^{BE}_{NT,t}\right)$, where inflation for the two types of the firm is given by

$$\pi^{RE}_{NT,t} = \lambda_a(mc^{RE}_{NT,t} - p^{RE}_{NT,t} + \mu) + \beta\mathbb{E}^{RE}_t\pi^{RE}_{NT,t+1},$$

$$\pi^{BE}_{NT,t} = \lambda_a(mc^{BE}_{NT,t} - p^{BE}_{NT,t} + \mu) + \beta\mathbb{E}^{BE}_t\pi^{BE}_{NT,t+1}.$$

I outline the approach to solving the quantitative model in Appendix C.1.

Compared to the baseline model, the economy's response is less expansionary since half of the firms have rational expectations. In terms of the aggregates, this moves the economy closer to the the specifications of rational firms and behavioral households described in Section 4.6. While preserving the excess exchange rate volatility, these model variants dampen the amplification of the demand channel by behavioral expectations, resulting in lower inflation, reduced interest rates, and a more muted contractionary effect of depreciation compared to the full behavioral benchmark.

Consistent with the survey data and previous results, the firms with overextarpolative expectations have more pessimistic views on how the economy evolves after a financial shock. Figure C.17 shows one-quarter-ahead expectations of rational and behavioral firms after a 1% positive financial shock. Behavioral firms expect higher inflation, deeper recession, and a larger fall in demand.

The difference in the actions of the two types of firms is also consistent with the data. Figure C.18 compares the responses of behavioral and rational firms to a 1% positive financial shock. Behavioral firms (blue) make higher exchange rate forecasts initially, but as they see the true realizations of the financial wedge ψ_t, their forecasts gradually converge with the rational expectations (red). The expected price of inputs $\mathcal{E}_t P_M$ follows the exchange rate forecast. Behavioral firms raise their prices by more, contract their output and don't expand demand for labor. In contrast, rational firms maintain stable output and expand employment; despite a decline in domestic demand, their market share increases due to differences in price-setting relative to behavioral firms.

The differences between rational and behavioral firms are quantitatively large and persistent. The 1.4% disagreement in the one-quarter exchange rate forecast corresponds to a 0.6% difference in current output and a 0.3% difference in expected output growth. Note that while rational firms barely contract, behavioral firms in the heterogeneous agent economy recover slowly and maintain lower output than those in the full behavioral benchmark despite the muted aggregate recession. This results from price stickiness: after over-adjusting prices in response to depreciation, behavioral firms face low demand for their goods until they can reoptimize, at which point their new prices may still be excessively

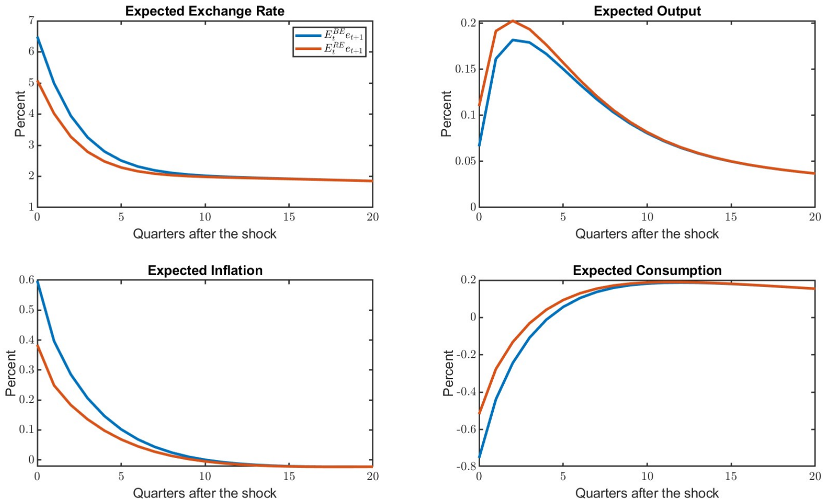

Figure C.17: Beliefs about the Aggregate Economy in Response to a Financial Shock: Rational and Behavioral Firms

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The red line refers to the rational firms in the two-type model ($\hat{\rho}^{RE} = 0.78$, $\rho = 0.78$, measure 1/2), while the blue line refers to the behavioral firms in the two-type model ($\hat{\rho}^{BE} = 0.94$, $\rho = 0.78$, measure 1/2).

