Exchange Rate Expectations and Aggregate Dynamics

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Abstract

The paper explores the role of expectations 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 anticipating depreciation are more likely to reduce employment and production. Based on these observations, I develop a behavioral general equilibrium model of a small open economy, in which exchange rate is driven by a financial shock to the uncovered interest parity (UIP) 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 more than under the rational expectations benchmark, potentially reversing the sign of 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 relevant prices for an open economy, and its fluctuations can significantly impact 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. Because 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?

To address the first question regarding expectation formation, I analyze firm-level survey data on exchange rate expectations and firm's actions. I document two stylized facts. First, exchange rate forecast errors are large compared to other macroeconomic variables and can be predicted using information available at the time of the forecast. Firms tend to overreact to news, excessively adjusting their forecasts in response to new information, and anchor their expectations to the observable value of the exchange rate, demonstrating excessive persistence of current conditions. Second, firms associate depreciations with a contractionary economic environment. I find that firms anticipating higher depreciation are more likely to expect low output growth and high inflation. Furthermore, these firms report having contracted their economic activity and expect to contract it in the near future.

To 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 and tradable and non-tradable sectors. To set prices in the presence of nominal rigidities, firms 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 raises the effective interest rate of dollar assets for domestic agents and depreciates the local currency. Economic agents misspecify the financial shock process and form behavioral expectations, disciplined by survey data. As behavioral expectations increase the perceived persistence of the shock, the output response to the financial shock changes. The first channel of financial shock transmission to output is through expenditure switching: depreciation makes home tradables more competitive, resulting in an expansion in that sector. The second channel, however, is a fall in aggregate demand: in response to inflation, monetary authorities increase domestic interest rates, which suppress demand and cause a contraction in the non-tradable sector. Both the price-setting decisions of firms and the consumption-saving decisions of households are forward-looking and affected by the expected path of the exchange rate. Behavioral beliefs can affect the relative strength of the two channels, reverse the sign of the output response, and lead to contraction. If the behavioral bias of firms is extrapolated to households, exchange rate volatility is amplified, and the contractionary effect of depreciation becomes quantitatively important.

I study the exchange rate expectations using the Monthly Survey of Macroeconomic Expectations conducted by the Central Reserve Bank of Peru, which collects individual-level forecasts from non-financial firms on a monthly basis, starting from 2009. Unlike much of the existing literature that studies expectations of professional forecasters and financial institutions, often limited to the consensus forecast, this dataset allows for the study of individual responses from a large sample (200 to 300 responses each month). I find that exchange rate errors are large compared to the forecast errors on output and inflation and exhibit overreaction biases. Even after accounting for the higher volatility of the realized exchange rate, the exchange rate errors are characterized both by a sizable consensus error and high disagreement among the forecasters, indicating that both common component and heterogeneity in the beliefs can play important roles.

Using panel data on firm-level responses, I show that firms' forecasts can be predicted based on the information available at the time of the forecast. The firms overreact to the new information, revising their forecasts too strongly. Additionally, they anchor their expectations to current conditions: for instance, a firm observing a high exchange rate is likely to predict greater depreciation than is realized. While similar findings are prevalent in behavioral macroeconomics (see Coibion and Gorodnichenko (2015), Bordalo et al. (2018)), 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 and firms' anticipated and recent actions. On the cross-section controlling for time effects, the firms expecting depreciation are more likely to forecast lower GDP growth and higher inflation. These firms expect to contract their own production and employment in the next three months and report having already cut them compared to the previous month. The result holds after controlling for the forecasts on output and inflation.

Motivated by these observations, I explore the impact of behavioral biases in exchange rate expectations on the transmission of aggregate shocks. I employ a small open economy New Keynesian model in which firms need to forecast the future path of their marginal costs to set sticky prices. Expectations about exchange rates influence their pricing decisions by affecting the evolution of both future costs and the demand for their variety of good. The primary driver of exchange rate is financial shock, proposed by Itskhoki and Mukhin (2021a) as a possible solution to exchange rate disconnect puzzles - a collection of stylized facts about exchange rate comovement with macro variables that are hard to reconcile with standard international macro models. Financial shock can be interpreted as a wedge in the cost of dollar borrowing by domestic agents necessitating a depreciation to maintain the no-arbitrage condition between local currency and dollar bonds. I expand the model by allowing for behavioral expectations of economic agents. 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, with emphasis 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. First, by generating depreciation, it makes domestic goods and factors of production cheaper relative to international prices. Tradable firms expand exports, and households switch consumption from imports to domestically produced goods, thus expanding the tradable sector. However, the financial shock also has a negative impact on domestic demand: rising prices for both imports and domestic goods lead monetary authorities to increase domestic interest rates to counteract inflation, which discourages household from consumption. In this paper, I show that the relative strength of these two opposing channels depends on the perceived persistence of the financial shock. Both exporting and domestically-oriented firms are forward-looking in their price-setting choices, and the expected persistence of exchange rates amplifies both an increase in domestic, local-currency-denominated prices and a decrease in dollar-denominated prices for export. Both expansionary and contractionary channels become stronger, but in general equilibrium, the latter is more sensitive to perceived persistence. As monetary authorities increase the real interest rates to curb inflation, forward-looking households expect a higher path of interest rates and decrease their consumption. The aggregate demand channel becomes especially sensitive to expectations, making the behavioral expectations economy more contractionary than a rational expectations economy.

I calibrate the model by targeting key Peruvian macroeconomic variables, with an emphasis on trade openness and the share of employment in the service sector, which determine the sizes of the tradable and non-tradable sectors, as well as the share of exports. I dicsilpine the true and perceived persistence of financial shock using survey data estimates of the coefficient of overreaction to current conditions and the expected persistence of the exchange rate. The paper compares the performance of behavioral and rational models against the unconditional moments of exchange rate comovement with macro variables - excess volatility of exchange rates and the negative correlation between real exchange rate and relative consumption (Backus-Smith puzzle). As the choices of forward-looking agents are determined more by expectations than initial conditions, I show that contemporaneous moments are shaped 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, by construction, only the behavioral model can also account for the facts documented in the empirical part of the paper. The two models differ in autoregression coefficients of the realized variables, with medium-run persistence of nominal exchange rate and persistence of ex-ante UIP deviations being more in line with the behavioral model.

I demonstrate the model's consistency with cross-sectional data by examining the response of small price-taking firms with varying beliefs about the financial shock process. The model replicates patterns in firms' beliefs and actions documented in the survey. Firms expecting a depreciation caused by a financial shock also anticipate declines in output and spikes in inflation. They are more likely to report a recent contraction in their economic activity and expect to decrease it further in the next quarter. These results hold for both tradable and non-tradable firms, though the effect is stronger in the non-tradable sector. In addition, they are supported by heterogenous firms' expansion, in which behavioral firms contract more than rational firms in response to the financial shock. Conversely, if the variance in expectations is generated by another shock, the resulting patterns are not consistent with the survey. As long as depreciation is driven by domestic total factor productivity (TFP) shock or demand shock, the firms expecting depreciation become more likely to expand in the present, which contradicts the empirical observations. Monetary policy shock does generate a contraction in a firm's economic activity, however, firms associate the expected depreciation with an increase in future demand and aggregate output.

Finally, I study the aggregate dynamics of the economy using impulse responses to financial shock. In the calibrated model, the impact of expectations is strong enough to reverse the output response to depreciation: while a rational expectations model predicts expansion from depreciation, the behavioral model generates a recession. The contractionary effect of firms' behavioral expectations does not rely on a similar bias in the expectations of households. For aggregate demand to react to the firms' bias, households only need 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. If the households expect the financial shock to be persistent, the UIP condition requires a stronger response from the exchange rate: the future path of exchange rates is revised upward and, since the price of a currency depends on its future value, the exchange rate depreciates more compared to the rational expectations benchmark. In combination with firms' expectations, households' bias generates an economy with a volatile exchange rate and strong recessionary impact of depreciations.

Related literature.

First, the paper builds on the literature studying the dynamics of exchange rate and its relation to the macroeconomic aggregates with segmented market models (see Gabaix and Maggiori (2015), Itskhoki and Mukhin (2021b), Fanelli and Straub (2021)). The model expands upon Itskhoki and Mukhin (2021a), an influential paper suggesting financial shock as a solution for exchange rate disconnect puzzles. While preserving their model's key features, I show that the expected persistence of financial shock influences its transmission to the economy, affects the unconditional moments and, due to the behavioral bias of the firms, may differ from the true shock process.

This generation of models is used to assess what drives exchange rate dynamics. Eichenbaum et al. (2021), 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 moments of interest. While Eichenbaum et al. (2021) and Engel and Wu (2023) find financial shock to be the main driver of exchange rates, the other two papers attribute the main role to demand and trade rebalancing shocks, respectively. I add to this discussion by bringing survey evidence and showing that the expectations of economic agents are consistent with financial shocks but not with other domestic shocks.

Additionally, I contribute to the ongoing debate on the output response to depreciation. Auclert et al. (2021) discusses the relative importance of expenditure switching and aggregate demand changes. However, unlike my model, where the strength of the aggregate demand response depends on expectations, Auclert et al. (2021) relies on household heterogeneity and low import and export elasticities as the causes of recessionary depreciations. 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. This paper, in contrast, studies the determinants of output response to Itskhoki and Mukhin (2021a) financial shock.

The implications of this paper are relevant to broader questions in international macroeconomics. The key mechanism of the model is based 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), Cugat et al. (2019), Guo et al. (2023) and De Ferra et al. (2020)) and the literature on exchange-rate pass-through (e.g. Amiti et al. (2014), Amiti et al. (2019), Devereux and Engel (2002), Burstein et al. (2007), Drenik and Perez (2021), Cravino (2017)).

Second, 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 (2021) and Angeletos et al. (2021) study the behavioral bias using survey expectations of economic agents. On a large sample of individual-level forecasts, I show that the overreaction bias is present in forecasts of exchange rates, a relatively understudied variable in this strand of literature. The inflation expectations of firms are explored in-depth by Coibion et al. (2018), Coibion et al. (2018), Coibion et al. (2020), Candia et al. (2023) and McClure et al. (2024), with important takeaways being the evidence of causal relation between inflation expectations and firms' actions and joint formation of expectations of output and inflation. While my data doesn't allow for establishing a causal relation between exchange rate expectations and firms' actions, I motivate my model with this literature.

While behavioral macroeconomics is a developed field, it typically studies closed economy framework, and its implications for international macroeconomics questions remain understudied. One 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. (2022). This line of research suggests that, according to the UIP, the exchange rate can be viewed as a sum of the expected interest rate differentials, and study if the distorted expectations on the macroeconomic fundamentals can account for the UIP deviations. Several recent papers have examined this issue in general equilibrium framework (see Candian and De Leo (2023), Müller et al. (2024), Na and Xie (2023) and Kolasa et al. (2022)), studying how behavioral expectations can lead the real shocks to account for UIP-related puzzles. Candian and De Leo (2023) is closely related to this paper as it introduces the overextrapolation of real shocks in the general equilibrium model and can account for the Backus-Smith correlation and, partially, excess volatility of exchange rate. This model differs from their framework by focusing on the transmission of financial-shock-driven depreciation to the macroeconomy in a model disciplined by firm-level exchange rate expectations.

Another distinction is the focus of the previous literature on advanced economies, while this paper builds on the data from Peru. Kalemli-Özcan and Varela (2021) use consensus exchange rate forecasts to show that they help to explain the UIP deviations in advanced economies but not in emerging markets. This motivates the focus of this 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 UIP-based exchange rate determination.

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 formation and their implications for the actions of firms. 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 as it presents monthly firm-level expectations on the exchange rate by 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 exchange rate forecasts are related to firms' actions and forecasts of other macro variables.

2.1 Firm-level Exchange Rate Forecast

Survey Data. The Monthly Survey of Macroeconomic Expectations is a dataset collected by the Central Reserve Bank of Peru at the end of the 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 200-300 observations per month. The median number of responses per firm is 12, and 95% of the dataset is accounted for by firms who participated at least 10 times. However, the 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, but no individual-level responses are available for these respondents.

The Survey asks the respondents to make quantitative forecasts and supplement them with qualitative questions regarding the firm's performance and the expected evolution of the aggregate economy. The firms report their beliefs on the exchange rate, GDP growth and inflation at the end of current and next 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 performance of the economy and respondent's sector 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

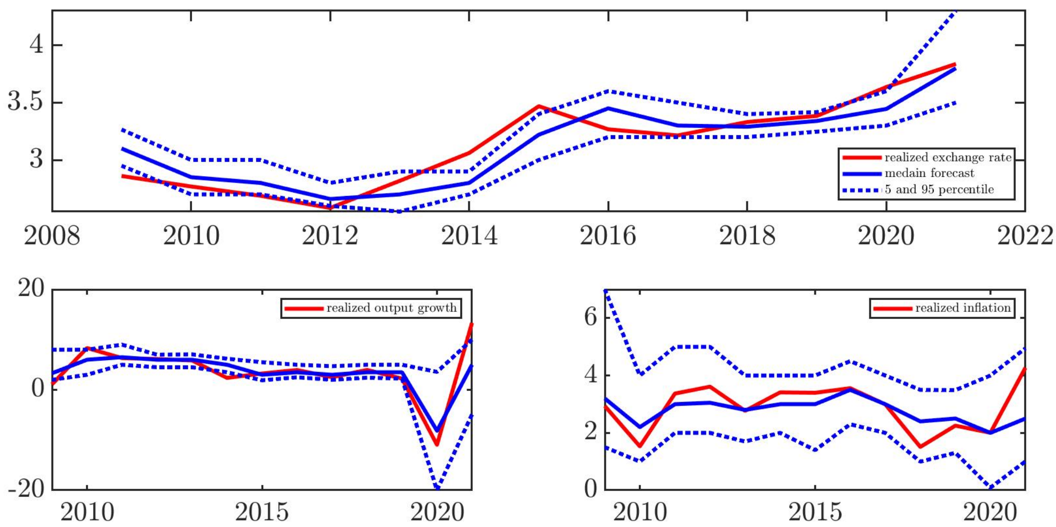

Figure 1: Realized and forecasted macroeconomic variables

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- 95-percentile of firms' six-month-ahead forecasts (blue). Appendix A.1 shows similar plots for other horizons.

decreased output of your firm compared to the previous month?'). There are three possible answers to qualitative questions: increase, decrease or stay constant.

Summary statistics. The focus of this paper is on the exchange rate forecast. Firms tend to make sizeable errors while predicting the nominal exchange rate. The median absolute error for the two-quarter-ahead forecast is 4.14%, compared to the annual average change in exchange rate being 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 forecasts exhibit significant disagreement among forecasters, the realized exchange rate often lies outside the 90% confidence interval. In those cases, 90% firms have the same sign of the forecast error, over- or under-predicting the exchange rate. This pattern contrasts sharply with the inflation forecast, where the median forecast tracks the realized inflation closely, possibly due to the inflation targeting policy of the Central Bank of Peru. 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.

Furthermore, compared to the two other forecasts, both systematic and idiosyncratic components of the exchange rate forecast error are substantial. While the consensus error (representing the 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 of the firms and will be used to study the relation between forecast and reported choices of the firm. Appendix A.2 demonstrates the descriptive statics on forecast revisions. In contrast to errors, it shows similar properties of all three variables.

	Δe	Δy	π
Median absolute error	4.14	1.05	0.53
Mean relative error	0.84	0.47	0.48
Mean consensus error	4.13	0.88	0.32
Median disagreement	0.61	0.28	0.52

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.

2.2 Systematic Deviation from Rational Expectations Hypothesis

This section shows that one source of the consensus error for exchange rate forecasts is systematic deviations of the firms' beliefs from the full-information rational expectations (FIRE) framework. 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 the forecast was made. However, the exchange rate errors are systematically predictable.

First, I show that the exchange rate errors are predictable with 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 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. 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 I use end-of-month nominal exchange rate as the current value of e_t.

Second, I provide further evidence with Coibion and Gorodnichenko (2015) (CG) regression that relates forecast errors to forecast revisions:

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

Under rational expectations, the CG coefficient is zero, $\beta_{CG} = 0$, as any information that becomes available 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

	(1)	(2)	(3)	(4)	(5)
β_{BGS}	-0.03	-0.07	-0.08	-0.13	-0.10
	(0.00)	(0.00)	(0.11)	(0.60)	(0.11)
β_{CG}	-0.37	-0.39	-0.35	-0.26	0.94
	(0.05)	(0.05)	(0.16)	(0.50)	(0.46)
	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 median coefficients in fixed panel regressions with a fixed horizon of 1 to 11 months. Column (4) presents the median 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 news indicative of expected depreciation, they revise their forecasts too much upwards, giving excessive weight to the new information and resulting in the negative forecast error. Similarly, the reluctance to revise the forecast in response to the news would lead to the positive error and regression coefficient $\beta_{CG} > 0$.

The 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 values. The value $\beta_{BGS} = -0.07$ means that a 10% increase in the current exchange rate is associated with the end-of-year forecast being 0.7% higher than the realized exchange rate. Similarly, $\beta_{CG} = -0.39$ indicates that a 10% upward revision of the forecast results in the end-of-year forecast overestimating the exchange rate by 3.9%. The aggregate forecast in Column (5) also shows evidence of the persistence of the current conditions but underreacts to the news. While individual-level data on exchange rate is underexplored, these results are consistent with the studies of other macroeconomic and financial variables (see Angeletos et al. (2021), Bordalo et al. (2020)). The likely explanation of the negative β_{CG} for consensus forecast is individual-level overreaction combined with idiosyncratic noise. Appendix A.3 presents the BGS and CG regression results for forecasts of varying horizons showing they are robustly negative. Appendix A.4 shows that the overreaction to current conditions also present in the forecasts of financial firms and professional forecasters.

Table 3 compares the realized persistence of 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 exchange rate at the longer, 3-quarter-ahead horizons. While the forecasts show non-stationarity, the realized values tend to be below one. At shorter horizons, low expected persistence may potentially be explained by informational frictions.

	Expected (1)	**Expected (2)**	**Expected (3)**	**Realized**
ρ^1_{Ee}	0.94	0.95	0.95	0.99
	(0.01)	(0.01)	(0.02)	(0.03)
$\rho^2_E e$	1.00	0.99	0.98	0.97
	(0.01)	(0.01)	(0.05)	(0.06)
ρ^3_{Ee}	1.02	1.02	1.03	0.95
	(0.01)	(0.01)	(0.08)	(0.09)
	Panel	Panel	Aggregate	Aggregate
Fixed effect	No	Yes	No	No

Table 3: Expected and Realized Persistence of Exchange Rate

Notes: The table compares the empirical autoregression coeffients for exchange rates with expected persistence of exchange rate estimated as the regression of forecast on the observable value. I estimate the regressions on 1-, 2- and 3-quarter horizons. Columns (1) and (2) present the results of panel regressions with and without form fixed effects, while Column (3) uses consensus forecast. Column (4) refers to the empirical estimate on relazied exchange rates. The exchange rate data is end-of-month interbank exchange rate from the Central Reserve Bank of Peru from 2009 to 2022 for consistency with the survey. the standard errors are Newey-West.

