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Evidence from Iran Consumer Prices

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ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

Pricing Behavior and Exchange Rate: Evidence from Iran Consumer Prices*

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Abstract

This paper provides new evidence on the impact of exchange rate growth on pricing behavior. Using comprehensive micro data on consumer price quotes in Iran from 2006 to 2022, we examine how prices adjust in response to different macroeconomic conditions, ranging from low to high inflation and from stable exchange rate to sudden exchange rate jumps. While previous studies mostly focused on the impact of inflation on the pricing behavior, this research highlights the distinct role of exchange rate growth. Our key findings are: (1) In the short run, pricing behavior responds more strongly to inflation than to exchange rate growth, but in the long run, this difference disappears. (2) The impact of exchange rate growth is driven by both expected inflation and cost shocks, with cost shocks remaining significant even after controlling for expected inflation. (3) Expected inflation influences pricing behavior independently of actual inflation. (4) Expected exchange rate growth increases the absolute size of price changes but does not affect the frequency. (5) Provincial inflation has a distinct effect on pricing behavior compared to national inflation.

Keywords: inflation, exchange rate, pricing behavior, price rigidity, expected inflation, frequency of price changes
JEL Codes: E31, E32, L11

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1 Introduction

Pricing behavior, the manner in which outlets adjust their prices, provides valuable insights into the response of price adjustment to economic shocks. Understanding this behavior is essential for comprehending a range of macroeconomic phenomena, including the costs of inflation, the welfare implications of business cycles, and the design of optimal macroeconomic policies.

In the macroeconomic literature, pricing behavior is typically quantified by both the frequency of price changes and the absolute size of price changes The frequency of price changes measures price rigidity, and its inverse—implied duration—acts as an indicator of price rigidity (Nakamura and Steinsson (2013) and Klenow and Malin (2010)). On the other hand, the absolute size of price changes reflects price dispersion (Nakamura et al. (2018)). Together, these metrics are critical for understanding inflation decomposition (Klenow and Kryvtsov (2008) and Alvarez et al. (2019)).

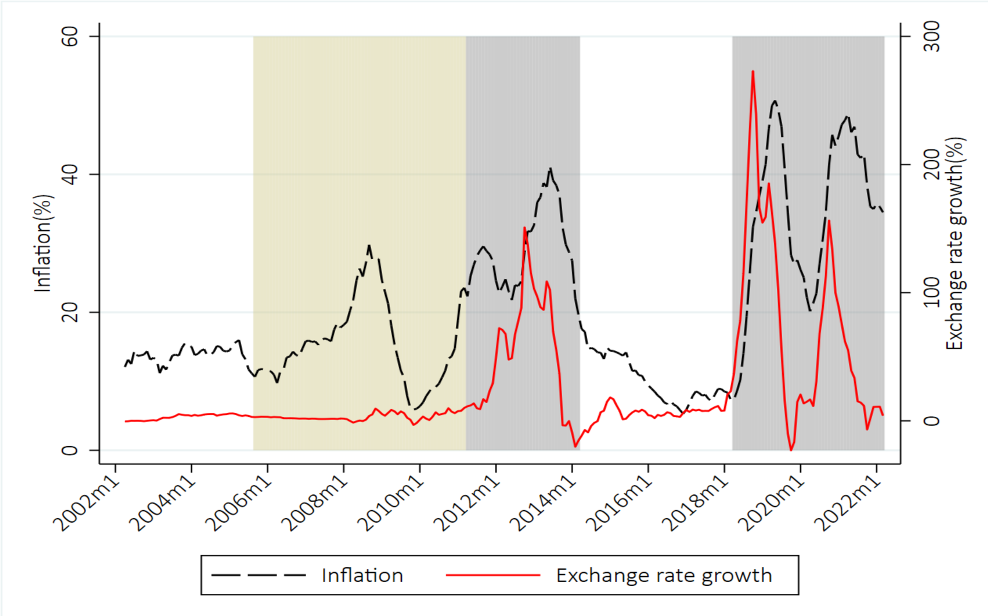
This paper investigates the impact of exchange rate (FX) fluctuations on pricing behavior, using a comprehensive dataset of Iran consumer prices spanning from 2006 to 2022. The study focuses on three distinct macroeconomic environments: inflationary periods characterized by sharp FX jumps, inflationary periods with stable FX, and periods of low inflation (see Figure 1). By examining these different conditions, this paper aims to provide novel insights into how FX fluctuations influence pricing behavior across varying levels of inflation.

Macroeconomic models generally classify pricing behavior into two categories: time-dependent and state-dependent. In time-dependent models, such as those introduced by Calvo (1983) and Taylor (1980), inflation is driven by increases in the absolute size of price changes, while the frequency of price changes remains fixed over time. As a result, price rigidity does not respond to macroeconomic variables. Conversely, in state-dependent models, such as the menu cost model, firms adjust frequency of price changes in response to macroeconomic conditions, resulting in variability in price rigidity. Both types of models provide predictions for the frequency and absolute size of price changes, and these real-world metrics help evaluate the accuracy of macroeconomic pricing models.

Menu cost models[1], as a typical example of state-dependent models, treat common shocks as one of the determinants of pricing behavior. It is evident that such shocks influence a nominal state of economy shared by all economic agents. In most of the literature, the price level (Consumer Price Index (CPI)) is regarded as the nominal state variable in-

[1]Initial menu cost models explain pricing decisions as a response to common shocks like inflation (Sheshinski and Weiss (1977)). Golosov and Lucas Jr (2007) extend this framework by incorporating both common and idiosyncratic shocks, providing a more comprehensive understanding of pricing behavior.

Figure 1: Inflation and FX growth



Notes: Inflation is calculated as the 12-month urban CPI (excluding housing rent) growth rate. FX growth shows the 12-month growth of the USD cash price in the unofficial (non-regulated) market. The khaki background shows inflationary periods without jumps in the FX (2006m4 – 2011m3) and the gray background shows inflationary periods with jumps in the FX(2011m4-2014m3 and 2018m4-2022m3).

fluenced by common shocks (Nakamura and Steinsson (2008) and Alvarez et al. (2019)). However, some studies use alternative indices as the nominal state variable. For example, Golosov and Lucas Jr (2007) use the nominal wage, and Alvarez and Neumeyer (2020) use aggregate input price as the nominal state variable[1]. But which index should be considered the nominal state variable? Under steady state conditions, this question becomes less crucial, making any of them a suitable representation of the nominal state of the economy. In such cases, using CPI, PPI, FX and expected CPI as the nominal state variable does not significantly alter the predictions of economic models.

However, following aggregate shocks, the steady state assumption may no longer hold, and the information content of the nominal state variable may vary across different macroeconomic indicators. In such situations, the information about the nominal state of the economy is distributed among multiple variables. Therefore, price setters need to consider more than one macroeconomic variable when making pricing decisions, because different variables may provide complementary insights into pricing behavior. Pricing

[1] Golosov and Lucas Jr (2007) consider the nominal wage as the nominal state variable in relation to the Phillips curve, while Alvarez and Neumeyer (2020) focus on aggregate input price to address cost shocks. In both models, the growth rates of nominal wage and aggregate input price are equivalent to inflation in the long run.

models often overlook aggregate shocks and just rely on CPI inflation as a nominal state variable, analyzing varying inflation levels through comparative statics. For instance, Alvarez et al. (2019) explore a menu cost model across a spectrum of inflation rates, ranging from near-zero inflation to hyperinflation.