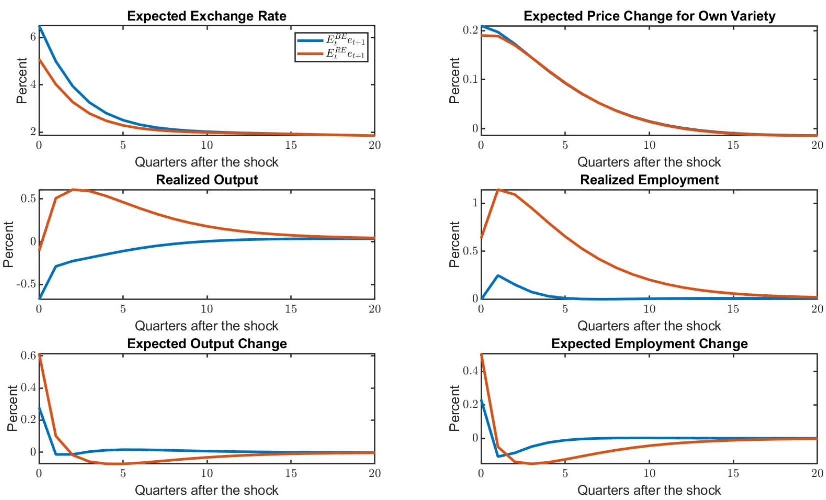

Figure C.18: Current and Expected Actions in Response to a Financial Shock: Rational and Behavioral Firms

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The red line refers to the rational firms in the two-type model ($\hat{\rho}^{RE} = 0.78$, $\rho = 0.78$, measure 1/2), while the blue line refers to the behavioral firms in the two-type model ($\hat{\rho}^{BE} = 0.94$, $\rho = 0.78$, measure 1/2). Rational and behavioral firms in this figure refer to the weighted average across sectors.

high if expectations haven't yet aligned with those of rational firms.

C.10 Empirical Evidence of Recessionary Depreciations

In this appendix, I provide the empirical estimates of the real variables' responses to exchange rate fluctuations using data from Peru. Using local projections, I confirm that depreciations are contractionary in terms of demand and aggregate output, in line with the behavioral model. Moreover, I confirm that, similarly to the model, the exports expand and production of non-tradables contracts. I do not identify the shocks, but I provide suggestive evidence on the comovement between the real exchange rate and real variables.

I estimate the cumulative local projections of the following form:

$$\Delta_h y_{t+h} = \alpha_h + \beta_h \Delta RER_t + \gamma_h X_t + \varepsilon_{h,t},$$

where Δ_h refers to the cumulative change from period $t-1$ to period $t+h$, $\Delta_h y_{t+h} = y_{t+h} - y_{t-1}$, and X_t is the matrix of control variables. As the dependent variable, I use log differences for output, demand, exports, and non-tradable output. Output and demand indices are provided directly by the Central Reserve Bank of Peru database. To measure exports, I normalize export volumes by the export price index. To construct an index for non-tradable production, I calculate the weighted average of retail, construction, and 'other services' indices, with the relative weights of these three sectors estimated based on their average annual output. The controls for output and demand include the log difference of US industrial production (US IP), used as a proxy for global demand, and lags of the dependent variable, interest rate change, and the log difference of CPI. For export, I use own lag and US IP. For non-tradables, I use lags of the dependent variable and interest rate change. The Peruvian macroeconomic data is taken from the Central Reserve Bank of Peru database, and US industrial production comes from the Federal Reserve Bank of St. Louis. The sample spans 2009-2019 to align with the sample in the Survey and exclude the impact of COVID-19, which caused a sharp contraction in output due to the national lockdown. I use monthly data but report the estimates on a quarterly frequency. All the time series, except RER and interest rate, are deseasoned with 13-term Henderson filter.

Figure C.19 presents the results for demand and output. Each exhibits a contraction after a depreciation, with the impact being more pronounced and persistent for demand. This aligns with the theoretical model, where the fall in aggregate demand drives the decline in output, despite being partially offset by the expenditure-switching effect. In contrast to the baseline model, however, the impact is delayed and peaks around 7 quarters after the deprecation.

Figure C.20 demonstrates the sectoral responses to a depreciation. Consistent with the model, export increases after a deprecation, while non-tradable output falls. As in the case with aggregate output and demand, the response is delayed.