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 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 answers of those groups, so that the differences between quartiles are driven by heterogeneity within time period and can be interpreted as deviations from the average at given period. 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, and the Figure 2 shows that the first quartile of firms expect the annual depreciation to be approximately 8% below the fourth quartile. The outcome variables are qualitative, so the reported median 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. 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.

The 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 is the most pronounced for employment, with the difference in the relative prevalence of expanding versus contracting firms being 4.7 percentage points higher in the first quartile than in the fourth quartile. Moreover, the firms intend to continue contracting in the following three months, with the difference between the first and the fourth quartiles being 13.9 and 10.7 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.5 provides a short discussion of the validity of the model, while A.6 shows robustness checks such as non-residualized version of the Figure 2 and regressions allowing to control for fixed effects.

In addition to having more pessimistic views on the dynamics of the individual firm,

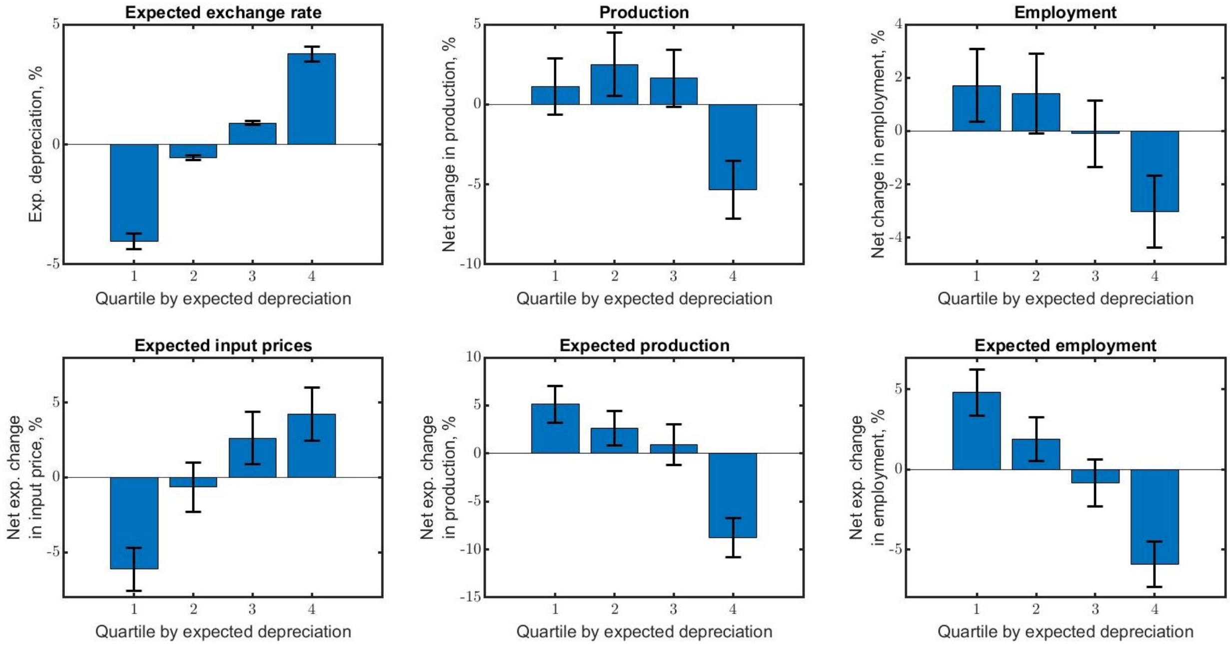

Figure 2: Recent and Expected Actions by Expected Depreciation

Notes: The graph 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 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 change direction. 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 t-test.

the firms with high exchange rate expectations differ in forming the expectations on the aggregate economy. Figure 3 shows that beliefs of depreciation are associated with lower forecasts on output growth and higher expected inflation. Figure 4 shows that exchange rate expectations are negatively related to expected aggregate demand, recruitment and wages. In the fourth quartile, there are 14% more firms expecting a fall in aggregate consumption compared to the first quartile. Appendix A.7 provides robustness checks.

To sum up, the firms expecting depreciation are more likely to contract in the present or the near future. They forecast a decline in aggregate demand, accompanied by inflation, high input costs and the slowdown in the labor market. In this paper, the decline in firms' activity as they expect depreciation would be explained by their expectations of unfavorable conditions in the future. While these data doesn't allow to establish causal relations, this interpretation is supported by the evidence from Candia et al. (2023), 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 be the pessimism of poorly-performing firm who attribute their low productivity to mispercieved aggregate conditions.

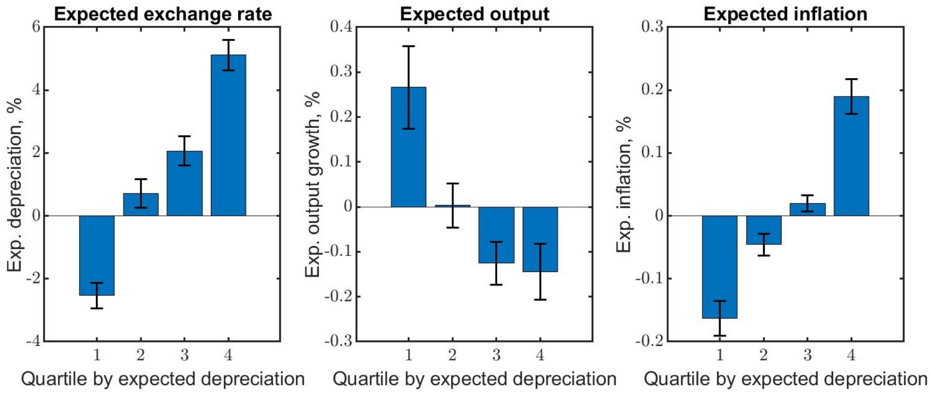

Figure 3: Expected Output and Inflation by Expected Depreciation

Notes: The graph shows the inflation and output forecasts by expected depreciation quartiles. For every period t, the 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 t-test.

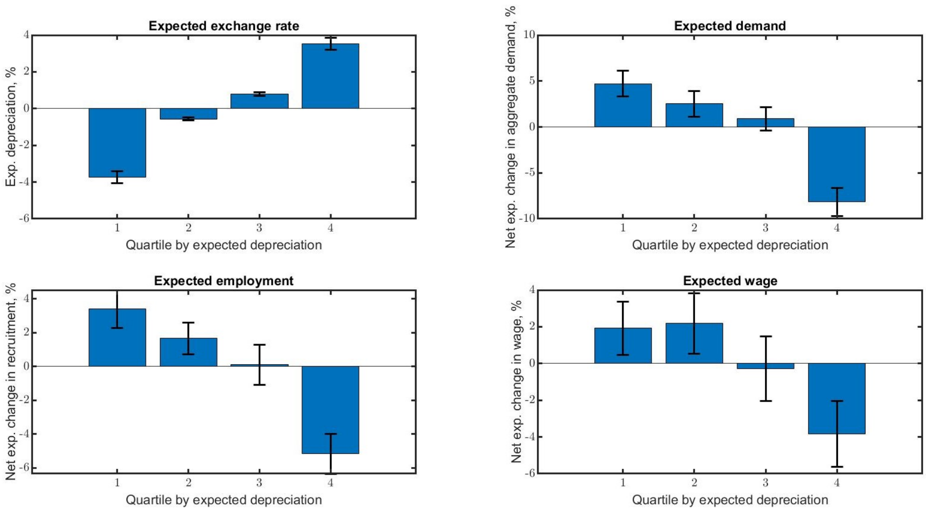

Figure 4: Beliefs on Aggregate Economy by Expected Depreciation

Notes: The graph 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 forecast by running cross-section regressions. 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 can take values -1, 0 and 1 depending on the change direction. 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 t-test.

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 is driving the exchange rate. Second, I introduce overreactive expectations. Finally, I simplify the model and solve it analytically to discuss the intuition on how the expectations affect the macroeconomy.

3.1 Non-tradable Firms

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

$$\mathbb{E}_0^f \sum_{t=0}^{\infty} \Theta^t \Pi_{NT,t},$$

where the operator $\mathbb{E}^f[\cdot]$ refers to the expectations of firms.

The firm j in sector NT has decreasing return to scale and produce using labor $L_{NT,j,t}$ and imported inputs $M_{NT,j,t}$ with production function $Y_{NT,j,t} = A_{NT,t} L^{\alpha}_{NT,j,t} M^{\alpha_M}_{NT,j,t}$, 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 price of imported inputs in dollars. Firm j faces a 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 demand for its variety of non-tradable goods. The static choice of a firm is the solution to the cost minimization problem,

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

The firms are subject to price stickiness and Calvo pricing. 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

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

where $\mu = \log(\frac{\varepsilon}{\varepsilon-1})$ is the log of 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:

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

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

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

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 return to scale.

Exchange rate directly affects the costs of the firm due to increase in the relative price of imported inputs and indirectly through its impact on demand, nominal wage and sectoral prices. The future path of exchange rate matters for price-setting decisions. When exchange rate is driven by financial shock, depreciation would be 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. While the tradable goods are priced in local currency for domestic markets, the exports are denominated in dollars. Then, the profit of a tradable firm j becomes

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

where $X_{j,t}$ is the output exported by firm j, $P^*_{X,j,t}$ is it dollar-denominated price. The firm produces the output for both markets together, $Y_{H,T,j,t} + X_{j,t} = A_{T,t} L^{\alpha}_{T,j,t} M^{\alpha_M}_{T,j,t}$. The demand for variety j of tradable goods is given by

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

where X_t is aggregated according to the Dixit-Stiglitz function, $X_t = \left(\int_0^1 X_{j,t}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}}$, where I assume that foreign households has the same demand and same elasticity of substitution ε as domestic households. Demand for export from 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 reset simultaneously. The only difference in price-setting is that the nominal marginal cost is denominated in dollars for the export price, resulting in 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, exchange rate has the opposite impact on demand and costs for exports and domestically sold goods. Depreciation makes exports more competitive compared to foreign goods by lowering dollar cost of labor, which encourages firms to decrease the dollar cost and expand exports. Dollar pricing allows to avoid the excessive sensitivity of exports to exchange rate fluctuations[1] and 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] Under local currency pricing and price stickiness, the output of firms who cannot update price expands dramatically in response to depreciation.

3.3 Households

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

$$\mathbb{E}_0^{hh} \sum_{t=0}^{\infty} \beta^t u(C_t, N_t),$$

where C_t is the consumption of final good at period t and N_t is labor supply. Parameter β is a discount factor, σ is a risk-aversion parameter, ϕ determines the Frisch elasticity of labor supply, and φ is a scale parameter. Operator $\mathbb{E}_0^{hh}$ denotes the expectations of the representative household. The households have GHH utility, $U_t(C_t, N_t) = \frac{1}{1-\sigma}\left(C_t - \varphi \frac{N_t^{1+\phi}}{1+\phi}\right)^{1-\sigma}$, which is a common assumption for the models exploring the expectations about the future (see Uribe and Schmitt-Grohé (2017); Jaimovich and Rebelo (2009)). Under GHH preferences, the wealth effect does not affect labor supply. Therefore, optimistic expectations about the future don't reduce the labor supply today and allow for expansion in economic activity.

Households receive labor income $W_t N_t$ and profits of tradable and non-tradable firms they own, π_T and π_{NT}. They consume tradable and non-tradable goods ($C_{NT,t}$ and $C_{T,t}$) aggregated in the basket 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 non-tradable consumption and η is intersectoral elasticity of substitution. Tradable goods are composed from domestic and imported goods, $C_{H,T,t}$ and $C_{F,T,t}$, similarly:

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

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 $S \in [NT, HT, FT]$ denotes the type of good.

Households have access to incomplete financial markets and are able to save and borrow in non-state-contingent riskless bonds in 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 frictional interest rate $\tilde{R}_t^*$ introduced in the following section.

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 yields the functions for labor supply and demand for each type and variety of goods:

$$N_t^{\psi} = \varphi \frac{W_t}{P_t}$$
$$C_{S,j,t} = \left(\frac{P_{S,j,t}}{P_{S,t}}\right)^{-\epsilon} C_{S,t}$$

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

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 as follows:

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

Exchange rate affects the static problem of the households by changing the relative prices: a depreciation would make imported goods expensive and encourage switching to Home tradables. The expected exchnage rate enters the dynamic Euler equation for international asset. Expected depreciation increases the return on dollar asset 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 (2021a). Financial markets have two types of assets - local currency (LC) and dollar-denominated bonds - traded by three types of agents: household, financial intermediaries and noise traders. LC assets cannot be traded internationally. The demand for dollar bonds is formed by households and noise traders, but they cannot trade directly with foreign agents. The dollar bonds trade has to be intermediated by financial arbitrageurs.

Noise traders employ a zero-capital strategy matching their demand for dollar bonds with the supply of LC bonds. Their demand is assumed to be independent of macroeconomic fundamentals and can be interpreted as driven by their 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 meets the demand of households and noise traders by providing carry trade with the rest of the world. However, that exposes the arbitrageurs' balance sheet to exchange rate fluctuations. Since they are risk-averse, they require a premium. 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 a position of an individual intermediary. For simplicity, I assume that the arbitrageurs share the same expectations $\mathbb{E}_t^{hh}(\cdot)$ as households[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 households as lump-sum subsidies.

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

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

In a frictionless economy, the expected return for international bonds would equal the return on domestic bond, and the left-hand side of the UIP equation would be zero. However, in the presence of frictions, the arbitrageurs require excess returns to absorb the exchange rate risk. The deviations from UIP are increasing in their exposure to the dollar, which, in turn, depends on the demand of domestic agents for international bonds. For instance, if the exogenous demand for dollar bonds by noise traders ψ_t increases and the arbitrageurs need to meet that demand by opening a short position in dollars, they need the return on domestic debt to exceed the return on dollar debt, so they charge an extra premium to sell dollar assets. Then, from the no-arbitrage condition and assuming the domestic interest rate is constant, the households must expect the local currency to appreciate in the future and depreciate today. This way, financial shock affects the path of the exchange rate.

In this setting, the intermediation between domestic households and the rest of the world is frictional, with domestic households having to pay the additional wedge for borrowing in dollars. The effective household interest rate $\tilde{r}_t^*$ becomes

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

Finally, note that the term $\psi_B B_t^*$, coming from the households demand for dollar assets, is small. It plays a double role as the way to stabilize the external debt and ensure the existence of the equilibrium for a small open economy, as it Schmitt-Grohé and Uribe (2003).

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

3.5 Prices and Monetary Policy

The paper assumes that imported goods are priced in dollars and the law of one price holds, $P_{F,T,t} = \mathcal{E}_t P^*_{F,t}$, where $\mathcal{E}_t$ is the nominal exchange rate.

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

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

The real exchange rate (RER) with the dollar 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^*_t is assumed to be exogenous and constant.

The monetary policy follows 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 interest rate.

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, as domestic bonds are not traded internationally, their net supply equals zero, $B_t = 0$.

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

$$P^*_{F,t} X_t + \frac{B^*_{t+1}}{R^*} = B^*_t + P^*_{F,t} C_{F,t} + P^*_M M_t.$$

The import includes both consumption goods and intermediate inputs. The term denoting the excess return based on the financial premium is absent from the country resource constraint as financial arbitrageurs are domestic agents.

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:

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

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 mistakingly assume that the shock follows a process of persistence $\hat{\rho}^{hh}$ and $\hat{\rho}^{f}$ correspondingly. The agents don't learn the true 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, $(\mathbb{E}_t\psi_{t+1} - \mathbb{E}_{t-1}\psi_{t+1}) - \left(\mathbb{E}_t^{RE}\psi_{t+1} - \mathbb{E}_{t-1}^{RE}\psi_{t+1}\right) = (\hat{\rho} - \rho)(\varepsilon_t^\psi + \rho\psi_{t-1})$. The systematic error for the financial wedge becomes increasing in the current value of ψ_t as well as the difference between misspecified and true persistence: $(\psi_{t+1} - \mathbb{E}_t\psi_{t+1}) - \left(\psi_{t+1} - \mathbb{E}_t^{RE}\psi_{t+1}\right) = -(\hat{\rho} - \rho)\psi_t$. 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, financial wedge would be the key driver for exchange rate, so exchange rate forecasts would share these properties, as shown in the Appendix C.4.

The assumption of misspecified persistence of shocks is explored in the literature on behavioral macroeconomics. Angeletos et al. (2021) use it, in combination with idiosyncratic noise due to information rigidities, to reconcile the individual forecasts overreaction with underreaction to the news in aggregate forecasts. They show that an alternative way of modelling overreaction with diagnostic expectations as in Bordalo et al. (2018), where agents give extra weight to recent information due to the representativeness bias, may not be consistent with the aggregate underreaction. Although I don't introduce informational rigidities in the model, I document in the empirical section of this paper that the aggregate underreactuon is present in the exchnage rate forecast data, $\beta_{CG} > 0$. I use this fact to inform my approach to modelling individual-level overreaction.

3.8 Simplified Analytical Model

In this section, I discuss the intuition behind the impact of perceived financial shock persistence on aggregate dynamics. I impose several simplifying assumptions to make the model solvable analytically and study how financial shock affects 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 financial shock.

Simplifying Assumptions. Both tradable and non-tradable firms produce with one factor of production - labor. Non-tradable firms have 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:

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

Tradable firms are price-takers in international markets, so that the price for exported goods is fixed in dollars. They don't produce for 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 $l_{T,t} = \frac{1}{1-\alpha}(e_t - w_t)$.

Households consume non-tradables and imports only, and the demand for Home tradable goods is set to zero. Additionally, I impose several parameter restrictions: $\eta = \sigma = 1$ and $\phi = 2$. With GHH preferences, labor supply equals real wage, giving rise to the labor market clearing condition:

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

where a denotes the share of exports, while $1-a$ is the share of non-tradables.

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

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

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 constrain (expressed in dollars), stating that the discounted sum of net exports must equal zero:

$$\mathbb{E}_t \sum_{t+1}^{\infty} \beta^t \left(\frac{\alpha}{1-\alpha}(e_t - w_t) - a(c_t - e_t + p_t) \right) = 0 \tag{5}$$

The monetary policy rule remains unchanged,

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

Finally, I impose that households and firms share the same beliefs about the persistence of financial shock, $\hat{\rho} = \hat{\rho}^{hh} = \hat{\rho}^f$.