In an economy characterized by aggregate shocks, price setters may consider additional macroeconomic variables beyond CPI inflation. This paper specifically investigates the impact of FX fluctuations on pricing behavior due to several reasons. Firstly, FX pass-through influences inflation (Devereux and Yetman (2010)). Secondly, fluctuations in FX can act as cost shocks and impact pricing behavior (Alvarez and Neumeyer (2020)). Thirdly, FX can be nominal anchor and influence expected inflation, particularly in economies with weakly anchored expectations that are more susceptible to aggregate shocks (Mishkin (1999)). By simultaneously playing the role of a nominal anchor and a source of cost shocks, FX growth influences pricing behavior through two main channels: by raising expected inflation and by increasing cost pressures. By controlling for both expected inflation and expected FX growth, this study aims to provide evidence for how these two channels impact pricing behavior.

To address the question of how FX growth affects pricing behavior, we focus on Iran economy from April 2006 to March 2022[1], using 34,312,302 urban price quotes collected by Statistical Center of Iran (SCI) to calculate the CPI. The Iran economy experienced three distinct macroeconomic phases during these years. Before 2011, inflation was high and volatile, but the FX remained stable, with no significant growth. From 2011 to 2014, high inflation occurred alongside rapid FX growth. During 2014-2018, macroeconomic stability returned, with inflation reaching single digits[2], and the FX remained stable. However, after 2018, both inflation and FX growth became volatile again. Appendix A. provides a detailed discussion of the macroeconomic environment of the Iran economy during these periods.

This research can be situated within two interrelated bodies of literature: empirical pricing behavior and FX pass-through. The first, empirical pricing behavior, is relatively new in macroeconomics and started to receive more attention after 2000 due to increased access to micro level data. In the 1990s, the prevailing belief, based on industry-specific data, was that prices changed roughly once a year (Taylor (1999)), a view shaped by the low inflation environment of the time. However, as researchers began using micro data more extensively, new insights emerged. For instance, Bils and Klenow (2004) analyzed

[1]We matched the Iranian calendar to the Georgian calendar.

[2]Since 1971, Iran has experienced two-digit inflation, with the first, second, and third quartiles of 12-month inflation being 12.1%, 16.9%, and 26.2%, respectively. Thus, single-digit inflation indicates stability.

US price quotes and found that more than 20% of consumer prices are changed monthly, with a median price duration of just 4.3 months. When they incorporated this shorter duration into a model based on Calvo (1983) pricing framework, they found that time-dependent models failed to explain for both the low persistence and the high volatility of inflation. This realization sparked a deeper investigation into the role of pricing behavior in shaping macroeconomic dynamics.

Following Bils and Klenow (2004), numerous studies have explored pricing behavior using micro data, comparing empirical observations with theoretical models. Key contributions include those by Nakamura and Steinsson (2008), Klenow and Kryvtsov (2008), Gagnon (2009), Wulfsberg (2016), and Alvarez et al. (2019), which provide novel evidence on various aspects of pricing behavior. These studies examine the role of temporary price changes in price rigidity, the measurement of the absolute size of price changes, and the decomposition of inflation into its intensive and extensive margins, as well as into price increases and decreases. Among these contributions, the most notable finding is the examination of the relationship between inflation and pricing behavior. Understanding this relationship is essential for insights into money neutrality and the shape of the Phillips curve[1].

The second literature, FX pass-through estimation, initially focused on the effect of FX on price levels across countries (see Devereux and Yetman (2010), Campa and Goldberg (2005) and Choudhri and Hakura (2006)). These studies found low pass-through from FX to domestic price levels. As access to micro level data expanded, research in FX pass-through began using price quotes to refine their analyses. For instance, Gopinath and Itskhoki (2010), using US import prices, show that goods with a higher frequency of price changes exhibit higher long-run pass-through than that of low frequency. Additionally, Cavallo et al. (2024), by using data from The Billion Prices Project (Cavallo and Rigobon (2016)), found that large shocks increase the frequency of price changes, leading to higher rates of cost pass-through and faster propagation of shocks. In another study using US import prices, Gopinath et al. (2010) document a large difference in FX pass-through between goods priced in domestic currency (dollar) and foreign currency

[1]Although pricing behavior influences money neutrality and the shape of the Phillips curve, the literature lacks consensus on the degree of money neutrality. For example, Golosov and Lucas Jr (2007) show that under a menu cost model, money is nearly neutral. However, Midrigan (2011), by extending the menu cost model, demonstrate that the real effects of monetary policy shocks are much larger than those found in Golosov and Lucas Jr (2007). Meanwhile, Karadi and Reiff (2019) argue that the model in Golosov and Lucas Jr (2007) better explains the pricing facts than Midrigan (2011). In contrast, Alvarez et al. (2016), using a random menu cost model, find that the degree of money neutrality is weaker than in Golosov and Lucas Jr (2007). Ultimately, the degree of money neutrality and its relationship with pricing behavior are still open questions.

(non dollar). They also found that goods priced in dollar have a lower frequency of price changes, but the absolute size of price changes is similar across both groups. Auer et al. (2021), using Swiss import prices and retail prices, examined the impact of a sudden FX appreciation in January 2015, showing that retail import prices in categories invoiced in foreign currency fell more sharply than that of invoiced in domestic currency during the first two quarters following the appreciation.

The primary contribution of this paper is its evidence on the effect of FX shocks on pricing behavior, offering valuable insights for extending menu cost models to account for unstable environments where information about the nominal state is dispersed across multiple macroeconomic variables. Additionally, by controlling for expected inflation, the research provides novel insights into the dual role of FX growth as both a source of cost shocks and a driver of inflation expectations.

Another key contribution of this research is the evidence it provides on province-level inflation, enabling the distinction between the influence of provincial and country-level factors on pricing behavior[1]. Our dataset spans all 31 provinces, with the sampling process and weights specifically designed to measure inflation at the province-level. Unlike many studies that focus on specific geographic areas[2], our observations extend beyond major cities. By including 231 cities, we can analyze pricing behavior across various provinces with differing inflation rates.

Our results show that inflation increases both the frequency and absolute size of price changes, confirming the findings of Nakamura and Steinsson (2008), Gagnon (2009), Wulfsberg (2016), and Alvarez et al. (2019). However, the key finding of this paper is that FX growth increases both the frequency and absolute size of price changes, consistent with the results of Auer et al. (2021). Notably, the magnitude of this positive effect is smaller than that of inflation in the short run; however, in the long run, the impact of FX growth on pricing behavior can offset the effect of inflation. Additionally, FX growth amplifies the effect of inflation on the frequency of price changes, but not on their absolute size. This suggests that the impact of inflation on the frequency of price changes becomes more pronounced during periods of higher FX growth.

Our findings show that the effect of FX growth remains significant even when controlling for expected inflation. This suggests that FX growth influences pricing behavior not

[1] Iran is the 18th largest country by area and the 17th largest by population in 2024. The country is divided into 31 provinces, each of which can experience different inflation rates.