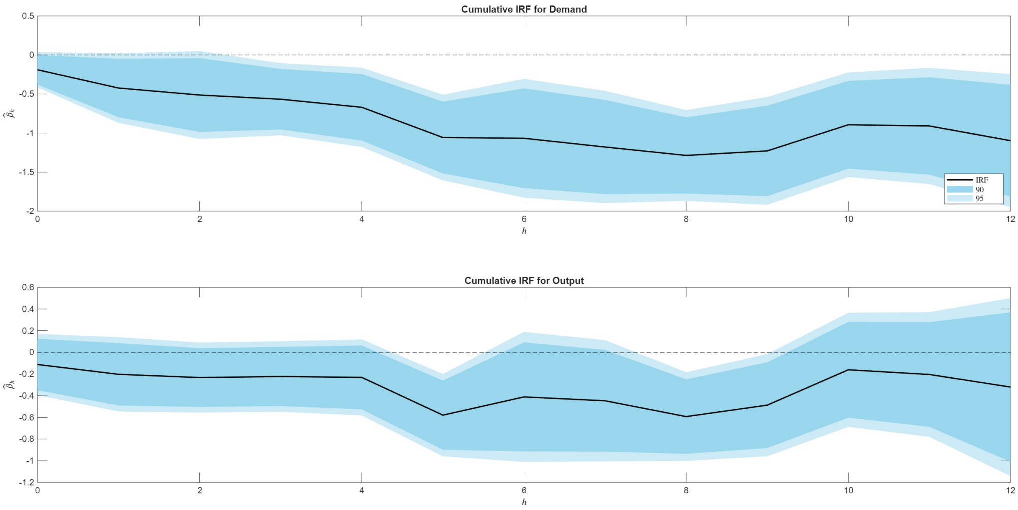

Figure C.19: Local Projections for Output and Demand

Notes: The figure shows the cumulative response of aggregate output and demand to a 1% depreciation of the real exchange rate. The local projection is estimated at quarterly frequency using monthly data from the Central Reserve Bank of Peru for 2009-2019. Both dependent and independent variables are in log differences. The controls include the log difference of US industrial production (sourced from the US Bureau of Economic Analysis) and lags of the dependent variable, interest rate change, and the log difference of CPI. Blue and light blue areas denote 90% and 95% confidence intervals, respectively, with Newey–West standard errors. All variables except the real exchange rate and interest rate are deseasoned.

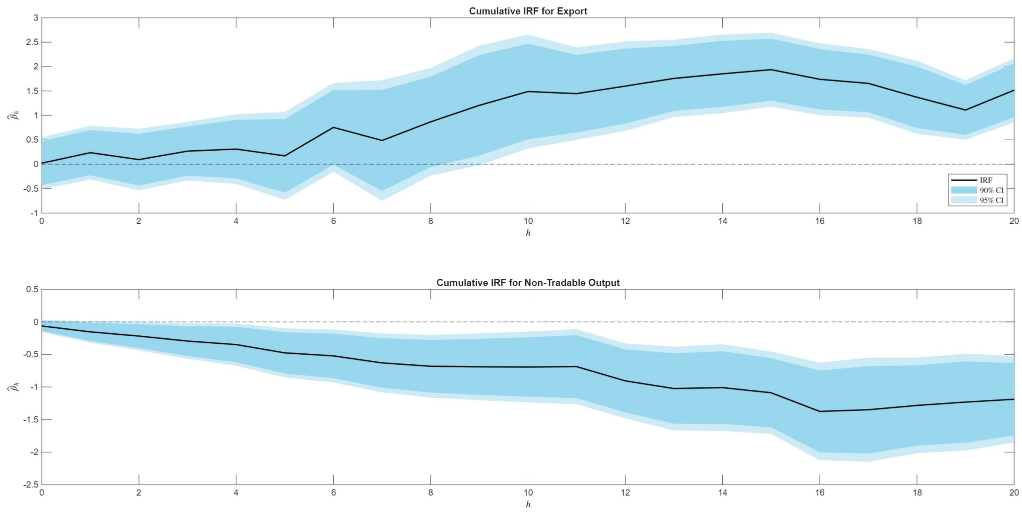

Figure C.20: Local Projections for Export and Non-Tradable Output

Notes: The figure shows the cumulative response of export and non-tradable output to a 1% depreciation of the real exchange rate. The local projection is estimated at quarterly frequency using monthly data from the Central Reserve Bank of Peru for 2009-2019. Non-tradable output is calculated as a weighted average of construction, retail, and 'other services'. Both dependent and independent variables are in log differences. The controls include the log difference of the US industrial production (sourced from the US Bureau of Economic Analysis) for export, the lag on domestic interest rate change for non-tradables, and the lag of the dependent variable for both. Blue and light blue areas denote 90% and 95% confidence intervals, respectively, with Newey-West standard errors. All variables except the real exchange rate are deseasoned.