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

$$e_t = \mathbb{E}_t \sum_{k=t}^{\infty} \psi_k - \mathbb{E}_t \sum_{k=t}^{\infty} r_k + \bar{e} = \mathbb{E}_t \sum_{k=t}^{\infty} \psi_k - \mathbb{E}_t \sum_{k=t}^{\infty} \phi_\pi \pi_k + \bar{e} = \frac{\psi_t}{1-\hat{\rho}} - (\phi_\pi - 1)\,\bar{p} + \phi_\pi p_{t-1},$$

where I assume that, in the long run, the real variables, including the real exchange rate, return to the steady state. The notations $\bar{e} = \bar{p}$ denote the expected long-run nominal level of exchange rate and prices.

Overextrapolating expectations with $\hat{\rho} > \rho$ amplify the impact of the financial shock and, other things being equal, require stronger depreciation of the exchange rate. As the financial wedge must be offset with expected appreciation to keep the expected return on international assets equal to domestic assets, the current real exchange rate has to depreciate on impact and eventually converge back to the steady state. Higher persistence of financial shock requires a prolonged period of expected appreciation, therefore causing stronger depreciation on impact.

The second term on the right-hand side refers to the expected path of 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. The overextrapolative expectations $\hat{\rho} > \rho$ can lead to stronger response of the interest rates. Moreover, the magnitude of the increase in interest rate path can depend on price-setting behavior of firms and, therefore, on their expectations.

Financial Shock and Aggregate Demand. Similarly, I substitute forward the Euler equation:

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

In the absence of financial frictions, consumption comoves with real exchange rate: 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.

Using the expressions for c_t and e_t as functions of financial shock, the aggregate demand for non-tradable goods can be written as

$$c_{NT,t} = c_t - p_{NT,t} - p_t = -p_{NT,t} - (\phi_\pi - 1)\bar{p} + \phi_\pi p_{t-1}.$$

The demand for non-tradables decreases in the nominal price for non-tradables as well as in the long-run price level or, in other words, the expected path of nominal interest rates. Financial shock rises the expected path of interest rates and suppress the domestic demand.

Finally, the aggregate consumption is given by

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

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

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

where $w_t^r = w_t - p_t$ denotes real wage.

The impact on the real exchange rate is ambiguous: the labor supply from export increases as depreciation makes Home goods more competitive on the international market, however, the labor supply from non-tradable sector decreases due to the fall in aggregate demand. However, holding $p_{t,NT}$ constant, real wage increases in exchange rate:

$$w_t^r = \underbrace{a/(1-\alpha)\left[(1-a)(e_t - p_{NT}) - w_t^r\right]}_{\text{export}} - \underbrace{(1-a)\phi_\pi p_{NT}}_{\text{non-tradables}}$$

Using the discounted sum of nominal wages from equation (5), $p_{t,NT}$ can be expressed as a function of the financial shock ψ:

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

where $\Lambda = \frac{\alpha}{1-\alpha}\frac{1}{1-\beta\phi_\pi a}$ (see derivation in Appendix B.1). Then, if the monetary policy is not too aggressive[3], $\phi_\pi < \frac{a+\frac{\alpha}{1-\alpha}}{\beta a^2}$, financial shock causes an increase in prices of non-tradables.

[3] Aggressive monetary policy can result in the fall in $p_{NT,t}$ offsetting the increase in price of inputs in the CPI. Price stability prevents the fall in aggregate output and leads to expansion due to the expenditure switching.

Moreover, price of non-tradables is very sensitive to the parameter $\hat{\rho}$: it enters the expression twice, first as amplification of current exchange rate similar to what we can see from the modified UIP expression, second as the result of the future path of exchange rate driving up the discounted sum of nominal marginal costs.

Financial Shock and Output. There are two channels of how financial shock can affect output:

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

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, 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, it appears in the term before the bracket, amplifying the change in output. Second, it determines the sign of the response by affecting the relative importance of the two channels. As aggregate demand for non-tradable goods is determined by the expected path of forward-looking prices, while production of tradables is static and only depends on the current variables[5], the aggregate demand channel is more forward-looking and more sensitive to the changes in the perceived persistence of financial shock. Therefore, a model with behavioral overreaction, $\hat{\rho} > \rho$ becomes more likely to contract in response to the depreciation induced by financial shock.

4 Quantitative Analysis

The section presents the main results of the paper. First, I calibrate the model and discuss its consistency with both unconditional macro moments. Second, I show that cross-sectional empirical evidence on firms' expectations is consistent with exchange rate expectations driven by financial shock but not 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 the expectations of firms and households in shaping that response.

However, that requires credible monetary policy with strong response to inflation.

[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 increase in export prices is not amplified by response in monetary policy and decline in foreign consumption.

	Parameter	Value	Source
σ	Risk-aversion coefficient	2	Itskhoki and Mukhin (2021a)
$1/\phi$	Frisch labor supply elasticity	1	Itskhoki and Mukhin (2021a)
ϕ_L	GHH preferences constant	0.2	Schmitt-Grohé and Uribe (2012)
η	Sectoral elasticity of substitution	0.5	Uribe and Schmitt-Grohé (2017)
η_F	Elasticity of substitution of country of origin	1.5	Feenstra et al. (2018)
ε	Elasticity between varieties	6	Gali 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

4.1 Calibration

The calibration is based on the conventional parameter values in the international macro literature and empirical moments for the Peruvian economy.

The paper follows Itskhoki and Mukhin (2021a) in using conventional values for risk-aversion coefficient $\sigma = 2$ and Frisch labor supply elasticity $1/\psi = 1$. The GHH preference constant $\phi_l = 0.2$ suggests that households spend 20% of time on labor as in Schmitt-Grohé and Uribe (2012). 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 Gali 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 and trade openness, both calculated as the averages for 2009-2022 using the annual data by the World Bank. The external demand parameter $C_F = 0.022$ targets the PPP exchange rate. As tradable and non-tradable firms have different degrees of exposure to exchange rate, those parameters help to match the relative importance of the sectors of the economy for the aggregate dynamics. Under the standard assumption that $\rho = 1/\beta - 1$, the quarterly discount factor $\beta = 0.992$ is chosen to target the annual interest rate, estimated as the average using the Central Reserve Bank of Peru data on the reference interest rate. Finally, the production function parameter $\alpha_M = 0.15$ fits the share of imported inputs in relation 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. The steady-state international debt $\bar{B}$ is set to zero, resulting in balanced trade. I normalize the price level in the rest of the world P_F^* and the dollar price of the imported inputs P_M^* to 1. The value of $\psi_B = 0.01$ targets the empirical persistence of the external debt position reported by the Central Reserve Bank of Peru.

The bottom part of Table 5 assigns the values to the parameters governing the beliefs of the firm and the true persistence of financial shock. While the volatility of financial shock innovation is normalized to 1, the behavioral and true persistence, $\rho_\psi = 0.64$ and $\rho_\psi = 0.92$, are chosen to match the moments estimated on the survey data: the overreaction coefficient

Parameter	Value	Target	Data	Model
$\boldsymbol{\beta}$	0.992	Annual interest rate	3.24%	3.27%
$\boldsymbol{a}$	0.3	Employment share in service sector	55.7%	53.9%
$\boldsymbol{a_F}$	0.7	Trade openness	50%	52%
$\boldsymbol{C_F}$	0.022	PPP exchange rate	1.77	1.70
$\boldsymbol{\alpha_M}$	0.15	Imported inputs expenditure relative to labor expenditure	18%	17%
$\boldsymbol{\psi_B}$	0.01	Persistence of external position	0.98	0.99
$\hat{\boldsymbol{\rho}}_{\boldsymbol{\psi}}$	0.92	Expected persistence of exchange rate, 3 q. ahead	1.02	1.02
$\boldsymbol{\rho_\psi}$	0.64	Overreaction to current condition	-0.07	-0.07

Table 5: Targeted Moments

Notes: The table presents the calibrated model parameters. The target moments are calculated with the Central Reserve Bank of Peru and the World Bank data as the average for 2009-2022. The share of imported inputs expenditure is taken from Gopinath and Neiman (2014). The expected persistence of the exchange rate and overreaction to current conditions are estimated on survey data as panel regressions with fixed effects. The business cycle moments are the median across 100 simulations of the model. A simulation spans 1200 periods with the first 200 periods omitted.

β_{BGS} and the expected persistence of exchange rate ρ_{Ee}.

The 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 increase: as the true shock process becomes persistent, the exchange rate becomes determined largely by the backward-looking variables (prices, external debt) and less responsive to the expectations. 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} is negative for $\hat{\rho}_\psi > \rho_\psi$. With the behavioral parameter fixed, $\hat{\rho}_\psi = 0.92$, the coefficient is increasing with ρ_ψ as it closes the gap.

The model is solved at first order with control variables evolving with high-persistence laws of motion while the shocks following the true, low-persistence laws of motion. Appendix C.1 provides the details.

4.2 Non-targeted Moments

In this section, I show that financial shock generates several exchange rate disconnect moments but the perceived persistence of the shock has strong implications for the degree of excess volatility of exchange rate and its comovement with output. I show that the relation between true and perceived persistence of the shock cannot be inferred from the contemporaneous aggregate data moments and autoregression estimates offer support to the behavioral model.

As in Itskhoki and Mukhin (2021a), financial shock can explain the excess volatility of the exchange rate relative to macro variables and the Backus-Smith puzzle - the negative correlation between the real exchange rate and relative consumption $(c - c^*)$. 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 an increase in consumer prices. Moreover, the

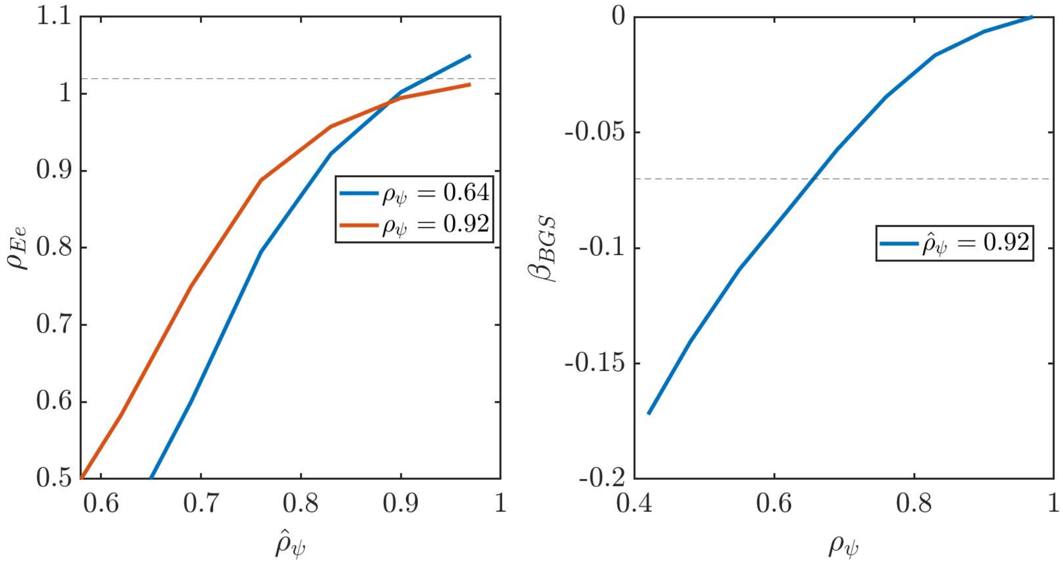

Figure 5: Identification of ρ_ψ and $\hat{\rho}_\psi$

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 $\rho_\psi = 0.64$ and $\rho_\psi = 0.92$ correspondingly. The plot on the right shows the identification of ρ_ψ, with the target value (dashed line) being the empirical estimate of the overreaction coefficient β_{BGS} and the model counterpart estimated under assumption $\hat{\rho}_\psi = 0.92$. The model estimates are the median across 100 simulations of the model. A simulation spans 1200 periods with the first 200 periods omitted.

home bias limits the impact of expenditure switching on consumption and output, resulting in real variables not being as volatile as the exchange rate.

Figure 6 show the unconditional moments for behavioral economies with different perceived persistence $\hat{\rho}_\psi$. The excess volatility of exchange rate moments (the volatility of exchange rate relative to consumption and output) are present for any $\hat{\rho}_\psi$ but are more pronounced when the agents believe the shock is temporary. That happens because the real variables don't respond strongly to temporary shocks: consumption is smooth due to the little 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, though, both households and firms adjust. The correlation between consumption and the real exchange rate[6] is negative for all values. It becomes stronger for permanent shock as the relative role of the past conditions (prices, household debt) in consumption determination decreases.

The correlation between output and the RER, 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. As demand channel is more forward-looking, higher persistence makes it dominate expenditure switching.

Additionally, Figure 6 demonstrates that the aggregate disconnect moments cannot iden-

[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.

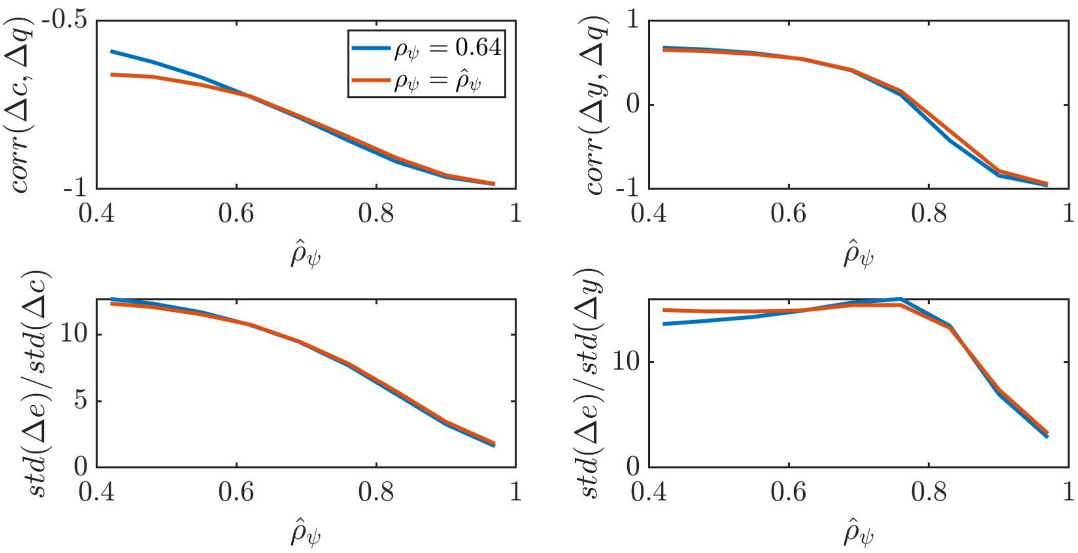

Figure 6: Exchange Rate Disconnect Moments

Notes: The plot shows the exchange rate unconditional moments dependence 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 $\rho_\psi = 0.92$. The red line depicts the rational expectations model where the true and perceived persistence 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 periods omitted.

tify the true persistence of the financial shock. The Figure compares the behavioral model with the true persistence fixed at $\rho_\psi = 0.64$ (blue) with the 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.

Table 6 reiterates these points by comparing free models: behavioral expectation model with $\rho_\psi = 0.64$ and $\hat{\rho}_\psi = 0.92$, RE model with the same true persistence of $\rho_\psi = 0.64$, and RE model where the beliefs of the behavioral agents are correct with $\rho_\psi = 0.92$. 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, rational expectation model generate low expected persistence of exchange rate, $\rho_{Ee} = 0.48$ at three quarter horizon, and implies weak response of macro variables to exchange rate fluctuations. As shown in Appendix C.3, in two-shock model, rational expectations model with low persistence cannot generate a negative Backus-Smith correlation on its own.

Despite the similarity in contemporaneous unconditional moments, behavioral and rational models with $\rho = 0.92$ differ in their implied persistence of exchange rate and UIP deviations. Figure 7 compares the two models against the data and shows that rational model generates an exchange rate process close to a unit root, while behavioral model sug-

	Data	BE	RE, $\rho_\psi = 0.64$	RE, $\rho_\psi = 0.92$
$\boldsymbol{\beta_{BGS}}$	-0.07	-0.07	0.00	0.00
$\boldsymbol{\rho(Ee)}$	1.02	1.02	0.47	1.00
$\boldsymbol{\beta_{CG}}$	-0.39	-0.15	0.00	0.00
$\boldsymbol{\sigma(\Delta e)/\sigma(\Delta c)}$	3.96	2.70	10.43	2.89
$\boldsymbol{\sigma(\Delta e)/\sigma(\Delta y)}$	3.71	5.41	14.97	5.88
$\boldsymbol{\sigma(\Delta c)/\sigma(\Delta y)}$	0.94	2.00	1.42	2.04
$\mathbf{corr}(\boldsymbol{\Delta c, \Delta q})$	-0.08	-0.98	-0.74	-0.98
$\mathbf{corr}(\boldsymbol{\Delta y, \Delta q})$	-0.02	-0.89	0.51	-0.85
$\mathbf{corr}(\boldsymbol{\Delta c - \Delta c^*, \Delta q})$	-0.26	-0.98	-0.74	-0.98
$\mathbf{corr}(\boldsymbol{\Delta y - \Delta y^*, \Delta q})$	-0.09	-0.89	0.51	-0.85

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 for 2009-2022. The second column refers to the one-shock behavioral model with $\rho_\psi = 0.64$ and $\hat{\rho}_\psi = 0.92$. The third and fourth columns refer to the rational models with the persistence of 0.64 and 0.92 correspondingly. The business cycle moments are the median across 100 simulations of the model. A simulation spans 1200 periods with the first 200 periods omitted.

gests a stationary process. Compared to the data, the rational model performs better for one-quarter ahead autocorrelation coefficient; however, as the horizon increases, the empirical estimates converge closer to behavioral model. Additionally, ex-ante UIP deviations, which in the model correspond to the financial wedge ψ_t, also don't exhibit the persistence of the rational model. Appendix C.2 checks robustness by showing the estimates on smoothed data.

4.3 Consistency with Cross-sectional Data: Financial Shock

The following section explores if the behavioral model is consistent with cross-sectional survey data on beliefs and actions. I study how a deviation of exchange rate expectations affects the actions of a firm as well as the expectations of other variables.

I generate the deviations 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 AR(1) process with persistence 0.92. The shocks come from a discretized normal distribution with 11 possible values. I study macroeconomic expectations and current actions of a firm i vary depending on it's individual expectation of financial shock. I sort the responses by expected depreciation and take the average by quartile. For expected exchange rate, output and inflation I look at two-quarter-ahead forecasts. For other variables, which only have qualitative responses in the survey, I calculate the index depending on the difference between fractions of expanding and contracting firms, to make it consistent with the data. While working with own firm's actions, I account calculate it separately for price-updating and non-updating firms in both sectors and report the weighted average.

Figure 8 shows the quantitative beliefs of the firms about the aggregate state of the economy and compares them with the empirical counterparts, both expressed as the average deviation from the period t median. The Figure 8 shows that the agents expecting depreciation tend to forecast low output growth and demand, accompanied by high inflation.