[2] For example, studies using US price quotes, such as Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008), and Nakamura et al. (2018), are limited to the metropolitan areas of Los Angeles, New York, and Chicago. Meanwhile, Alvarez et al. (2019) focuses on the Buenos Aires metropolitan area, and Alvarez and Neumeyer (2020) uses data from Buenos Aires city, both in Argentina.

only through expected inflation but also through cost shocks, highlighting the dual role FX growth plays in shaping pricing behavior.

The province-level analysis indicates that both provincial and national inflation influence the frequency of price changes. However, only provincial inflation impacts the absolute size of price changes, while national inflation lacks significant explanatory power in this regard. This suggests that when price setters decide whether to adjust prices, they consider both national and provincial inflation rates. However, when determining the size of price change, they rely solely on provincial inflation.

The remainder of the paper proceeds as follows: Section 2 describes the institutional context and the Iran economy from 2006 to 2022. Section 3 introduces the data and indices used in the study. Section 4 details the empirical strategy. Section 5 discusses the results. Section 6 provides additional evidence on pricing behavior, including the effects of aggregate demand, lags in inflation and FX growth, and long-term inflation and FX growth. Finally, Section 7 offers concluding remarks.

2 Institutional context

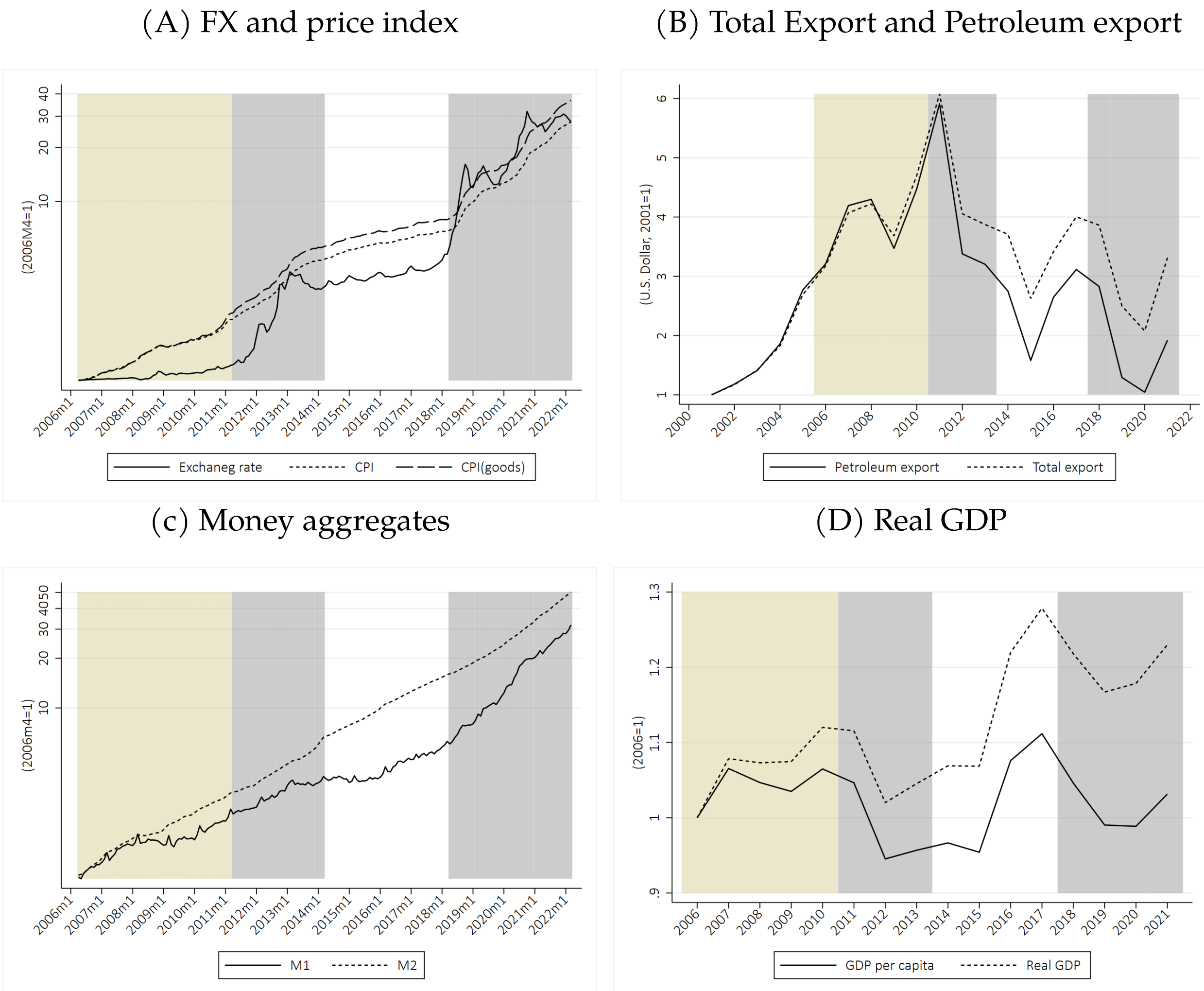
Iran economy experienced different macroeconomic conditions between 2006 and 2022, providing a valuable laboratory for investigating the role of inflation and FX in shaping pricing behavior (Figure 2). From 2006 to 2010, Iran faced high inflation alongside a stable FX. During this period, M1 and M2 growth were high, but the FX remained stable due to foreign currency income from petroleum export. Due to sanctions, exports declined in 2011, leading to high inflation together with FX growth between 2011 and 2013.

In 2014, following a change in government, expectations of sanction relief increased, and with forecasts of improved export conditions, expected FX stabilized and expected inflation declined. Consequently, between 2014 and 2017, the economy entered a stable phase marked by single-digit inflation and a stable FX. However, this stability was short-lived. After 2018, with the imposition of new sanctions, macroeconomic variables became unstable once again[1]. During these periods, the country faced various conditions, ranging from stable FX to sharp FX jumps, and inflation fluctuations between 5% and 60%. These diverse conditions offer a useful environment to analyze the effects of inflation, expected inflation, and FX growth on pricing behavior.

Iran economy is a valuable case study for examining the effects of aggregate shocks on pricing behavior. Golosov and Lucas Jr (2007) introduce idiosyncratic shocks into the

[1]The political background and policies shaping these macroeconomic environments are discussed in Appendix A.