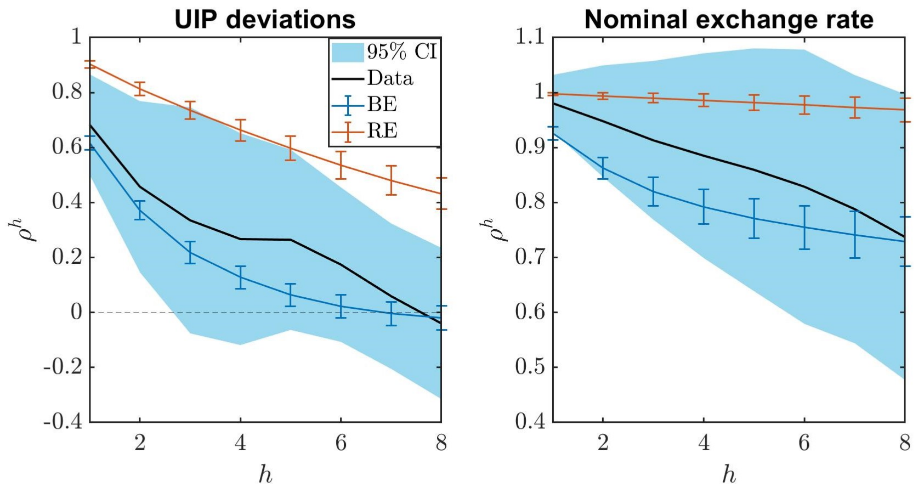

Figure 7: Non-Targeted Persistence

Notes: The plot compares the persistence of nominal exchange rate and UIP deviations on horizons from 1 to 8 quarters in the data and in two models - behavioral with $\rho = 0.64$ and $\hat{\rho} = 0.92$ and rational with $\rho = 0.92$. The empirical estimates are using monthly data. The ex-ante UIP deviations are estimated with annualized deposit interest rates for Peru and the US from the Central Reserve Bank of Peru and Federal Reserve data. The 12-month ahead exchange rate are estimates based on weighted average of professional forecasters consensus expectations at the end of the current and next year by the Central Reserve Bank of Peru. Blue area refers to 90% confidence interval. The model moments are the median across 100 simulations. A simulation spans 1200 periods with the first 200 periods omitted.

They expect a decline both in aggregate employment and real wages. Despite the Survey estimates being the unconditional moments potentially driven by several different shocks, financial shock is consistent with the patterns in the data. The model overestimates the co-movement of most expected macroeconomic variables with exchange rate forecasts, but that is an expected consequence of adding only one source of deviations on firms' expectations.

Moreover, the model correctly predicts the contraction in output and employment of a firm expecting depreciation. Figure 9 shows the deviation in firms' actions by exchange rate expectations as a weighted average by sector and price optimization status. The result is driven by price-optimizing firms increasing prices in response to future inflation while the fall in aggregate demand doesn't allow the firms with fixed prices to expand due to higher market share. As shown in Appendix Appendix C.6, non-tradable firms have stronger responses but tradable firms also contract in response to expected depreciation.

When the deviations in beliefs of small firms are modeled as news, however, the model doesn't generate expected decline in economic activity seen in the data. Instead, the firms who already raised prices expect to recover partially as the rest of the firms in their sector responds to depreciation. However, Appendix C.6 shows that expected contraction can be generated if the deviation in expectations is modeled as the difference in the expected persistence of financial shock. Moreover, Appendix C.9 studies an extension with half of the firms having rational expectations while another half is behavioral. Expected contraction is consistent with that model modification.

Summing up, the model driven by financial shock captures the regularities in the association between exchange rate forecast, beliefs about the future evolution of other macroeconomic variables, and recent and intended choices of the firm.

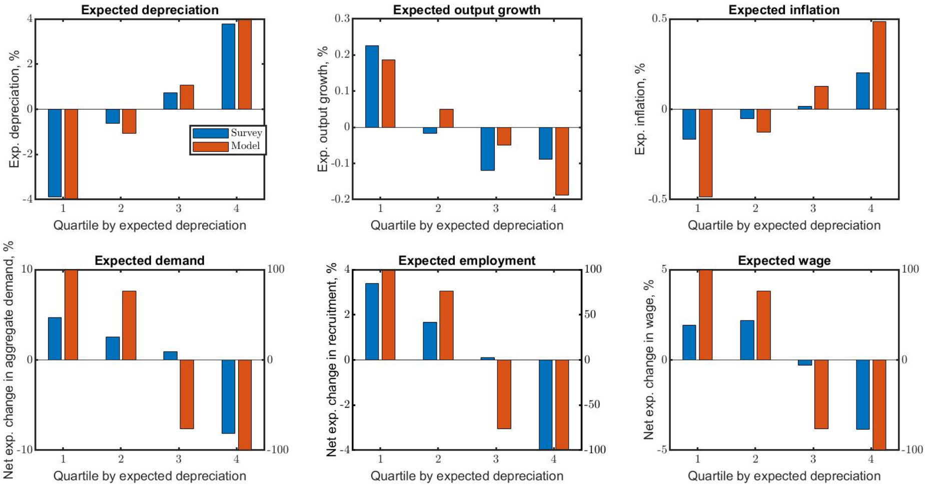

Figure 8: Beliefs on Aggregate Economy by Expected Depreciation: Data and Model

Notes: The graph compares the beliefs on the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and in the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on the next period financial shock. The forecast horizon is one quarter for aggregate demand and two quarters for other variables with the difference originating from different type of survey questions. The empirical estimates are described in the previous section. The expectations on 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. The model estimates of expected wage refer to the real wage.

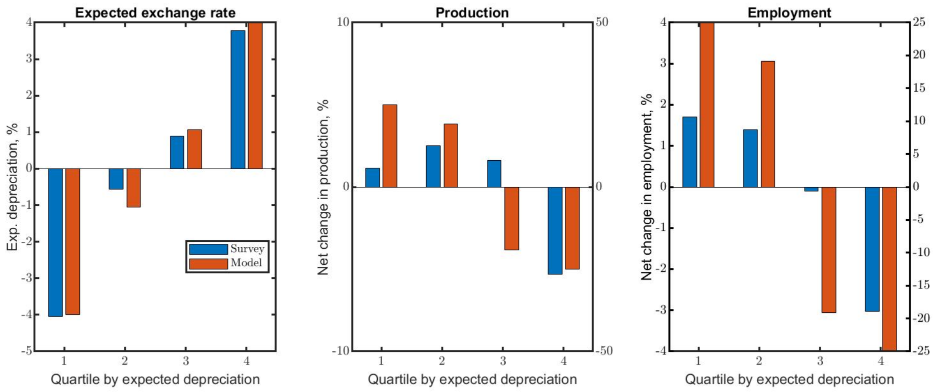

Figure 9: Actions by Expected Depreciation: Data and Model

*Notes:*The graph compares the recent actions by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on the next period 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 empirical estimates are described in the previous section. The exchange rate survey estimates refer to the expected percent change in the variable, while the rest of the survey responses show the net share of the agents reporting or expecting an increase.

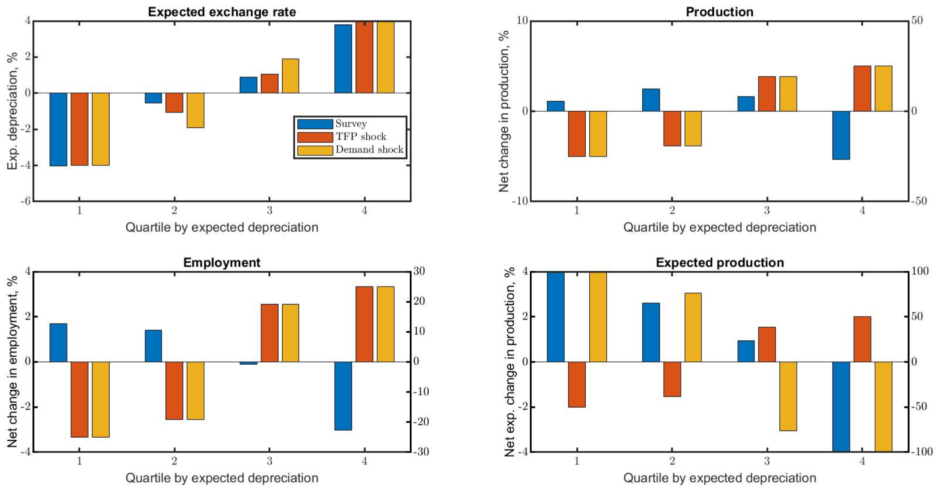

Figure 10: Expected and Recent Actions Expected Depreciation: TFP and Demand Shocks

*Notes:*The graph compares the recent and expected by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on the next period TFP (red) and demand (yellow) 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 empirical estimates are described in the previous section. The expected depreciation estimates refer to the expected percent change in the variable, while the rest of the survey responses show the net share of the agents reporting or expecting an increase.

4.4 Consistency with Cross-Sectional Data: Other Shocks

In this section, I show that, in contrast with financial shock, other standard domestic shocks to TFP, demand and monetary policy don't generate cross-section responses consistent with the survey data. TFP shock is defined as the shock to productivity, common to both tradable and non-tradable sector. Demand shock is the shock to discount factor, while monetary policy shock enters Taylor rule equation.

The real shocks - TFP and demand shocks - result in firms expecting depreciation expanding their output and employment. If depreciation is caused by non-financial domestic shock, according to UIP, it must result from a decrease in domestic interest rate, which made international assets more attractive for domestic agents and resulted in capital outflow and lower demand for local currency. With real shock, a decrease in nominal rate is the response of monetary policy to deflation. If firms receive the news of deflation, however, they reoptimize their prices today due to the possibility they won't be able to update them in the next period. Lower prices lead to higher demand for their variety of goods and expansion in production and output. Figure 10 shows that actions of the firms have the opposite comovement with exchange rate expectation compared to the data. Appendix C.7 provides more details by showing the expectations of the aggregate variables and impulse responses.

For monetary shock, a decrease in interest rate stimulates demand and output. Figure 11 shows that for depreciation driven by monetary easing, firms expecting high exchange rate would also expect expansion in demand and output. Appendix Appendix C.7 provides further details.

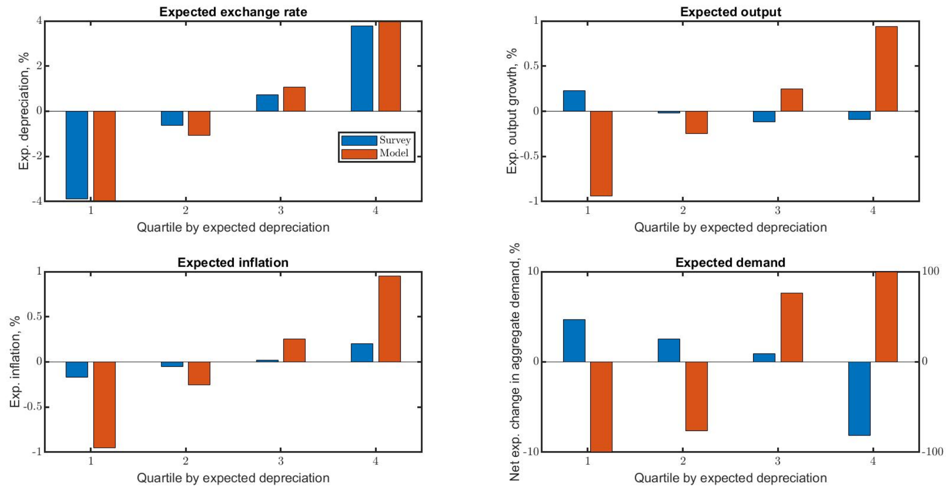

Figure 11: Beliefs on Aggregate Economy by Expected Depreciation: Monetary Shock

Notes: The graph compares the beliefs on the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and in the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on the next period monetary policy shock. The forecast horizon is one quarter for aggregate demand and two quarters for other variables with the difference originating from different type of Survey questions. The empirical estimates are described in the previous section. The expectations on exchange rate, output and inflation are quantitative, while the expected demand refers to the percent point difference between firms expecting an expansion and 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 contractionary impact of aggregate demand channel. In this section, I let both firms and households have behavioral expectations.

Figure 12 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 $\{\psi_{t+k}\}_{k=0}^{\infty}$ must be offset either by current depreciation or increase in the expected path of domestic interest rate. Both effects are present in this economy. The current depreciation leads to higher import prices, which generates CPI inflation, and monetary policy reacts by the interest rate hike. In the long run, the real variables return to the original steady state, and the nominal values (prices, exchange rate) change their level permanently. The expectation of long-run inflation encourages firms to raise local currency prices, and the change in the expected path of interest rate and relative prices pushes households to decrease their consumption. Both tradable and non-tradable firms face a decline in domestic demand. As Figure 13 (red) shows, the combination of low demand and high prices leads to a decline in output in non-tradable sector. 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 to increase the external demand for their variety of tradable goods. Tradable sector is additionally supported by expenditure switching from imports to Home tradable goods. Under rational expectations, despite the fall in domestic demand, the export expansion and

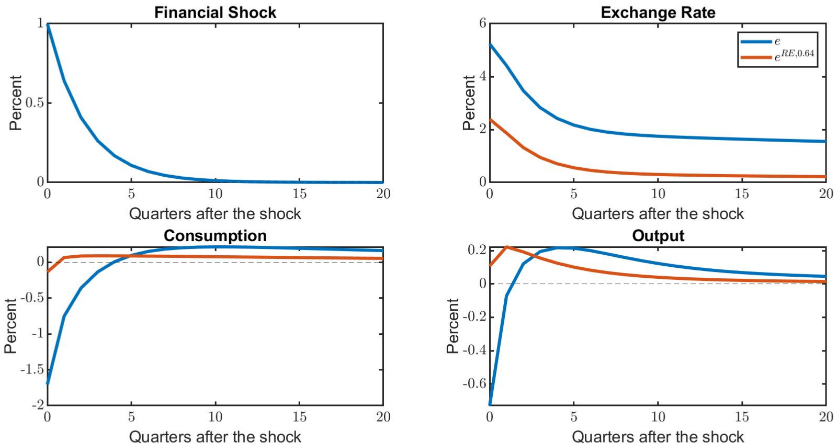

Figure 12: Macroeconomic Response to a Financial Shock

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.

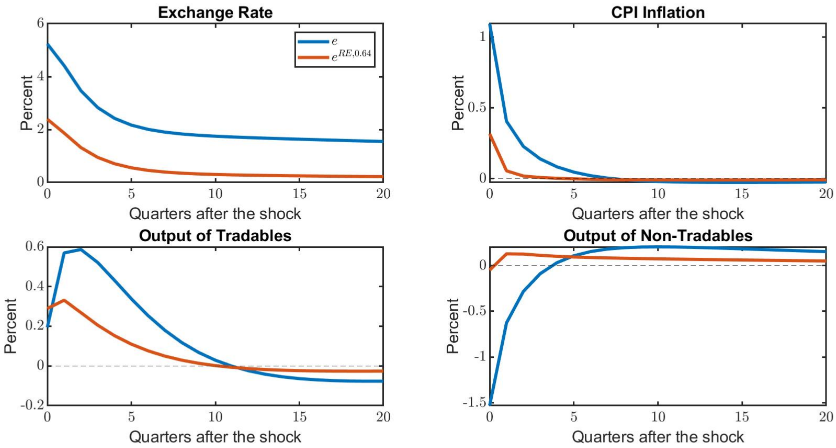

Figure 13: Sectoral Response to a Financial Shock

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.

expenditure-switching channel dominates and the aggregate output expands.

The beliefs on the persistence of financial shock change the response of macroeconomic variables. As shown in Figure 12 (blue) and explained in the analytical example in the previous section, the response of exchange rate and long-run price level is amplified due to the expectation of financial shock affecting the path of exchange rate for a longer period of time. The firms respond with stronger price changes, interest rate increases to curb inflation, and domestic consumption drops by more than in the RE model. Figure 13 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 decrease in domestic demand, both of which are amplified by expectations. However, since domestic demand channel is driven not only by price-setting but also by general equilibrium response

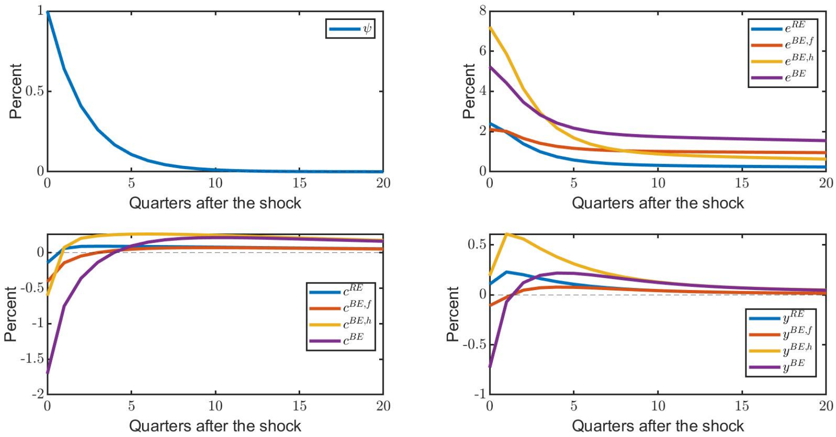

Figure 14: Macroeconomic Response to a Financial Shock: Impact of Behavioral Beliefs by the Type of Agents

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.

of forward-looking households, it reacts stronger to expectations. In behavioral economy, tradable sector still expands, but by less than in the RE model. So, under the persistent beliefs, the aggregate output contracts.

Appendix C.5 provides additional insights by showing high-persistence rational expectation model, which also corresponds to the agents' expected evolution of the economy on impact. Appendix C.8 discusses the role of price rigidities in shaping the result. Since the sensitivity of the domestic demand channel to expectations depends on firms' price-setting choices, in flexible price model, behavioral expectations don't affect its relative importance. However, they still amplify the response of the exchange rate and the macroeconomy.

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 household expectations. The following section separates the expectations of firms and households and studies their role individually. The firm expectations can generate a recessionary depreciation even when households are rational. However, the household expectations amplify the impact of the shock on exchange rate and make the recession quantitatively significant.

Figure 14 compares four versions of the model: the RE model (blue), the baseline behavioral model (purple), the model where only firms are behavioral (red), and the model where firms are rational but households are behavioral (yellow). Compared to the rational benchmark, household expectations magnify the response of the exchange rate to financial shock, as they enter the UIP condition. However, the expenditure switching still dominates the fall in domestic demand, and output expands.

In contrast, when firms are behavioral and households are rational, the exchange rate response is close to the fully rational model as firm's expectations don't directly affect the UIP condition. However, behavioral firms still anticipate prolonged depreciation and rise local currency prices accordingly. The long-run level of the exchange rate stays elevated in the behavioral model, reflecting higher inflation. As monetary authorities respond to the price changes, households correctly anticipate that in this economy, a depreciation of similar magnitude corresponds to a stronger increase in domestic interest rate. Therefore, rational households contract their demand in response to the current and expected actions of behavioral firms. Forward-looking decision-making of households amplifies the firms' behavioral bias and makes demand channel stronger than expenditure switching channel, resulting in a small contraction.

However, behavioral households can amplify the recession generated by the response of behavioral firms. For the decline output 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 firms' and households' expectations. According to behavioral macro literature, that can be a reasonable assumption. Candia et al. (2023) show on the example of inflation expectation surveys that while firms' expectations differ from both households' and professional forecasters' expectations, they typically lie between them and can be close to households' expectations. A plausible assumption may be that small firms have expectations similar to the ones of households while larger firms tend to be closer to the professionals. In a recent paper, McClure et al. (2024) show that output inflation expectations of low- and middle-rank managers indeed closely approximates the households expectations.

5 Conclusion

In this paper, I study exchange rate expectations of firms, documenting two key facts. First, firms' forecasts of exchange rates systematically depart from the rational expectation benchmark, showing overreaction in their expectations. Second, firms associate depreciation with economic contractions and tend to reduce their own economic activity when they expect a higher exchange rate.

I introduce behavioral expectations into a small open economy model, disciplining the agents' beliefs with the first fact, and show that exchange rates expectations driven by financial shocks are consistent with the second fact. I discuss the implications of behavioral beliefs for aggregate dynamics, showing that 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 regarding exchange rates. Communicating the source and expected persistence of exchange rate fluctuations may stabilize the exchange rate and alleviate the associated recession. 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.

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A Appendix A: Empirical Analysis

A.1 Appendix A1: Descriptive Statistics on Forecast Errors: Forecast Horizon

Figures 15 and 16 show the time-series of the realized macroeconomic variables compared to the firms' 3- and 9-month-ahead forecasts correspondingly. On 3-month horizon, the realized value of exchange rate is more likely to lie inside the 90% confidence interval than on 6- or 9-month horizon, showing that the forecast becomes more precise on shorter horizons. For both all horizons, exchange rate realization is less likely to lie inside the confidence intervals than for output and especially inflation, with one notable exception - the 9-month-ahead forecasts made in March 2020 severely underestimated the 12% fall in output caused by a national lockdown due to Covid-19.

Table 7 shows that the forecasts are more precise on shorter horizons. The difference between one- and three-quarter ahead forecast is especially strong for exchange rate, but weak for inflation. The fact that exchange rate errors are the largest among the three variables remains true for all forecast horizons.

A.2 Appendix A2: Descriptive Statistics on Forecast Revisions

Forecast revisions of the exchange rate show similar properties to output and inflation. As shown in 8 The share of non-revisions for exchange rate is high (47%) 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 25% cases, the respondent does not update any of the three forecasts. Moreover, the absolute revisions show similar magnitude and standard deviations relative to the volatility of the underlying variable. The disagreement of exchange rate revisions is also similar to the output and inflation revisions.

This finding is consistent with a model where the news on exchange rate, output and inflation are processed in a similar way. In particular, it is consistent with the hypothesis that all three variables respond to the same shocks and the agents adjust the macroeconomic expectations in accordance with the beliefs about the future trajectory of those shocks.

A.3 Appendix A3: Overreaction by Forecast Horizon

In this section, I estimate the BGS and CG coefficients while controlling for the forecast horizon. Figure 17 shows that both coefficients are robustly negative independent of the forecast horizon. In the quantitative model, the forecast horizon is one quarter or three months. For both regressions, the 3-month estimates are closed to the results of pooled regressions.

Figure 18 provides the robustness check on the pooled-horizon estimate of CG regression controlling for different definitions of forecast revision. While in the baseline results 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, $\mathbb{E}_{i,t}x_{t+h} - \mathbb{E}_{i,t-k}x_{t+h}$. The sign and magnitude of the overreaction are robust across different revision horizons.

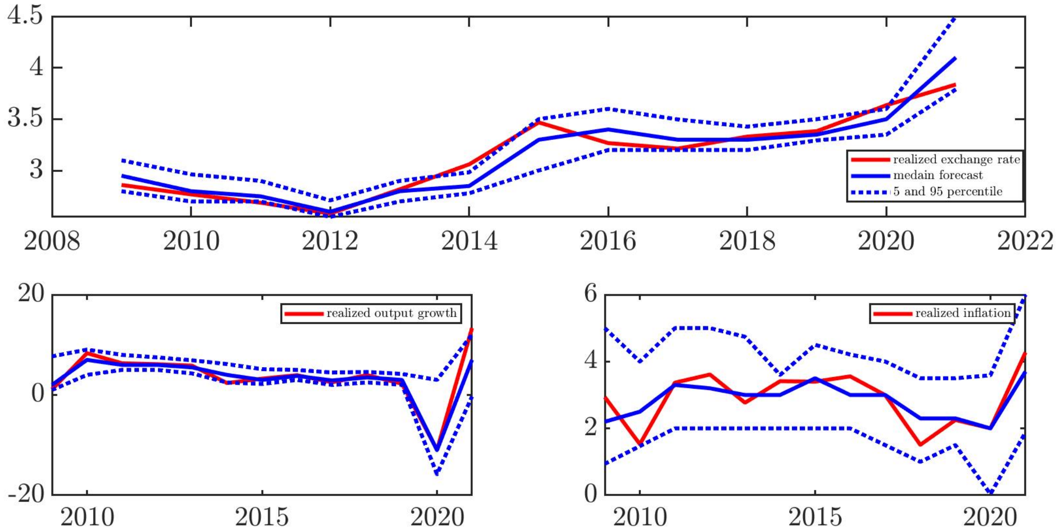

Figure 15: Realized and Forecasted Macroeconomic Variables: 3-months-ahead

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- 95-percentile of firms' three-month-ahead forecasts (blue).

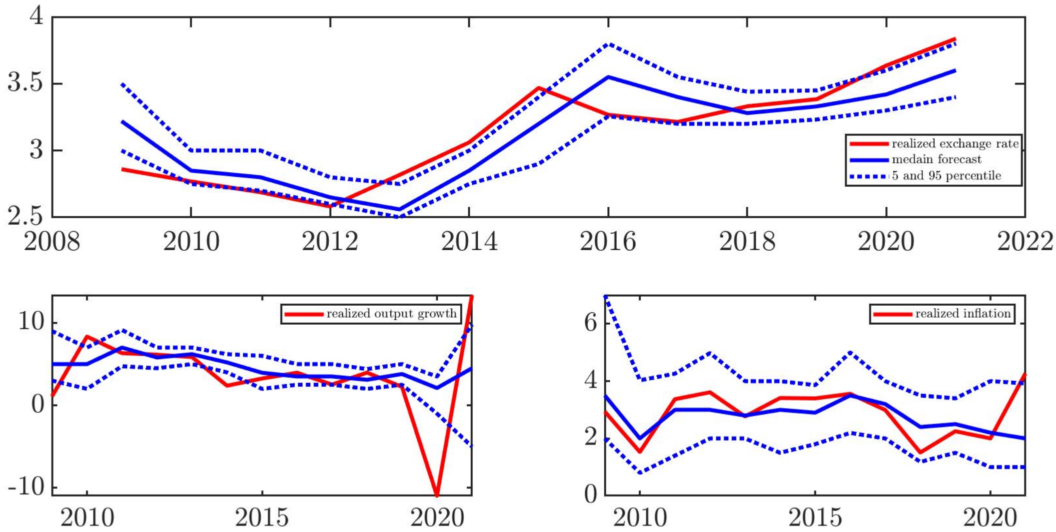

Figure 16: Realized and Forecasted Macroeconomic Variables: 9-months-ahead

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- 95-percentile of firms' nine-month-ahead forecasts (blue).

A.4 Appendix A4: Overreaction by Type of Respondent

The persistence of current conditions seems robust among different types of respondents. Table 9 compares the β_{BGS} regression coefficients for non-financial and financial firms and professional forecasters. In all three cases, the forecasts deviate from FIRE with $\beta_{BGS} < 0$,

	Δe	Δy	π
One-quarter-ahead forecast	2.64	0.83	0.51
Two-quarter-ahead forecast	4.28	1.05	0.51
Three-quarter-ahead forecast	5.63	1.33	0.59

Table 7: Summary Statistics: Magnitude of Absolute Error by Forecast Horizon

Notes: The table presents descriptive statistics on three, six and nine-month ahead forecast errors for exchange rate depreciation, output growth and inflation. The forecast error for variable x_t is the difference between the realized and forecasted variable, $x_t - E_{t-6}x_t$.

	Δe	Δy	π
Non-revision share	0.49	0.50	0.55
Mean absolute revision	1.65	0.73	0.35
Mean relative revision	0.32	0.32	0.32
Mean relative sd of revisions	0.95	1.06	0.79

Table 8: Summary Statistics: Revisions

Notes: Revision is defined as $E_{t-m}x_t - E_{t-m-1}x_t$. Non-revisions refer to the instances when the respondent provides the same forecast at time t and $t+1$. As the data is rounded to 0.01 percentage point, the share of non-revisions may also include the instances of forecasts updated by a smaller amount.

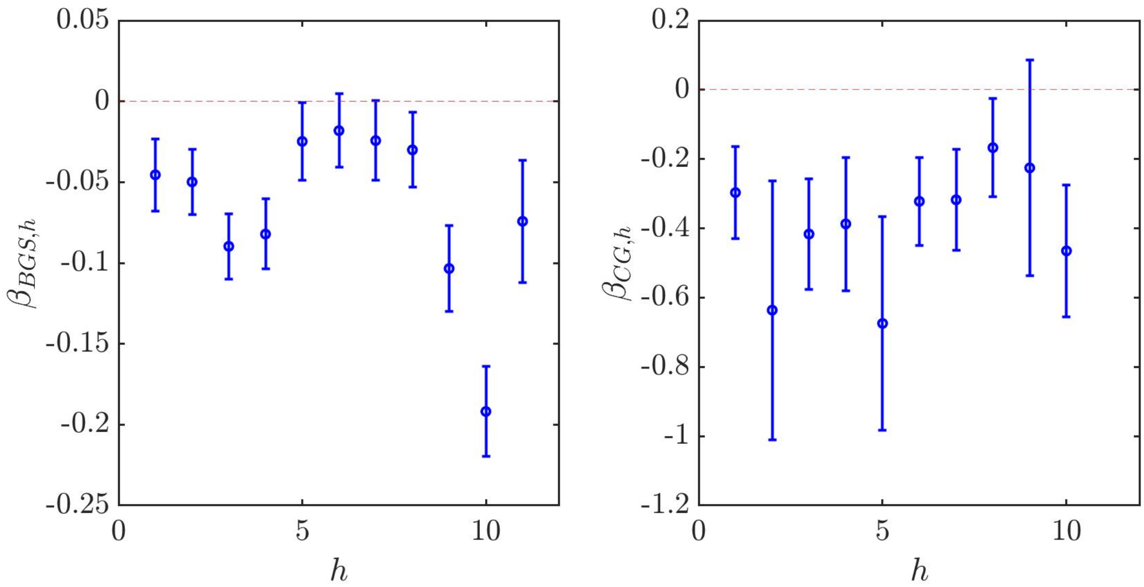

Figure 17: BGS and CG Regressions for h-month-ahead Forecast

Notes: The figure shows the coefficients and 90% confidence bands for BGS and CG panel regressions with fixed effects with different horizons h, where h refers to h-month-ahead forecast. The dotted red line is the coefficient of the panel regression with no distinction between the horizons. The solid red line is the fitted regression for the coefficients and horizon h.

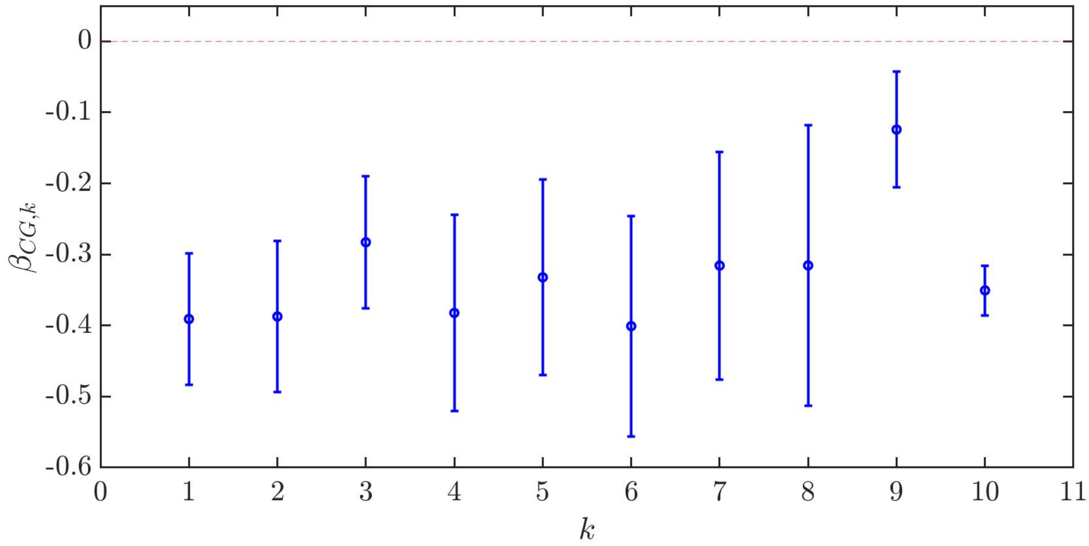

Figure 18: CG Regressions for k-month Revisions

Notes: The figure shows the coefficients and 90% confidence bands for CG panel regressions with fixed effects with different revision time k, where revision is $\mathbb{E}_{i,t}x_{t+h} - \mathbb{E}_{i,t-k}x_{t+h}$.

	Firms (non-financial)	Financial system	Professional forecasters
β_{BGS}	-0.12	-0.14	-0.15
	(0.04)	(0.05)	(0.05)

Table 9: Predictable Errors by Type of Respondent

Notes: The table shows coefficients from BGS (forecast error on current exchange rate) regression for consensus forecast among professional forecasters and financial and non-financial firms (March 2002 - August 2022). The standard errors are Newey-West.

indicating that the overreactive beliefs pattern is not specific to firms.

A.5 Appendix A5: Data Validity Discussion

As The Survey does not provide identifying information on the responding firms, it isn't possible to establish directly whether the firms report their actions accurately and whether expected actions and expectations are relevant to the realized actions of the firms. The concern is that the employee filling out the survey may not be making decisions on the scale of production and employment, which raises the question of whether the reported expectations are relevant to the firm's dynamics.

The data allows us to check the consistency of a firm's responses by tracing whether the expected actions are followed by their self-reported implementation. I observe a three-month-ahead expectation of the change in the firm's output, sales and employment at month $m-1$ and pair it with the same firm's month m response on the change compared to the previous month. The share of firms conforming with their intentions is 62.1%, 61.1% and 74.8% for output, sales and employment correspondingly. Table 10 shows the frequencies

Expectation	Realized Production			Realized Sales			Realized Employment		
	Incr.	Const.	Decr.	Incr.	Const.	Decr.	Incr.	Const.	Decr.
Increase	46%	39%	15%	49%	35%	16%	30%	63%	7%
Constant	13%	74%	14%	14%	70%	16%	4%	89%	7%
Decrease	11%	23%	65%	11%	26%	63%	3%	47%	51%

Table 10: Consistency between Expected and Realized Actions

Notes: The table shows the shares of the reported change in output, sales and employment in month m relative to the previous month $m-1$ by the expectation reported at month $m-1$. The survey question on expectation refers to the expected change in three months, $m+2$, relative to the current month $m-1$.

of self-reported recent actions by the expectations reported the month before. While the compliance is not perfect, the intended action tends to be the most likely outcome, and the difference between the groups is substantial. Therefore, the Survey shows consistency between expected and recent changes, so, assuming the self-reported recent changes are correct, the expected actions are informative about the firms' actions. However, the log difference of monthly GDP, reported by the Central Reserve Bank of Peru, is only weakly correlated with the median responses on the recent sales (correlation is 0.24). Two limitations of the Survey prevent the median from being representative of the aggregate dynamics: the unreported size of the firms and the qualitative answers not specifying the magnitude of the reported increase or decrease in the firm's sales.

A.6 Appendix A6: Firm's Actions by Expected Exchange Rate: Robustness

In this section, I discuss the robustness of connection between exchange rate forecast and actions of a firm by presenting non-residualized plots and regression results.

Figure 19 shows non-residualized plots that connect exchange rate forecasts with firms' expected and recent actions. As in the main section, for every period, I sort observations by expected depreciation and divide them into quartiles, calculating the mean. Then, I average the results for every quartile by time. Similar to the results in the main section, I document that firms expecting depreciation are more likely to contract their production and employment now and in the next three months. They also associate depreciation with higher input costs. In addition to the variables discussed in the main section, I add another three variables: recent and expected change an sales and expected change in price. While the results on sales resemble the results on production, the I don't document connection between the expected depreciation and the fraction of firms that intend to raise prices.

The table 11 supports these findings by regressing exchange rate expectations on the action variables, controlling for the forecasted output and inflation. For example, a firm that has recently hired new employees expects, on average, 0.52% lower depreciation compared to a firm that kept its employment constant and 1.04% lower depreciation compared to a firm that fired its workers.

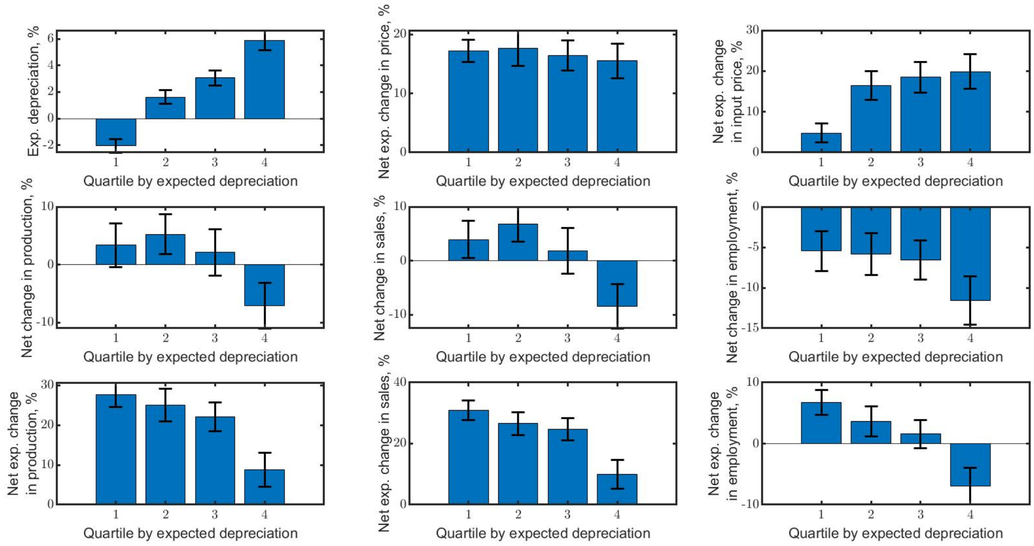

Figure 19: Recent and Expected Actions by Expected Depreciation: Non-Residualized

Notes: The graph shows recent and expected actions of firms by expected depreciation quartiles. The observations are sorted into four quartiles by expected exchange rate forecast, and the median 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 change direction. 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 t-test.