Figure 2: Iran economy in 2006-2022

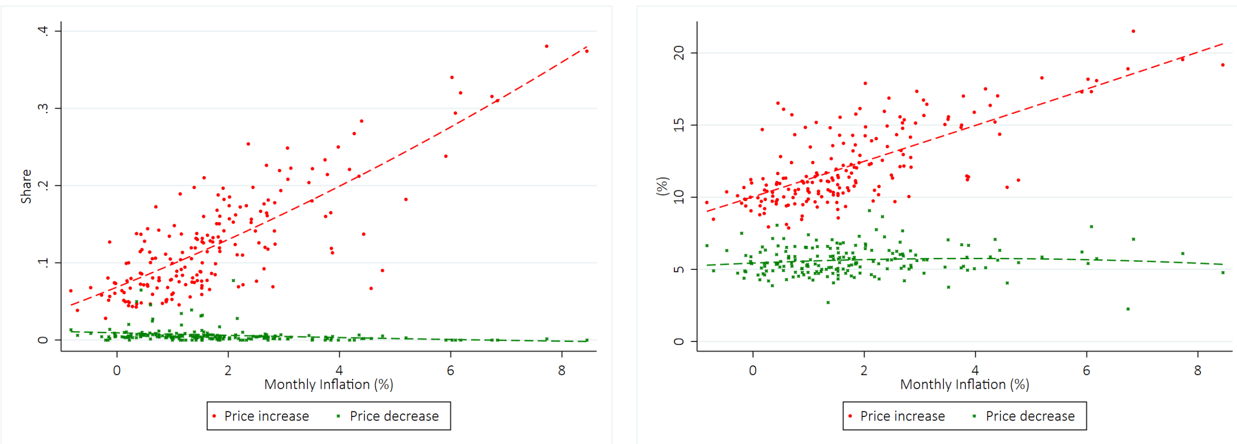


Notes: In Panel A, the FX shows the USD cash price in the unofficial (non-regulated) market, and CPI does not include housing rent. In Panel B, petroleum export is reported by Central Bank of Iran and it is defined as "the value of crude oil, oil products, natural gas, and natural gas condensate and liquids (Tariff Codes: 2709, 2710 and 2711) exported by National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Iranian Oil Refining and Distribution Company (NIORDC), petrochemical companies, and other companies (customs and non-customs)". In Panel D, real GDP is reported by SCI based on the base year 2011. Real GDP per capita is calculated using real GDP and the yearly population. The khaki background shows inflationary periods without jumps in the FX (2006m4 – 2011m3) and the gray background shows inflationary periods with jumps in the FX(2011m4-2014m3 and 2018m4-2022m3). All variables are normalized to their values at the first observation.

standard menu cost model, improving its ability to explain key facts, such as the substantial share of price decreases among total price changes. Expanding on Golosov and Lucas's model, Alvarez et al. (2019) analyze how the influence of idiosyncratic shocks on pricing decisions changes with the scale of common shocks. They found that during hyperinflationary periods, the impact of idiosyncratic shocks diminishes, leading to a smaller share of price decreases in the total frequency of price changes. Under these conditions, the menu cost model proposed by Golosov and Lucas Jr (2007) aligns more closely with the earlier model of Sheshinski and Weiss (1977).

Figure 3: Frequency and absolute size of price changes vs monthly inflation

Frequency of price changes | Absolute size of price changes



Notes: Frequency and absolute size of price changes are calculated as the weighed median over the products. Inflation is calculated as the monthly urban CPI (excluding housing rent) growth rate. Fitted lines are allowed to be quadratic.

Figure 3 shows the frequency and absolute size of price increases and decreases[1]. This figure indicates that the price decreases constitute a small share of total price changes, and their frequency and absolute size respond minimally to rising inflation. Conversely, price increases are very sensitive to inflation, with both the frequency and absolute size of price increases showing a linear relationship with inflation. Considering the findings of Alvarez et al. (2019), Figure 3 suggests that inflation as a common shock plays a dominant role in pricing decisions in Iran. Thus, the Iran economy provides a suitable environment for studying the impact of aggregate shocks on pricing behavior.

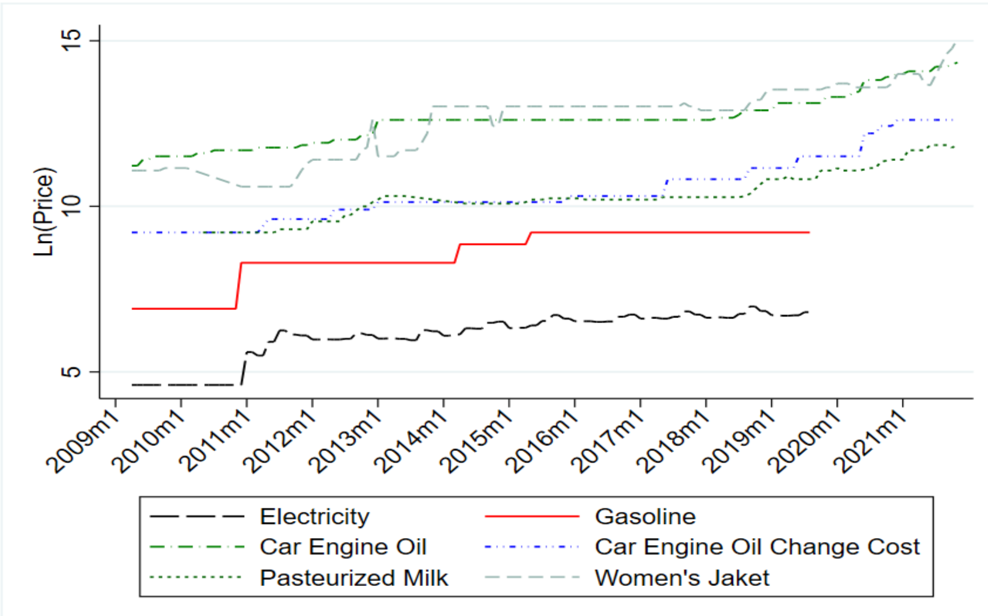
Research on pricing behavior in Iran faces the challenge of price controls. In response to an unstable macroeconomic environment, policymakers implement price controls on specific products, influencing both regulated and unregulated markets.

In certain cases, the government fully controls prices and meets demand as a monopolist, such as with utilities, bread, and internet, resulting is no unofficial market for these goods. Hence, SCI reports regulated prices in these markets, which change less frequently due to the government absorbing shocks, as these prices do not reflect typical market dy-

[1]The method of calculating the frequency and absolute size of price increases and decreases follows the approach used by Nakamura and Steinsson (2008) and Alvarez et al. (2019), as detailed in section 3.

namics. However, when government resources can't meet demand at regulated prices, unregulated markets coexist, as seen with products like meat, fruits, and vegetables. While SCI claims its price quotes cover both regulated and unregulated markets, the observed prices supports this claim, showing more frequent changes in markets the government cannot fully control compared to fully regulated markets[1].

Figure 4: The price trajectory of six different price-outlets



Notes: This graph shows the price trajectory of six different product-outlets. To investigate the long-run behavior of pricing, we choose lengthy trajectories.

Figure 4 shows price trends for six products across six outlets. Gasoline and electricity prices are fully regulated by the government, while pasteurized milk and car engine oil prices are influenced by the government but not fully controlled due to unmet market demand. In contrast, the prices of women's jackets and car engine oil change services are set entirely by private sellers without government regulation.

The price trajectories of car engine oil and pasteurized milk more closely resemble those in unregulated markets than regulated ones. In regulated markets, like gasoline and electricity, prices remain fixed during inflation periods (2006–2014 and 2018–2022)[2].

[1]For example, Cavallo (2013), using online prices across several Latin American countries (Brazil, Chile, Colombia, Venezuela, and Argentina), shows that in Argentina from 2007 to 2011, the CPI reported by the statistical institution was three times lower than the unbiased CPI, while in other countries the official CPI closely matched the online prices. This bias may be due to the price quotes collection being limited to controlled prices.