A.7 Appendix A7: Expectations on Exchange Rate and Macroeconomic Aggregates: Robustness

This section provides non-residualized quartiles plots ans regression estimations for robustness check on the connection between exchange rate forecasts and other macroeconomic variables.

Figures 20 and 21 show non-residualized plots that connect exchange rate forecasts with firms' expected and recent actions. As in the main section, for every period, I sort observations by expected depreciation and divide them into quartiles, calculating the mean. Then, I average the results for every quartile by time. They confirm the results documented in the main section: expected depreciation is associated with high inflation and the decline in economic activity (output, demand, wage and employment).

The table 12 shows the results of regressions of exchange rate expectations on the expectations of other variables, controlling for the forecasted output and inflation. To interpret, firms expecting an increase in expected demand tend to expect 0.5% and 1.0% lower annual depreciation compared to firms expecting stable or decreasing demand, correspondingly.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Production	-0.17							
	(0.07)							
Sales		-0.31						
		(0.06)						
Employment			-0.52					
			(0.10)					
Expected production				-0.27				
				(0.10)				
Expected sales					-0.27			
					(0.09)			
Expected employment						-0.35		
						(0.11)		
Expected price							0.07	
							(0.09)	
Expected input price								0.36
								0.09
Expected output growth	-0.06	-0.06	-0.06	-0.01	-0.01	-0.02	-0.06	-0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Expected inflation	0.79	0.76	0.76	1.22	1.15	1.05	0.78	0.72
	(0.09)	(0.07)	(0.07)	(0.15)	(0.12)	(0.10)	(0.09)	(0.07)

Table 11: Exchange Rate Forecast and Actions

Notes: The table shows the coefficients of panel regression with fixed effects where the dependent variable is expected annual depreciation. The expected production, sales and employment data start in 2015, while the rest of the variables span from 2009 to 2022. The standard errors are clustered by firms.

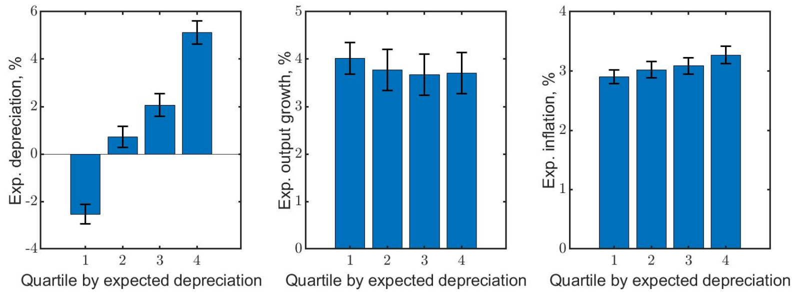

Figure 20: Expected Output and Inflation by Expected Depreciation: Non-Residualized

Notes: The graph shows the inflation and output forecasts by expected depreciation quartiles. For every period t, the 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 t-test.

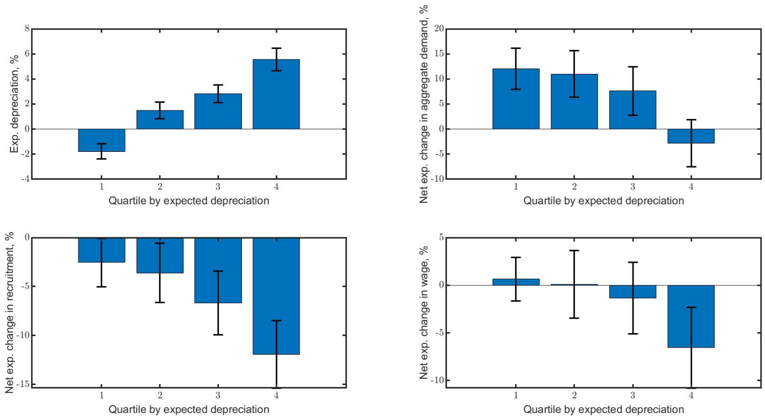

Figure 21: Beliefs on Aggregate Economy by Expected Depreciation: Non-Residualized

Notes: The graph 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 forecast by running cross-section regressions. 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 can take values -1, 0 and 1 depending on the change direction. 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 t-test.

	(1)	(2)	(3)
Expected demand	-0.50		
	(0.08)		
Expected recruitment		-0.66	
		(0.09)	
Expected wages			-1.03
			(0.16)
Expected output growth	-0.06	-0.06	0.00
	(0.01)	(0.01)	(0.01)
Expected inflation	0.78	0.79	1.25
	(0.07)	(0.07)	(0.13)

Table 12: Exchange Rate Forecast and Macroeconomic Beliefs

Notes: The table shows the coefficients of panel regression with fixed effects where the dependent variable is expected annual depreciation. The data on expected demand, recruitment and investment spans 2009-2022, 2013-2022 and 2018-2022, correspondingly. The standard errors are clustered by firms.

B Appendix B: Model

B.1 Appendix B1: Analytical Example: Derivation of the Price of Non-Tradables

To derive the price of non-tradables $p_{NT,t}$, I use the price-setting equation

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

and plug it into the country resource constraint:

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

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

where the discounted sum of nominal wage appears as wages are a part of the optimal production of exports. Using the result for import, can write this expression as a function of exchange rate and financial shock:

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

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

where the second expression is derived using the fact that financial shock ψ_t is expected to evolve according to AR(1) process.

The second term on the right hand side depends on the discounted sum of exchange rates. Using the expression for exchange rates as a function of financial shock and CPI prices derived in the main section, it can be written in the following way:

$$\mathbb{E}_t \sum_{k=t}^{\infty} \beta^k e_{t+k} = \mathbb{E}_t \sum_{k=t}^{\infty} \beta^k \left(\frac{\psi_{t+k}}{1-\rho} - (\phi_\pi - 1)\bar{p} + \phi_\pi p_{t+k-1} \right)$$

$$= \frac{\psi}{(1-\rho)(1-\beta\rho)} + \frac{(1-\phi_\pi)p_{NT,t}}{1-\beta} + \beta\phi_\pi \mathbb{E}_t \sum_{k=t}^{\infty} \beta^k p_{t+k},$$

where for the second term, I make use of the fact, since the price of non-tradables cannot be reset in the future and real variables converge to the steady state, in deviations, $\bar{p} = p_{NT,t}$.

As for discounted sum of prices, they can be written as a function of current price of non-tradables and the discounted sum of exchange rate:

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

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

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

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

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

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

C Appendix C: Quantitative Model

C.1 Appendix C1: Solution of the Model

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. I solve the behavioral model by estimating rational expectation versions with both true and behavioral parameters and using them to modify the law of motion of the economy. The forward-looking decisions are based on observable states and expectations consistent with behavioral parameters, but the backward-looking variables evolve according to the true shock process.

Estimate 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, they are functions of the parameters determining the persistence of the shocks. If estimated for ρ and $\hat{\rho}$, these matrices only differ in the column referring to ψ and e_ψ: the two economies are identical except the persistence of the financial wedge and the impact both wedge ψ_t and innovation e_ψ have on the economy.

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 x_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.

3. The agents don't use the observations to learn the true shock process. Instead, they interpret the predictable error $\psi_t - \mathbb{E}^{BE}_{t-1}\psi_t$ as a part of the innovation to the shock. Therefore, the states evolve as follows:

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

   where the first two terms refer to the fact that decision rules of the agents are equivalent to the ones in $\hat{\rho}$ rational model and the last term refers to the systematic error being interpreted as an innovation.

Notice that, while the shocks are states, $A(\cdot)$ and $B(\cdot)$ have only one entry on the diagonal, so the shock process becomes $\psi_t = \rho\psi_{t-1} + e_\psi$ (true law of motion).

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

Behavioral Model with $\hat{\rho}^{hh} \neq \hat{\rho}^{f}$. Next, I outline the solution of the model when the perceived persistence of the shocks differs for households and firms. The approach is based on approximating the long-run expectations of households. To do that, I need to substitute domestic and international Euler equations forward.

The international Euler equation can be expressed as

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

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

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

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

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

I assume that households change their long-run expectations in response to the perceived innovation, $\mathbb{E}_t^{hh}\bar{p} = \mathbb{E}_{t-1}^{hh}\bar{p} + \delta(\psi_t - \hat{\rho}^{hh}\psi_{t-1})$. If the households are rational, they only respond to the innovation to financial wedge e_t^{ψ}. However, if they are behavioral, they adjust their expectations in response to the systematic forecast error. The parameter δ is found 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 long-run prices according to the impulse response to a financial shock.

An important consideration is that the parameter δ depends not only on the expectations of households but also on the expectations of firms since the long-run price level depends on the price-setting decision rule. 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. The parameter δ^{RE} corresponds to the responses of firms with perceived persistence ρ and is estimated to match the baseline rational expectations model.

Case 2: Rational households and behavioral firms. The approach is based on estimating the behavioral model where model expectations would equal firms' expectations but not households' expectations. First, a rational model with persistence ρ is estimated using the parameter δ^{RE}. Second, I guess a parameter $\delta^{BE} \neq \delta^{RE}$ and estimate a model with true persistence $\hat{\rho}$, rational firms that have the model expectations, and behavioral households with expectation ρ pinned down by the approximated expression. Lastly, I return to the true shock process ρ while keeping the model expectations consistent with the expectations of behavioral firms. In this case, if δ^{BE} is guessed correctly, the rational households should be able to predict the long-run price level $\bar{p}$ while accounting for the behavioral price-setting rule of firms. The expectations of firms and households are different, but both types of agents 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. The second-stage results, given the estimated δ^{BE}, would refer to the case where the true persistence of the shock is $\hat{\rho}$, firms are rational and households hold behavioral beliefs.

Heterogeneous Firms. I use a similar approach to solve the model with two types of firms from C.9. I approximate the beliefs of the rational firms as a function of the expectations of behavioral firms and their systematic bias:

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

where $S \in [NT, HT, X]$ and ω is a parameter I guess and verify.

The Phillips curve is expressed as

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

I estimate a behavioral model where model expectations belong to behavioral firms and are not consistent with the future path of the economy. I verify the guess of the parameter ω by estimating the impulse response to financial shock and comparing the realizations with the expectations of the rational firms.

C.2 Appendix C2: Robustness for Non-Targeted Persistence

In the main section, the persistence of nominal exchange rate and UIP deviations is estimated using monthly data. I want to check if low estimated persistence is driven by high-frequency volatility of exchange rate. I verify the robustness of the estimates by running autoregressions on the data smoothed with simple 3-month moving average to make it comparable with the quarterly frequency of quantitative model. Figure 22 shows the results. While the estimates on short horizon indeed become more persistent, the overall conclusions don't change. For nominal exchange rate, the rational expectation model performs better at 1-2 quarter horizons, however, it doesn't capture the non-stationary behavior of exchange rate on longer horizons. For UIP deviations, behavioral model outperforms the rational model.

C.3 Appendix C3: Multi-shock economy

This section studies the unconditional moments in a two-shock economy and shows that the behavioral model can match the exchange rate disconnect moments as well as the RE model with the same persistence of beliefs.

I introduce the second shock - a shock to the total factor productivity, which affects both tradable and non-tradable sectors. 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.7 discusses the impulse response to a 1% TFP shock under both rational and behavioral beliefs.

Table 13 reports the unconditional moments for behavioral and rational economies. The volatility of the TFP shock $\frac{\sigma e_a}{\sigma e_\psi}$ matches the volatility of the exchange rate relative to output, $\sigma(\Delta e)/\sigma(\Delta y)$. By construction, only the behavioral model generates the biased forecast with $\beta_{BGS} < 0$ and $\beta_{CG} < 0$. The behavioral model and the rational expectations model with persistent shocks, $\rho = 0.92$, result in similar comovement patterns between real exchange rate, output and consumption, capturing the excess volatility of exchange rate and the negative correlation with output and consumption. The two specifications differ in the autocorrelation of output and exchange rate, with the rational model overestimating them and the behavioral model underestimating the persistence of the exchange rate. The rational model with transitory shocks, $\rho = 0.64$, doesn't generate a negative correlation between real exchange rate and relative consumption or output: the response of real variables to financial shock is weak and insufficient to offset the positive correlation between exchange rate and consumption due to TFP shock.

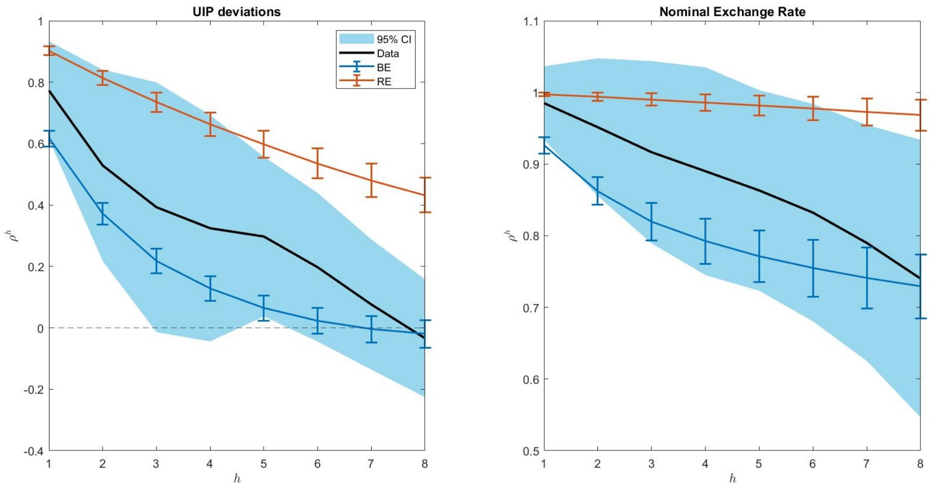

Figure 22: Non-Targeted Persistence: Smoothed

Notes: The plot compares the persistence of nominal exchange rate and UIP deviations on horizons from 1 to 8 quarters in the data and in two models - behavioral with $\rho = 0.64$ and $\hat{\rho} = 0.92$ and rational with $\rho = 0.92$. The empirical estimates are using monthly data smoothed as a simple moving average for the last three months. The ex-ante UIP deviations are estimated with annualized deposit interest rates for Peru and the US from the Central Reserve Bank of Peru and Federal Reserve data. The 12-month ahead exchange rate are estimates based on weighted average of professional forecasters consensus expectations at the end of the current and next year by the Central Reserve Bank of Peru. Blue area refers to 90% confidence interval. The model moments are the median across 100 simulations. A simulation spans 1200 periods with the first 200 periods omitted.

C.4 Appendix C4: Errors and Revisions of Exchange Rate

To study the implications of misspecified beliefs, I show how the overestimation of the persistence ρ_ψ translates into the systematic exchange rate error. In Figure 23, as the shock hits at $t = 0$, both rational (red) and behavioral (blue) agents underpredict the exchange rate as depreciation is driven by innovation to the financial wedge. Both revise their one-quarter-ahead forecasts upwards. However, starting $t = 1$ and under no new shocks, the rational agents predict the exchange rate evolution accurately and make no additional revisions. In contrast, the behavioral agents overextrapolate the depreciation for several periods after the shock, which leads to a negative forecast error. As the agents see the true realizations of the shock and exchange rate, they revise their next forecast downwards.

C.5 Appendix C5: Rational Expectations Models with Low and High Persistence

This appendix compares the financial shock impulse responses by behavioral model an rational model with two different persistence, ρ and $\hat{\rho}$, equal to the true and perceived persistence in the behavioral model, correspondingly. The response of the rational model with persistence $\hat{\rho}$ show, additionally, how economic agents in behavioral model expect the economy to evolve on impact at $t = 0$.

Figure 24 shows that at $t = 0$, the rational economy with a persistent financial shock $\hat{\rho} = 0.92$ (yellow) responds identically to the behavioral model (blue). However, starting at

	Data	BE	RE, $\rho = 0.64$	RE, $\rho = 0.92$
$\sigma(\Delta e)/\sigma(\Delta y)$	3.71	3.69	3.73	3.67
$\rho_3(Ee)$	1.02	1.01	0.98	1.00
β_{BGS}	-0.07	-0.06	0.00	0.00
β_{CG}	-0.39	-0.16	0.00	0.00
$\rho_3(e)$	0.95	0.87	0.98	0.99
$\rho(y)$	0.66	0.68	0.86	0.95
$\sigma(\Delta e)/\sigma(\Delta c)$	3.96	2.38	3.91	2.47
$\sigma(\Delta c)/\sigma(\Delta y)$	0.94	1.55	0.96	1.48
corr$(\Delta c, \Delta q)$	-0.08	-0.60	0.14	-0.55
corr$(\Delta y, \Delta q)$	-0.02	-0.32	0.47	-0.20
corr$(\Delta c - \Delta c^*, \Delta q)$	-0.26	-0.60	0.14	-0.55
corr$(\Delta y - \Delta y^*, \Delta q)$	-0.09	-0.32	0.47	-0.20
$\frac{\sigma e_a}{\sigma e_\psi}$		1.25	2.85	1.4

Table 13: Non-Targeted Moments: Two Shocks

Notes: The table presents the non-targeted moments. The empirical unconditional macro moments are calculated with the Central Reserve Bank of Peru for 2009-2022. The second column refers to the one-shock behavioral model with $\rho_\psi = 0.64$ and $\hat{\rho}_\psi = 0.92$. The third and fourth columns refer to the rational expectations model with the persistence of 0.64 and 0.92 correspondingly. The relative magnitude of financial and productivity shocks for every column matches the excess 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 periods omitted.

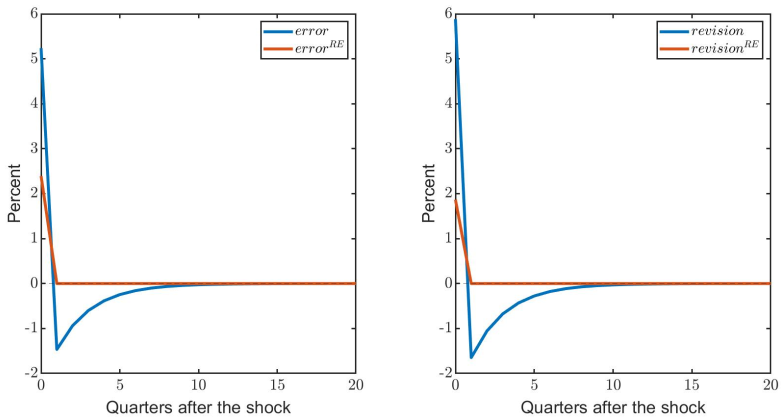

Figure 23: Forecast Errors and Revisions in Response to a Financial Shock

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.