[2]Electricity prices in Iran exhibit seasonal fluctuations, leading to a non-flat trend, unlike gasoline prices.

In contrast, unregulated markets show gradual price increases during inflation. This evidence supports SCI's claim that their sample is not biased toward regulated prices.

3 Data and indices

The first subsection describes the dataset, consisting of price quotes from urban areas. The second subsection outlines the indices constructed from these data, while the third details the proxies used for expected inflation.

3.1 Price quotes

We use monthly Iran urban price quotes from April 2006 to March 2022. The SCI collects over 240,000 urban price quotes each month[1]. Each price quote reflects the consumer price of goods and services (hereinafter referred to as "products") on the shelf. SCI reports various types of CPI—urban, rural, provincial, and national—using specific price quotes and product weights[2]. According to the Household Income and Expenditure Survey (HIES) conducted in 2016, urban price quotes account for 66% of consumer expenditures, with the remaining portion attributed to housing rent (see Figure 5)

In our database, we have 37,937,720 price quotes, 306,519 outlets, and 1,312,214 product-outlets across all 31 provinces in Iran. Since 2016, this dataset covers 231 cities and over 240,000 monthly price quotes for over 53,000 outlets. Our dataset contains 453[3] products classified based on the COICOP[4] (1999) classification[5].

We exclude four types of observations: those deemed unreliable by SCI, those showing a price change of more than 900% or less than 90% from the previous month[6], and those with no weight. After data cleaning, our sample consists of 34,312,302 observations.

[1]This sample size applies to the period 2017-2022. For earlier years, the average monthly sample sizes were 150,000 between 2006-2010 and 180,000 between 2011-2016.

[2]Product weights are derived from the HIES to represent consumer baskets.

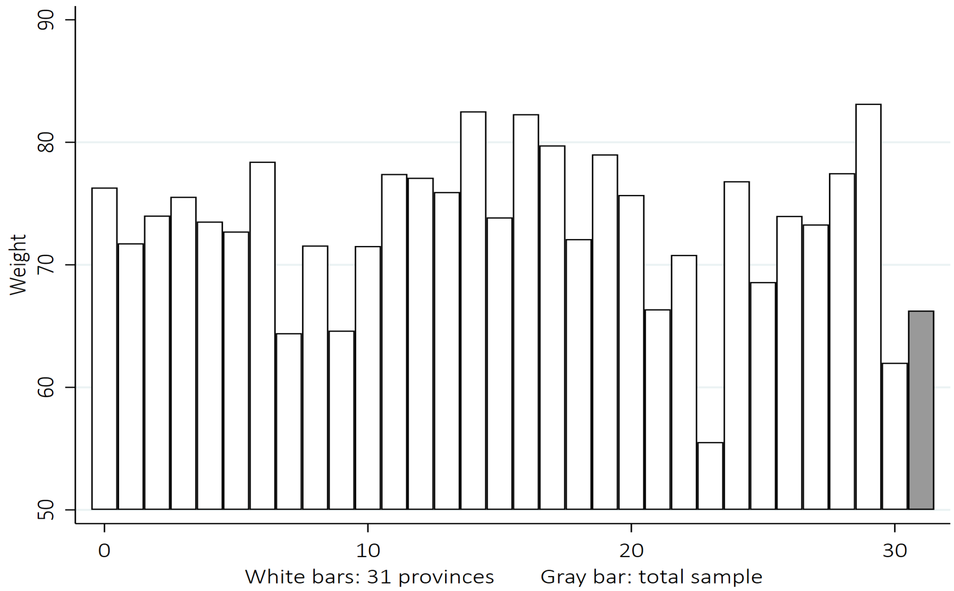
[3]The monthly CPI is derived from 455 products, including 2 related to housing rent.

[4]Classification of individual consumption by purpose.

[5]"Halwa Fish", "Pasteurized Milk", "Seedless Grapes", "Women's Jacket", "Construction Worker", "General practitioner's visit", "Car Engine Oil" and "Car Engine Oil Change Cost" are some examples of these products.

[6]This is likely due to recording errors, such as a product priced at 1,000 Iranian Rials changing to 100 or 10,000 Rials the next month.

Figure 5: Weights of consumer baskets



Notes: The weights of the consumer baskets excluding housing rent. Based on these weights, we can see how important our dataset is to consumer expenditures. White bars represent provincial weights and gray bar represents national weight. These weights are calculated from the HIES 2016 by SCI.

3.2 Frequency and absolute size of price changes

Following the literature, we focus on the frequency and absolute size of price changes to describe pricing behavior. These two indices are calculated at the store, product, and aggregate levels. Equation 1 shows the price change indicator for the outlet-product o, product i, and time t[1].

$$\begin{cases} I_{oit} = 1 & \text{if } p_{oit} \neq p_{oit-1} \\ I_{oit} = 0 & \text{if } p_{oit} = p_{oit-1} \end{cases} \tag{1}$$

Frequency of price changes at the product level (fr_{it} in equation 2) is defined as the proportion of prices that change for product i at time t.

$$fr_{it} = \frac{\sum_o I_{oit}}{\sum_o 1_{oit}} \tag{2}$$

At the outlet, product, and aggregate levels, the absolute size of price changes is constructed similarly to the method used for constructing the frequency of price changes. It should be noted that the product-level index is defined as the average absolute price

[1]Given that the dataset tracks price quotes monthly, we define the decision period as one month.

growth, conditional on a price change occurring (Δp_{it} in equation 4).

$$PriceChange_{oit} = 100 \times \left| \frac{p_{oit}}{p_{oit-1}} - 1 \right| \tag{3}$$

$$\Delta p_{it} = \frac{\sum_{I_{oit}=1} PriceChange_{oit}}{\sum_o I_{oit}} \tag{4}$$

At the aggregate level, the frequency and absolute size of price changes are calculated using either the weighted mean (Klenow and Kryvtsov (2008)) or the weighted median (Bils and Klenow (2004)) of product-level indices. These calculations are applied to both overall price changes as well as specific price increases and decreases, enabling an assessment of both the frequency and absolute size of price changes across different products.

Table 1: Frequency and absolute size of price changes during 2006-2022.

		Frequency	Size
Simple Price Changes	Mean	0.24	14.71
	Med	0.15	11.25
Without Sales and Subs. Price Changes	Mean	0.21	14.88
	Med	0.13	11.34
Simple Price Increase	Mean	0.18	15.31
	Med	0.12	11.53
Simple Price Decrease	Mean	0.06	7.29
	Med	0.00	5.34

Notes: All statistics are weighted. *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the statistics, respectively. *Simple Price Changes* displays the statistics without filters. *Without Sales and Subs. Price Changes* shows statistics that filter out any sales (V-shape price changes in the 1-month window) and any observation reported as substitution. *Simple Price Increases* and *Simple Price Decreases* provide statistics without any filtering out that focus on price increases and price decreases.