$t = 1$, the two specifications diverge. While the behavioral model generates exchange rate overshooting, with initial depreciation exceeding the long-run change in the exchange rate, in the persistent rational expectations model, the exchange rate keeps depreciating until it reaches the new nominal price level, which is high due to the strong response of firms. This provides an additional insight into the causes of aggregate demand fall under behavioral expectations. As households expect the exchange rate to depreciate further after the initial impact, the cost of borrowing increases by more than financial wedge ψ_t. Another difference is that the recession recovery in the behavioral model is faster due to the agents eventually correcting their expectations.

Figure 25 provides additional details focusing on the sectoral responses. High-persistence rational model implies slow recovery in non-tradable sector and amplifies the hump-shaped response of the tradables.

C.6 Appendix C6: Consistency with Cross-Sectional Data: Robustness

In this section, I conduct two robustness checks on the consistency of firm's actions response to expected depreciation in the model and in the data. First, I discuss sectoral response to the financial shock news. Second, I examine an alternative way to generate the differences in financial shock expectations and discuss the response of expected actions.

Sectoral Response to Financial Shock News. Figure 26 shows that both tradable and non-tradable sector show the propensity to contract when receiving the news of financial-shock-driven depreciation. Both sectors increase the local currency prices, and domestic demand for their product falls. Tradable firms simultaneously decrease their dollar prices and increase their export, however, due to higher sensitivity of local-currency price, the contractionary effect dominates. Tradable firms show contraction of lower magnitude than 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 expected financial shock and exchange rate, which is closely resembles the way of model 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 financial shock, $\hat{\rho}^i_\psi \neq \hat{\rho}_\psi$. The behavioral parameter $\hat{\rho}_\psi$ is known by the firm i, and parameter $\hat{\rho}^i_\psi$ is potentially misspecified.

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 it's individual misspecified persistence of financial shock that taking eight possible values, $\hat{\rho}^i \in [0.3, 1.0] \neq \hat{\rho}$. For symmetry, I run impulse responses to a positive and negative financial shock. For each, I sort the responses by expected depreciation and take the average by quartile. For expected exchange rate, output and inflation I look at two-quarter-ahead forecasts. For other variables, which only have qualitative responses in the survey, I calculate the index depending on the difference between fractions of expanding and contracting firms, to make it consistent with the data. While working with own firm's actions, I account calculate it separately for price-updating and non-updating firms in both sectors and report the weighted average. Additionally, I add noise[7] by assuming a small firm also expects a TFP shock next period. I set $\rho_a = \rho_\psi = 0.64$ and choose $\sigma_a/\sigma_\psi = 2.25$ to match $\sigma(\mathbb{E}_{i,t}e_{t+1})/\sigma(\mathbb{E}_{i,t}y_{t+1}) = 3.1$.

Figure 27 shows recent and expected actions of firms. Similarly to the case where differences in beliefs are generated by news, firms contract their current economic activity if they expect higher depreciation. In addition, this version of the model manages to capture the expected decline in output. In the main specification, firm i is the only firm adjusting the price at $t = 0$, and its output is expected to recover at $t = 1$ as the shock realizes and the rest of the firms adjust their prices, restoring the market share of firm i. In this specification,

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

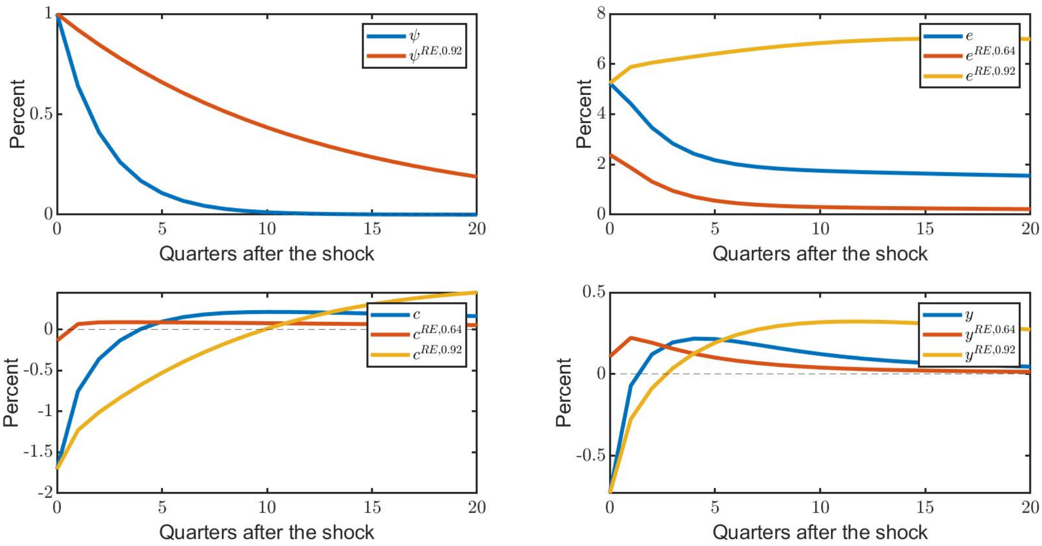

Figure 24: Macroeconomic Response to a Financial Shock

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. The yellow line represents the response of the rational expectations economy with $\rho_\psi = 0.92$.

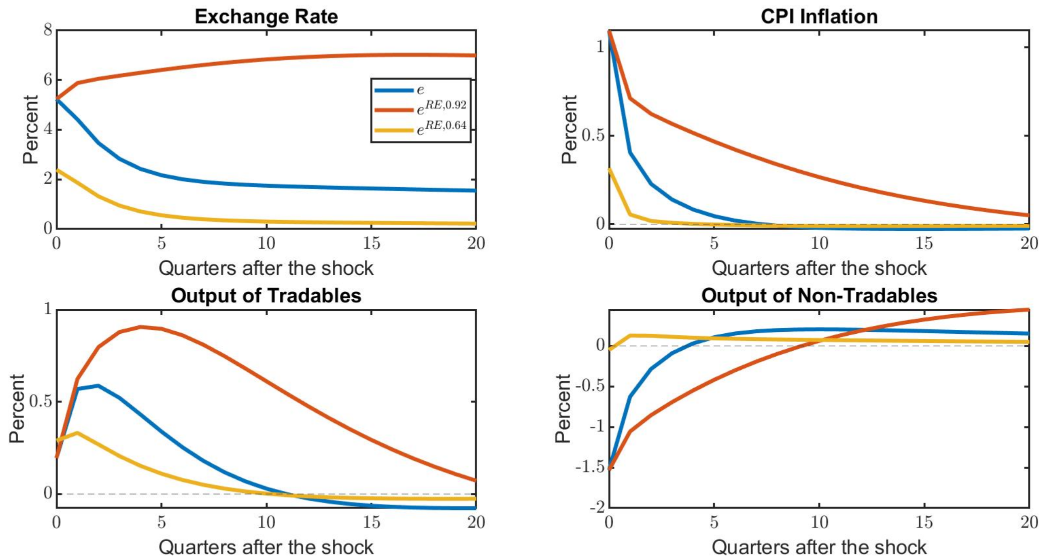

Figure 25: Sectoral Response to a Financial Shock

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 rational expectations economy with $\rho_\psi = 0.92$.

however, this effect is smaller. Firms expecting depreciation tend to anticipate having to decrease their output due to lower aggregate demand and their own price reoptimization.

A limitation of this specification of the model is that, due to small magnitude of the deviations real wages and employment in response to financial shock, the model doesn't capture the fact that they are expected to decrease when depreciation is high. Instead, the expectations of those variables are led by TFP news, resulting in expected depreciation being associated with higher wages and employment.

C.7 Appendix C7: Non-financial Shocks

In this section, I briefly discuss the impulse responses of non-financial domestic shocks with and without behavioral expectations.

Figure 28 shows the response of the economy to a TFP shock. As with financial shock, red line denotes rational expectations with $\rho = 0.64$, while blue line refers to behavioral model with $\rho = 0.64$ and $\hat{\rho} = 0.92$. A positive TFP shock allows firms to decrease prices due to lower marginal costs, which stimulates demand and increases output. Due to the monetary policy rule, deflation results in the decrease in nominal interest rate as monetary authorities stimulate the economy to help it achieve the potential output. Due to the UIP condition, that leads to expected appreciation for no-arbitrage condition for domestic and international assets to hold. Therefore, exchange rate depreciates during output expansion.

Figure 29 describes the response to a demand shock which increases the discount rate β and encourages households to save more, suppressing domestic demand. Output falls, real wage goes down due to lower demand for labor, and firms adjust their prices downwards due to the change in labor costs and the scale of production. As with TFP shock, this leads to lower domestic interest rate and exchange rate depreciation.

Figure 30 shows the cross-section of beliefs on the expected evolution of the economy by expected exchange rate driven by these two shocks. TFP shock fails to account for contractionary economic environment. Demand shock is consistent both with decline in output and consumption, but not with increase in 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.

Finally, Figure 31 discusses monetary policy shock. As interest rate spikes, households increase their savings, leading to the response of output and inflation similar to the one of demand shock. The interest rate, however, appreciates, as expected depreciation is needed to equalize domestic and international interest rates. Figure 32 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.

Note that behavioral expectations amplify the response of the economy but do not change the direction of change. The only shock that can cause contractionary depreciation is demand shock. However, for demand and TFP shocks, exchange rate doesn't show more volatility compared to output, contradicting the stylized fact on excess volatility. Monetary policy shock does generate a strong response of exchange rate, however, as appreciation is associated with decline in output and domestic consumption, it cannot account for the Backus-Smith puzzle.

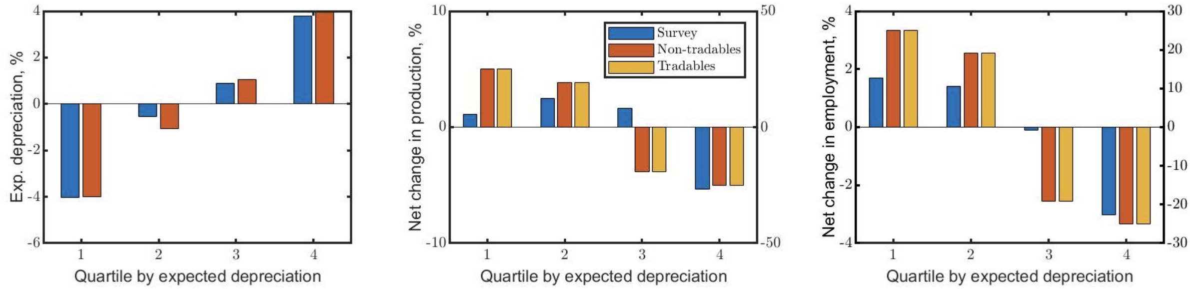

Figure 26: Firms' Actions by Expected Depreciation: Tradable and Non-tradable Sectors

*Notes:*The graph compares the recent actions of firms in tradable and non-tradable sector by expected depreciation quartiles in the data and the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on the next period 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 empirical estimates are described in the previous section. The exchange rate survey estimates refer to the expected percent change in the variable, while the rest of the survey responses show the net share of the agents reporting or expecting an increase.

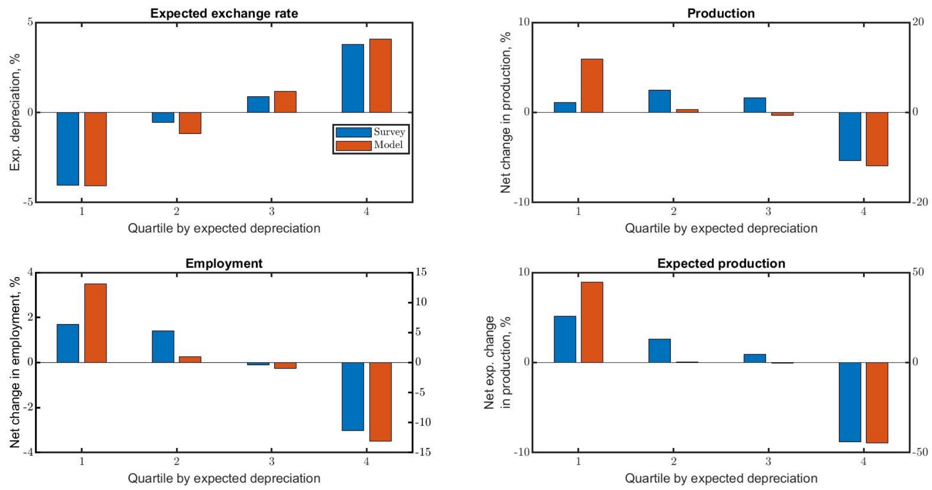

Figure 27: Expected and Recent Actions by Expected Depreciation: Varying $\hat{\rho}^i_\psi$

*Notes:*The graph compares the recent and expected 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 empirical estimates are described in the previous section. The expected depreciation estimates refer to the expected percent change in the variable, while the rest of the survey responses show the net share of the agents reporting or expecting an increase.

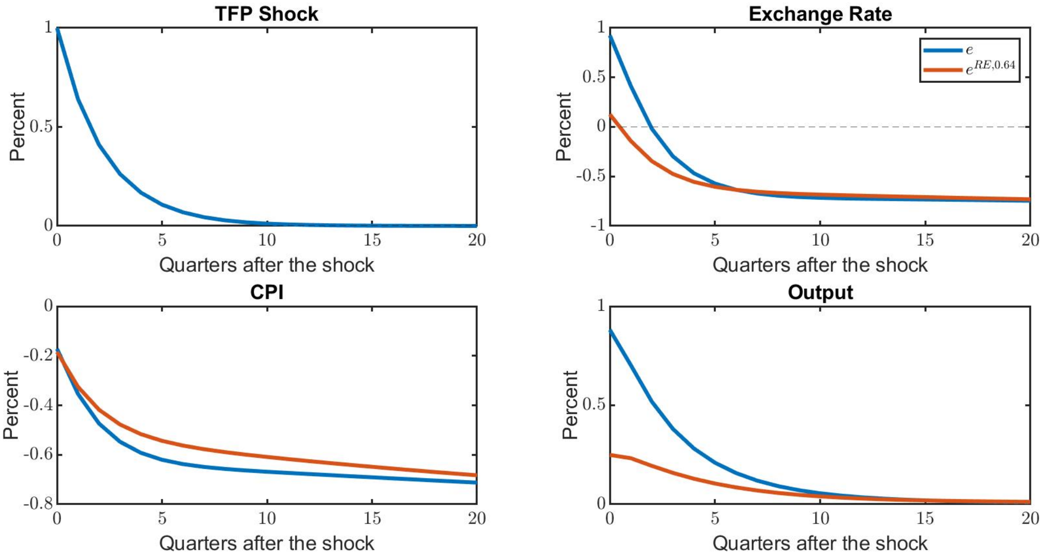

Figure 28: Aggregate Response to a TFP Shock

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.

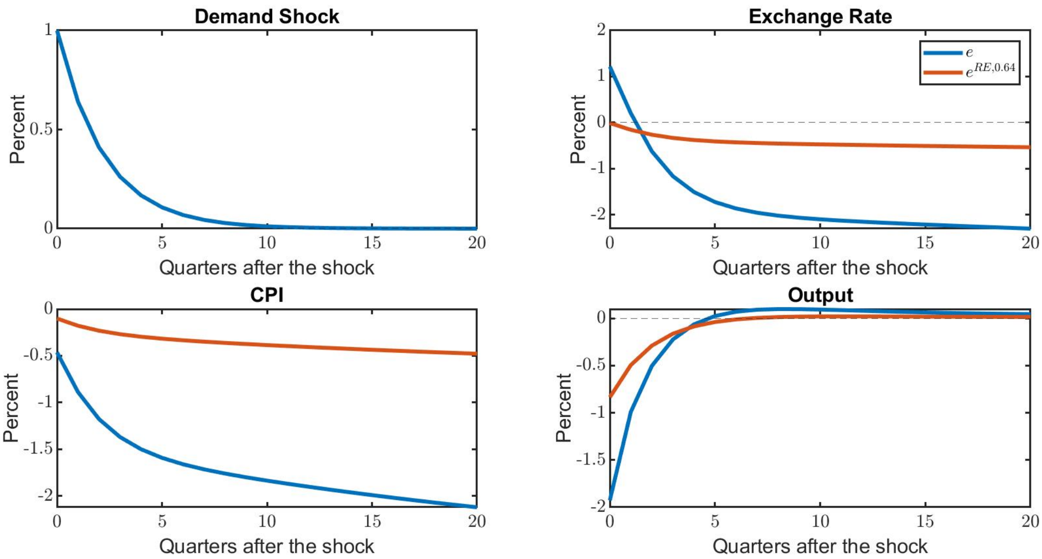

Figure 29: Aggregate Response to a Demand Shock

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.

C.8 Appendix C8: The Role of Price Stickiness

In this appendix, I discuss the role of price stickiness by comparing the baseline model with $\theta = 0.75$, where only a quarter of firms can reoptimize their prices in a specific quarter, with flexible price model, approximated by setting $\theta = 0.05$, where 95% of firms can adjust prices

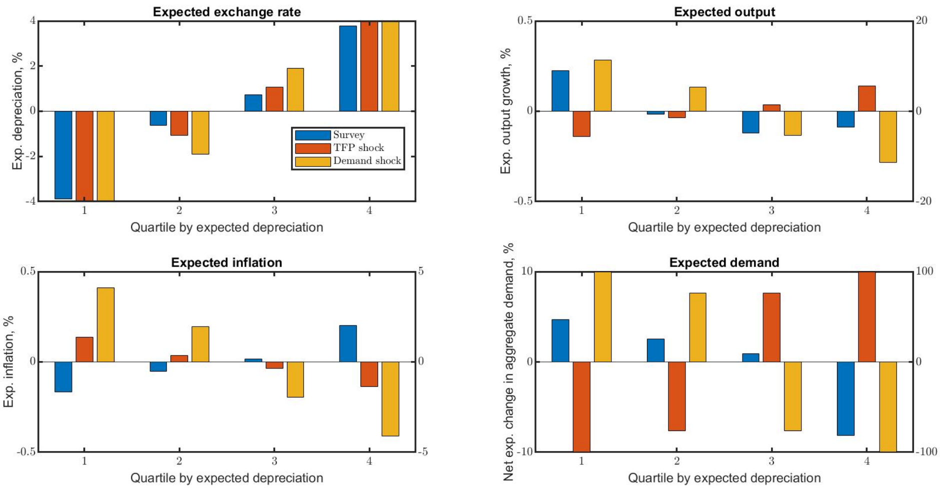

Figure 30: Beliefs on Aggregate Economy by Expected Depreciation: TFP and Demand Shock

Notes: The graph compares the beliefs on the evolution of the aggregate macroeconomic variables by expected depreciation quartiles in the data and in the model. The model estimates refer to the beliefs of a measure-0 firms receiving news on 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 type of Survey questions. The empirical estimates are described in the previous section. The expectations on exchange rate, output and inflation are quantitative, while the expected demand refers to the percent point difference between firms expecting an expansion and contraction.

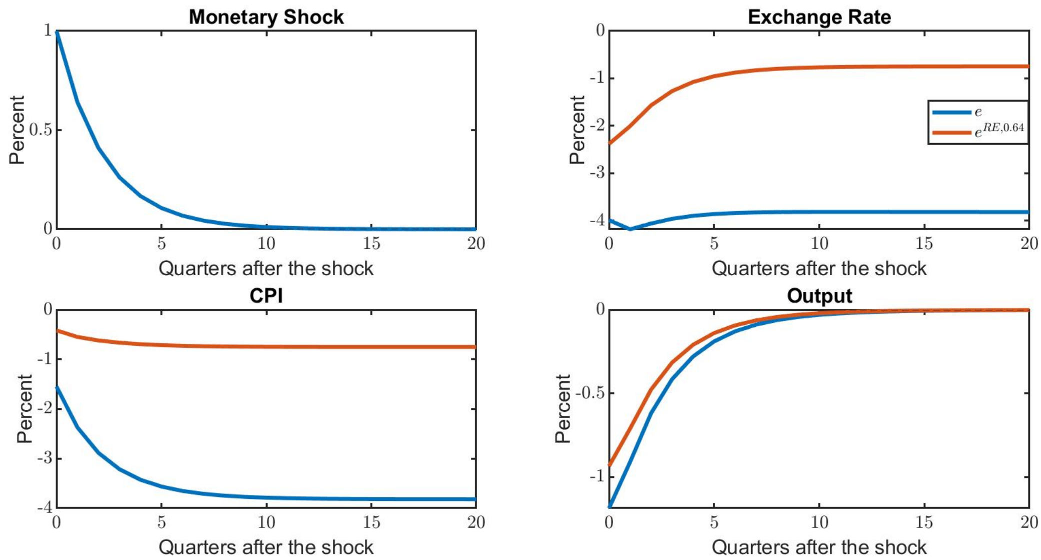

Figure 31: Aggregate Response to a Monetary Shock

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.

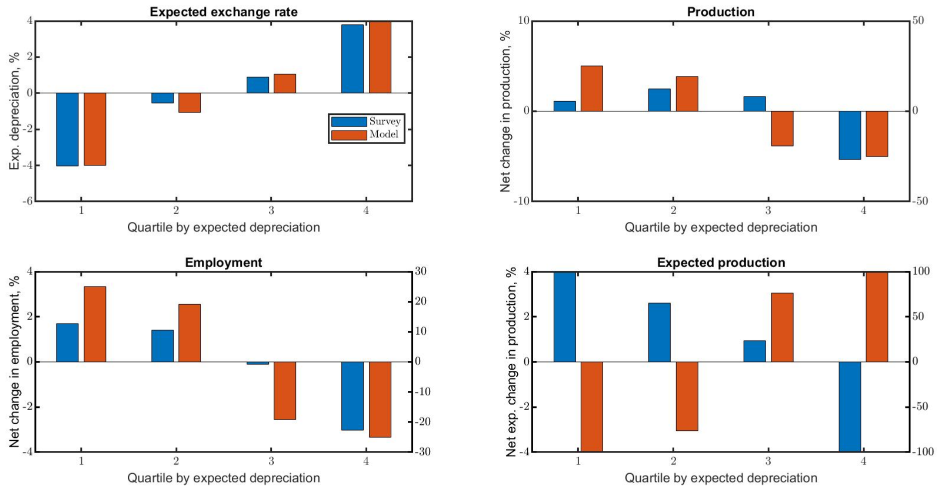

Figure 32: Expected and Recent Actions by Expected Depreciation: Monetary Shock

*Notes:*The graph compares the recent and expected 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 the news about monetary 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 empirical estimates are described in the previous section. The exchange rate estimates refer to the expected percent change in the variable, while the rest of the survey responses show the net share of the agents reporting or expecting an increase.

in a given period. The flexible price models differs from the qualitative model qualitatively since the problem of firms is now static, and, therefore, behavioral expectations of firm don't matter for their actions or for aggregate dynamics. The difference between behavioral and rational model is driven by households only.

First, I compare the response of the two models to financial shock under rational expectations. Figure 33 (yellow) the impulse response of exchange rate, output and consumption to a positive financial shock. Compared to the sticky price version, 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.

Figure 34 shows that even in the absence of nominal rigidities, prices of non-tradable increase. One reason is the increase in costs due to the price of imported inputs. Another is an increase in nominal wage: even as real wage falls, CPI price level increases due to the change in import prices. Moreover, if compared with the sticky price version as depicted in Figure 35 flexible price model generates a stronger response of inflation since all firms in the economy are able to reset their prices. Real interest rate, defined as $rr_t = r_t - \mathbb{E}_t^{hh}\pi_{t+1}$, is also higher for flexible price model. Both increase in prices and interest rates contribute to the fall in aggregate demand being strong enough to offset the expenditure-switching effect even in rational expectations model with $\rho = 0.64$.

When the nominal rigidities are absent, the price response is similar for behavioral (blue) and rational (yellow) model, resulting in the almost identical path of the realized interest rates. The marginal cost increases in nominal terms (higher import costs and CPI inflation, affecting nominal wage), but it is offset by a decrease in real terms (real wage, returns to scale). The static nature of firms' price-setting and quantitative similarity of their response, the contractionary channel of behavioral beliefs is absent in the flexible price model.

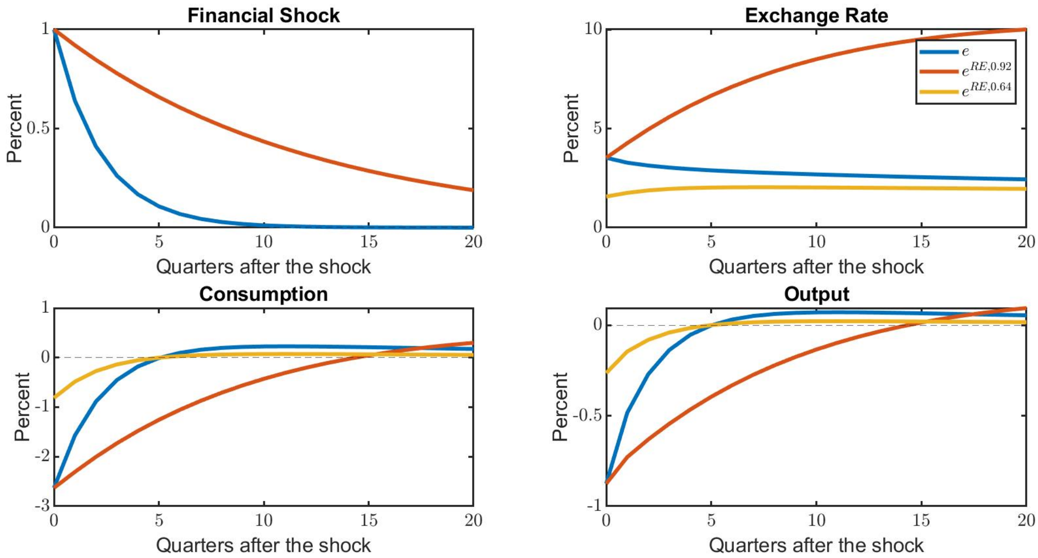

Figure 33: Aggregate Response to a Financial Shock: Flexible Prices

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 rational expectations economy with $\rho_\psi = 0.92$.

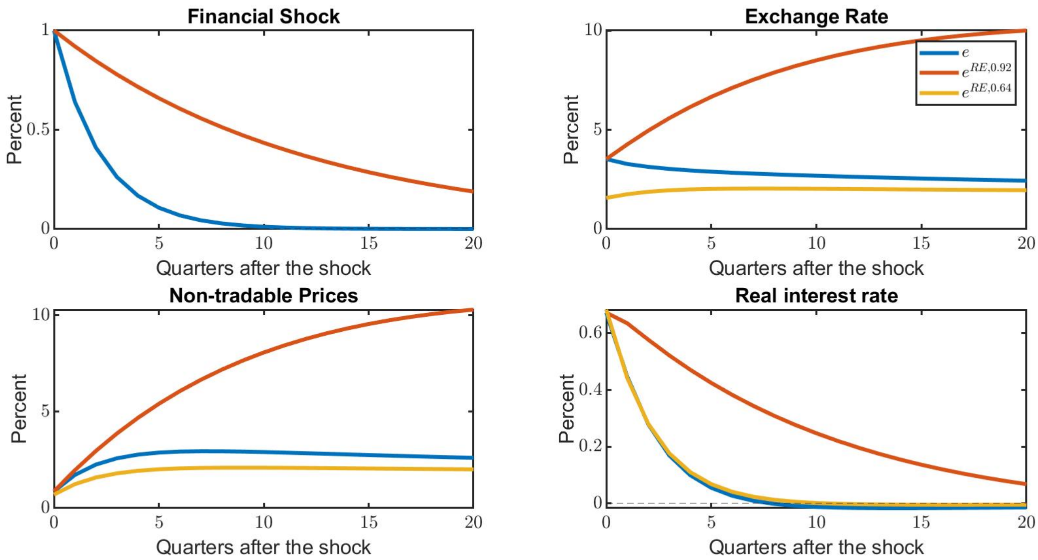

Figure 34: Prices and Real Interest Rate Response to a Financial Shock: Flexible Prices

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 rational expectations economy with $\rho_\psi = 0.92$.

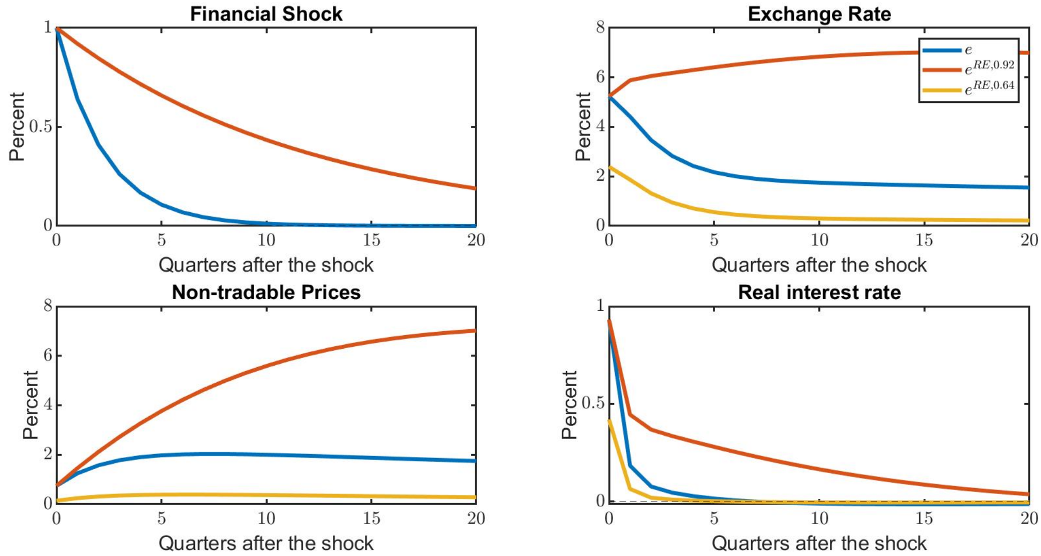

Figure 35: Prices and Real Interest Rate Response to a Financial Shock: Sticky Prices

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 rational expectations economy with $\rho_\psi = 0.92$.

However, the amplification impact of households' beliefs is present and results in both exchange rate volatility and real contraction being magnified. Despite similar response of prices, households expect the future path of real interest rates (red for the expectation at $t = 0$) to be much higher than under rational expectations due to the continuing depreciation of exchange rate.

To conclude, the presence of price stickiness matters for the relative importance of expenditure-switching and aggregate demand channel, dampening or preventing an output contraction. Nominal rigidities are necessary for firms' expectations to have contractionary impact under a depreciation generated by financial shock. However, the amplification of the shock by households' beliefs does not depend on the rigidities.

C.9 Appendix C9: Heterogeneous Firms

This section provides another approach to evaluating the consistency of the model with cross-sectional survey results. I assume that a fraction of the firms have rational expectations and compare their responses with behavioral firms. In contrast to the small price-taking firm in the previous section, the differing expectations can have an aggregate impact.

Both tradable and non-tradable sectors consist of a measure 1/2 of rational ($\hat{\rho}^{RE} = \rho = 0.64$) firms and a measure 1/2 of behavioral ($\hat{\rho}^{BE} = 0.92$, $\rho = 0.64$) 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. I outline the approach to solution in C.1.

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 36 shows one-quarter-ahead expectations of rational and behavioral firms compared

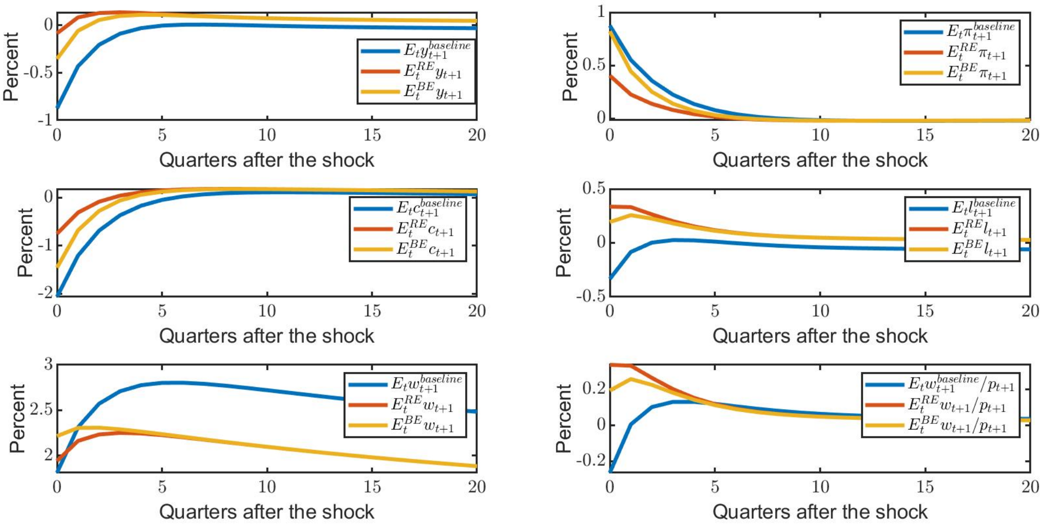

Figure 36: Macroeconomic Response to a Financial Shock: The Beliefs of Rational and Behavioral Firms

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the baseline model where all agents have overextrapolative expectations ($\hat{\rho} = 0.92$, $\rho = 0.64$). The red line refers to the rational firms in the two-type model ($\hat{\rho} = 0.92$, $\rho = 0.64$, measure 1/2), while the yellow line refers to the behavioral firms in the two-type model ($\hat{\rho} = 0.92$, $\rho = 0.64$, measure 1/2).

to the expectations in the baseline model. Behavioral firms expect higher inflation, deeper recession and a larger fall in demand. They expect labor demand and real wage to increase by less. Compared to the baseline model, the economy's response is less expansionary due to half of the firms having rational expectations.

The difference in the actions of two types of firms is also consistent with the data and stronger than for price-taking firms. Figure 37 compares the responses of behavioral and rational firms to a 1% positive financial shock. Behavioral firms (yellow) 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 more and intend to keep increasing them in the next period. Behavioral firms contract their output and demand for labor, while rational firms keep their output almost unchanged and even expand their employment: despite rational firms still facing the fall in domestic demand by behavioral households, their market share grows due to the differences in price-setting relative to behavioral firms.

In the next period, the rational firms expect to expand as the domestic demand starts to recover and the weak exchange rate encourages export. While behavioral firms also enter recovery the quarter after the shock, they erroneously expect further contraction due to shrinking market share and their belief that the financial wedge will stay high. The 2.1% difference in exchange rate forecast corresponds to 1.3% difference in current output of a firm and 1.0% difference in expected output growth. Die to price stickiness, the difference between the two types of firms is persistent and can potentially be a source of resource misallocation.

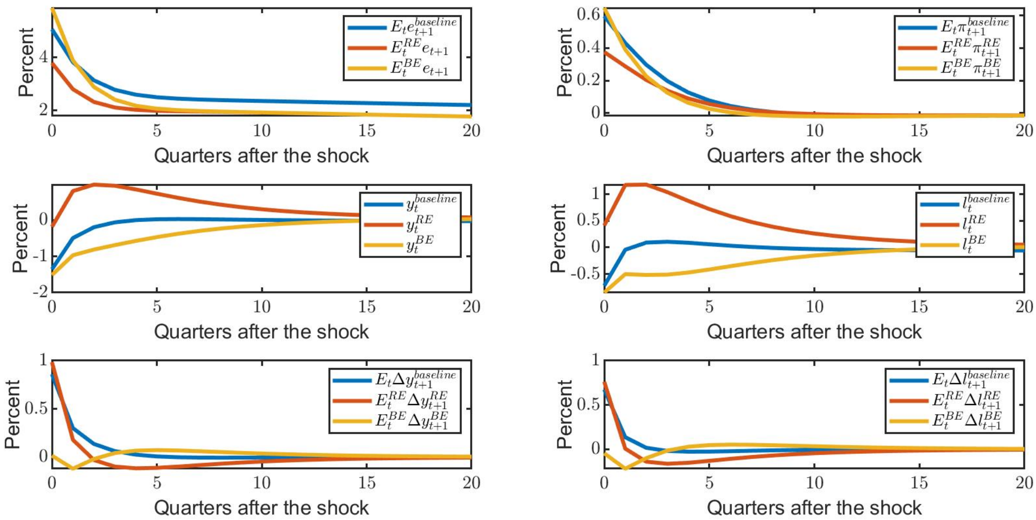

Figure 37: Macroeconomic Response to a Financial Shock: The Response of Rational and Behavioral Firms

Notes: The figure depicts theoretical impulse responses to a 1% financial shock. The blue line refers to the baseline model where all agents have overextrapolative expectations ($\hat{\rho} = 0.92$, $\rho = 0.64$). The red line refers to the rational firms in the two-type model ($\hat{\rho} = 0.92$, $\rho = 0.64$, measure 1/2), while the yellow line refers to the behavioral firms in the two-type model ($\hat{\rho} = 0.92$, $\rho = 0.64$, measure 1/2).