Table 1[1] indicates that the mean (median) frequency of price changes across products is 24% (15%). This is close to the findings of Nakamura and Steinsson (2008), who report a mean (median) frequency of 26.5% (19.4%) in the US from 1998 to 2005, and Wulfsberg (2016), who find a mean (median) frequency of 21.9% (14.3%) in Norway from 1975 to 2004.

The table also reveals that the mean (median) absolute size of price changes across products is 14.7% (11.2%). This aligns with previous studies: Nakamura and Steinsson (2008) report a median absolute size of 10.7% in the US during the same period, and Wulfsberg (2016) find that the mean (median) size of price changes in Norway is approx-

[1]Table 15 and Table 16 in Appendix C. display annual summary statistics.

imately 12% (9%)[1].

The effect of aggregate variables on sales is not the primary focus of our research. However, following Nakamura and Steinsson (2008), Klenow and Kryvtsov (2008), and Wulfsberg (2016), we report results for both the full sample and the sample excluding sales-related observations[2]. Later, we will show that our dataset contains few sales-related observations, which do not affect our main findings. Since our data does not explicitly flag sales price changes, we follow the method of Nakamura and Steinsson (2008), treating any V-shaped price change within a 1-month window as a sales proxy. Nakamura and Steinsson (2008) found that 4.1 percentage points (ppt) of the total frequency of price changes (19.4% in the US from 1998 to 2005) were due to V-shaped price changes within this window.

In Table 1, sales account for only 2 to 3 ppt of the total frequency of price changes, a small share likely due to persistent inflation in Iran. The state-dependent pricing model suggests that high inflation reduces the frequency of price decreases, which explains both the minor role of sales in the overall frequency and the small contribution of price decreases. Consequently, the negligible effect of sales on the absolute size of price changes—less than 1 ppt—is a natural result of their limited impact on frequency. As price increases dominate, the absolute size of price changes mainly reflects price increases, with price decreases playing a smaller role. Sales-related observations are a type of temporary price change that may affect our results. In Appendix D., temporary price changes are further discussed.

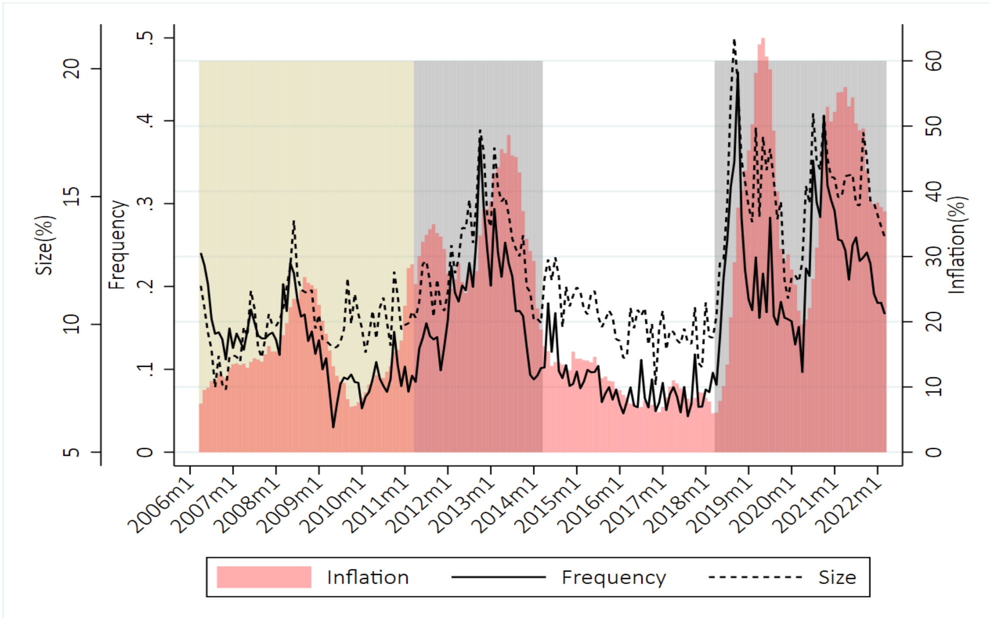
Table 1 presents simple summary statistics for the sample, while Figure 6 illustrates the relationship between pricing behavior and inflation over time. As inflation rises from 8% to 40%, the frequency of price changes fluctuates between 10% and 45%. Moreover, the absolute size of price changes increases from 10% to 20% in response to the inflation surge.[3]

[1]Wulfsberg (2016) does not directly report the absolute size of price changes but provides the size of price increases and decreases. The reported mean (median) size of price increases is 12.3% (9.3%), while the mean (median) size of price decreases is 10.5% (9.7%).

[2]There is no consensus about the effect of sales on the frequency of price changes. Wulfsberg (2016) found that sales in Norway from 1975 to 2004 had a minor impact on the total frequency of price changes. The full sample frequency was 14.3%, and excluding sales-related observations reduced it to 13%. In contrast, Nakamura and Steinsson (2008) showed that sales adjust a large portion of the frequency of price changes in the US from 1988 to 2005, where the full sample frequency was 19.4%, dropping to 10.9% when sales-related observations were excluded.

[3]The observed lag between pricing behavior and inflation results from using 12-month inflation calculations. This pattern disappears if inflation is calculated over shorter intervals, such as 3 months.

Figure 6: Inflation, frequency of price changes and size of price changes



Notes: Frequency and size of price changes are calculated as the weighed median over the products. Inflation is calculated as the 12-month urban CPI (excluding housing rent) growth rate. The gray background shows inflationary periods without jumps in the FX (2006m4 - 2011m3) and the khaki background shows inflationary periods with jumps in the FX(2011m4-2014m3 and 2018m4-2022m3).

3.3 Expected inflation

We use three proxies to measure expected inflation.

Alvarez et al. (2019) index: The first proxy is based on the method of Alvarez et al. (2019), where expected inflation is measured using realized inflation over an implied duration. This duration is calculated as the reciprocal of the monthly frequency of price changes[1] (see equation 5). For example, if the frequency of price changes is 0.25, the implied duration (k_t ins equation 5) is 4, and the monthly CPI growth rate over these four months is used as an indicator of monthy expected inflation.

$$\pi_t^e = \left(\frac{CPI_{t+k_t}}{CPI_t}\right)^{\frac{1}{k_t}}, \begin{cases} k_t = \frac{1}{fr_t}, \text{ if } \frac{1}{fr_t} \leq 12 \\ k_t = 1, \text{ if } \frac{1}{fr_t} > 12 \end{cases} \tag{5}$$

MBRI expected inflation: Since 2016, the Monetary and Banking Research Institute (MBRI), a research institute affiliated with the Central Bank of Iran (CBI), has conducted surveys among professionals to gather forecasts on key macroeconomic variables. These surveys include predictions for the end of the current year and the following year. Among

[1]The weighted median of frequency across products for each month.

the variables surveyed is annual inflation, which we use as a proxy for expected inflation. The survey data spans 18 periods and is a subset of the 191 periods available since 2016.

MBRI expected FX growth: The MBRI survey also includes professional forecasters' predictions for the unofficial market price of the US Dollar. Based on this data, we calculate expected FX growth, which we use as an additional proxy for expected inflation.

Details of the expected inflation indices and other macro variables used in this study are provided in Appendix B..

4 Empirical strategy

The goal of this research is to provide empirical evidence on the effect of FX growth on pricing behavior. This evidence can be compared with predictions from pricing models and could encourage theoretical studies to improve macroeconomic models.

In this regard, we follow Gagnon (2009) and Nakamura and Steinsson (2008), who use estimations to evaluate the impact of inflation on pricing behavior. Gagnon (2009) uses OLS regression at the country level, incorporating linear, quadratic, and cubic inflation terms, as well as year dummies, to analyze the relationship between inflation and pricing behavior. His findings show a positive correlation between inflation and both the frequency and the absolute size of price changes, with this relationship being stronger during periods of higher inflation.

Similarly, Nakamura and Steinsson (2008) use fixed-effect regressions at the product level to investigate the impact of inflation on pricing behavior. Their analysis reveals strong evidence of a positive correlation between inflation and the frequency of price increases. However, their findings regarding the frequency of price decreases and the absolute size of price changes (both increases and decreases) are mixed, with some coefficients being statistically significant and others not. Ultimately, Nakamura and Steinsson (2008) conclude that the positive correlation between inflation and the overall frequency of price changes is primarily driven by the frequency of price increases.

FX growth can inform the nominal state variable of the economy, and after aggregate shocks that push macro variables away from their steady state, FX can influence pricing behavior. FX growth affects pricing through two distinct mechanisms: first, FX can act as a nominal anchor, where FX growth raises expected inflation (Mishkin (1999)); second, FX influences the price of production inputs, making FX growth a source of cost shocks (Alvarez and Neumeyer (2020)). To distinguish between these mechanisms, we control for expected inflation; by doing so, the remaining effect attributed to FX growth is more likely to reflect cost shocks.

To assess the impact of FX growth on pricing behavior, we use OLS regression, following the methodologies of Nakamura and Steinsson (2008) and Gagnon (2009). This approach allows us to control for other variables that may correlate with FX growth and influence pricing behavior. Our regression models measure the effect of FX growth on pricing while controlling for CPI inflation and expected inflation[1].

To address our research question, our dataset enables us to conduct fixed-effect regressions at various levels, including product, province-product, and outlet-product levels. Our findings provide new insights into how the information contained in the nominal state variable impacts pricing behavior, offering guidance for improving menu cost models that account for the effects of common shocks on pricing.

We write product level regression as:

$$y_{it} = \beta_0 + \beta_1 \pi_t + \beta_2 X_t + \beta_3 (\pi_t * X_t) + \beta_4 \pi_t^e + FE_i + \epsilon_{it} \tag{6}$$

Where *i* denotes the product, and *t* denotes the time. The dependent variable y_{it} represents the pricing behavior index of interest, the frequency or absolute size of price changes at the product level (see equations 2 and 4). π_t denotes monthly inflation, X_t represents monthly FX growth, and π_t^e denotes monthly expected inflation. FE_i captures product-level fixed effects.

For province-product level regressions, we specify the following:

$$y_{pit} = \beta_0 + \beta_1 \pi_t + \beta_2 X_t + \beta_3 (\pi_t * X_t) + \beta_4 \pi_t^e + FE_{pi} + \epsilon_{pit} \tag{7}$$

$$y_{pit} = \beta_0 + \beta_1 \pi_{pt} + \beta_2 X_t + \beta_3 (\pi_{pt} * X_t) + \beta_4 \pi_{pt}^e + FE_{pi} + \epsilon_{pit} \tag{8}$$

Where *p* denotes the province, π_{pt} and π_{pt}^e represent monthly inflation and expected inflation at the province level, respectively, and FE_{pi} refers to product-province fixed effects.

For outlet-product level regressions, we specify:

$$y_{oit} = \beta_0 + \beta_1 \pi_t + \beta_2 X_t + \beta_3 (\pi_t * X_t) + \beta_4 \pi_t^e + FE_{oi} + \epsilon_{oit} \tag{9}$$

Where *o* denotes the outlet, and FE_{oi} refers to outlet-product level fixed effects. In equation 9, when the frequency of price changes is the dependent variable, all observations are included, and the explained variable is a dummy variable, leading to the estimation of a linear probability model in practice. However, when the absolute size of price changes

[1] The objective of this study is not to establish causality, as other papers in this literature do not claim causal inference either. However, we aim to control for CPI inflation and expected inflation to reduce omitted variable bias.

is used as the dependent variable, observations without price changes are excluded from the regression.

All regressions account for product weights to reflect different shares of products in household expenditure, using the product weights reported by SCI based on the 2016 HIES, which are also used to calculate urban inflation. In equation 6, we apply product weights at the country level, whereas in equations 7, 8, and 9, we use product weights at the province level.

In equation 6, the estimated coefficients for inflation, FX growth, and expected inflation are identical to those from a regression at the country level when the explanatory variables are calculated as weighted means. In this case, the contribution of fixed effects estimation at the product level lies in the reduction of standard errors, resulting in a more efficient estimation. However, in equation 8, where inflation and expected inflation are measured at the province level, the contribution of the fixed effects regression goes beyond efficiency and estimated coefficients are more precise and closer to capturing causal relationships.

All regressions exclude time fixed effects (whether periods, months, or years). Since all independent variables, except product fixed effects, vary over time, adding time fixed effects could obscure the mechanisms we seek to observe in the macro variables[1].

5 Results

This section provides the estimated regression results on the frequency of price changes and the absolute size of price changes.

5.1 Product level fixed effects

Tables 2 and 3 present the product-level fixed effects estimations for the frequency and absolute size of price changes, respectively, based on equation 6.

5.1.1 Product level: frequency of price changes

Table 2, Panel A, Column 1 shows that a 1 ppt increase in monthly inflation raises the frequency of price changes by 3 ppt (β_1 in Equation 6). With an average frequency of price changes at 0.24 (Table 1), it means that a 1 ppt increase in monthly inflation results in a 12% rise in the average frequency of price changes.

[1]While period fixed effects are not feasible, adding year and/or month fixed effects would not change our main findings.

Table 2: Frequency of price changes in product level fixed effects estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: frequency of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)	0.03***		0.030***	0.027***	0.026***		0.027***	0.024***
	(0.0017)		(0.0018)	(0.0018)	(0.0012)		(0.0014)	(0.0013)
FX growth (fx.)		0.003***	-0.0001	-0.001***		0.001***	-0.0001***	-0.002***
		(0.0002)	(0.0001)	(0.0003)		(0.0001)	(0.0002)	(0.0004)
Inf.*fx.				0.0004***				0.0005***
				(0.0001)				(0.0001)
Exp.inf					0.009***	0.020***	0.010***	0.010***
					(0.0017)	(0.0023)	(0.00193)	(0.0019)
Constant	0.183***	0.229***	0.183***	0.187***	0.171***	0.192***	0.169***	0.173***
	(0.003)	(0.0004)	(0.0036)	(0.003)	(0.0051)	(0.0045)	(0.0055)	(0.0053)
Observations	77,944	77,944	77,944	77,944	77,944	77,944	77,944	77,944
R-squared	0.131	0.031	0.131	0.133	0.137	0.067	0.138	0.141
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf.)	0.037***		0.042***	0.044***	0.031***		0.031***	0.014***
	(0.0028)		(0.0031)	(0.0058)	(0.0025)		(0.0032)	(0.0046)
FX growth (fx.)		0.006***	-0.002***	-0.002		0.006***	0.0001	-0.002**
		(0.0007)	(0.0006)	(0.0012)		(0.0005)	(0.0006)	(0.0009)
Inf.*fx.				-0.000				0.001***
				(0.0004)				(0.0003)
Exp.inf	-0.002	-0.003	-0.002	-0.003	0.02***	0.060***	0.025***	0.037***
	(0.0026)	(0.0026)	(0.0026)	(0.0031)	(0.0065)	(0.0063)	(0.007)	(0.0069)
Constant	0.183***	0.237***	0.185***	0.183***	0.147***	0.125***	0.147***	0.151***
	(0.0074)	(0.0049)	(0.0074)	(0.0095)	(0.0118)	(0.0123)	(0.0122)	(0.0124)
Observations	6,546	6,546	6,546	6,546	7,797	7,797	7,797	7,797
R-squared	0.285	0.073	0.292	0.292	0.273	0.212	0.273	0.279
F test	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . Both *inflation* and *FX growth* are monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

In Panel A, Column 2, a 1 ppt increase in FX growth leads to a 0.36 ppt increase in the frequency of price changes (β_2 in Equation 6). However, in Column 3, the FX growth coefficient becomes insignificant when included alongside inflation (β_3 in Equation 6). In Column 4, the interaction term between FX and inflation is positively significant, suggesting that inflation's effect on the frequency of price changes is amplified under higher FX growth.

The remaining columns of Table 2 introduce expected inflation as a control. In Panel B, which uses expected inflation from Alvarez et al. (2019), the expected inflation coefficient

(β_4 in equation 6) is positive and significant, with a magnitude that, while smaller than the inflation coefficient, is still considerable in comparison. In column 6, the inclusion of expected inflation as a control notably reduces the magnitude of the FX coefficient (from 0.003 in column 2 to 0.001 in column 6), though it remains significant.

Panel C incorporates data from the MBRI survey, which reports professional forecasts for FX growth[1]. This survey is conducted quarterly and covers 18 out of 191 periods available in the dataset. While this is a smaller sample, it provides insights into the role of expectations. In this case, the FX growth coefficient is not significant, and the inflation and FX coefficients remain similar to the results when expected FX growth is excluded[2]. Despite the positive effect of FX growth on the frequency of price changes, expected FX growth does not show a similar pattern.

Panel D employs the MBRI survey's report on inflation forecasting as a proxy for expected inflation. The results in Panel D are similar to those in Panel B: expected inflation remains significantly positive. Importantly, expected inflation is not overshadowed by inflation, nor does it offset the effect of FX growth.

There is a need to be cautious about causal interpretation of Table 2, but its results provide new insights into the factors that influence price changes. Insights such as these can be articulated as follows:

1. The coefficient for inflation is positive and statistically significant, confirming previous findings by Nakamura and Steinsson (2008), Gagnon (2009), and Alvarez et al. (2019), which demonstrate that inflation increases the frequency of price changes. As shown in Figure 3, our results support Nakamura and Steinsson (2008)'s conclusion that the relationship between inflation and the frequency of price changes is primarily driven by price increases[3].

2. The FX growth coefficient is also significant and positive. However, its magnitude is 10 times smaller than that of the inflation coefficient and loses significance when inflation is included (Panel A, column 3). This evidence highlights the greater importance of CPI inflation in constructing nominal state variable compared to FX growth. However, it's critical to note that this finding does not diminish the significance of

[1]While using expected FX growth as a proxy for expected inflation is uncommon, this index can be useful in conjunction with FX growth control.

[2]Panel A, Column 1 is not directly comparable to Panel C, Column 1 due to differing samples. Running the regression from Panel A, Column 1 with the sample used in Panel C, Column 1 yields an inflation coefficient of 0.0378, which remains significant.

[3]Separate regressions for the frequency of price increases and decreases reveal that the inflation coefficient for price increases (0.034) is larger in magnitude than that for price decreases (-0.004), although both coefficients are statistically significant.

FX for pricing decisions. Following an aggregate shock, a substantial FX jump can occur, leading to more than a 10% growth in the FX. In such environments, a 10% growth in the FX can increase the frequency of price changes by 3 ppt.

3. The interaction term between inflation and FX growth (β_3 in equation 6) is positive and significant in Panel A. It provides evidence that FX growth amplifies the effect of inflation on the frequency of price changes, indicating that the relationship between inflation and price change frequency is stronger in periods of high FX growth than in periods of FX stability (Figure 1).

4. FX growth increases the frequency of price changes through two mechanisms: expected inflation and cost shocks. Although the FX coefficient is lower than those of expected inflation (column 6), it remains positive and significant. Expected inflation does not fully offset the effect of FX growth, suggesting that cost shocks contribute to the increased frequency of price changes in response to FX growth.

5. Our findings suggest that FX growth increases the frequency of price changes, while expected FX growth does not exhibit a similar effect. This novel evidence can be attributed to the short decision horizon for price adjustment, since firms anticipate making another adjustment soon, they may rely primarily on current FX growth, with little need to consider expected FX growth.

5.1.2 Product level: absolute size of price changes

Table 3 shows how inflation, FX growth and expected inflation affect the absolute size of price changes. Similar to Table 2, it estimates equation 6 using product-level fixed effects and expenditure weights.

Panel A, column 1, shows that a 1 ppt increase in inflation leads to a 1.18 ppt increase in the absolute size of price changes. In column 2, a 1 ppt rise in FX growth results in a 0.11 ppt increase in the absolute size of price changes, indicating that the effect of FX growth is smaller than that of inflation. In column 3, the FX growth coefficient is no longer positively significant, suggesting it cannot sustain its impact in competition with inflation.

Panel B, using the Alvarez et al. (2019) method for expected inflation, shows a similar pattern to Panel A, with significant coefficients for expected inflation. Although smaller in magnitude than inflation, expected inflation still has a notable effect. Panel C mirrors these results for expected FX growth, which is also significant, though its impact remains smaller than both inflation and expected inflation. Panel D, based on the MBRI survey of

Table 3: Absolute size of price changes in product level fixed effects estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: absolute size of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)	1.18***		1.28***	1.25***	1.05***		1.15***	1.10***
	(0.071)		(0.082)	(0.103)	(0.072)		(0.082)	(0.103)
FX growth (fx.)		0.11***	-0.05***	-0.07**		0.04***	-0.07***	-0.10***
		(0.011)	(0.013)	(0.026)		(0.010)	(0.013)	(0.025)
Inf.*fx.				0.001				0.01
				(0.007)				(0.007)
Exp.inf					0.33***	0.87***	0.41***	0.42***
					(0.068)	(0.074)	(0.069)	(0.067)
Constant	12.67***	14.56***	12.59***	12.63***	12.25***	12.98***	12.04***	12.10***
	(0.128)	(0.022)	(0.136)	(0.168)	(0.166)	(0.144)	(0.179)	(0.202)
Observations	74,690	74,690	74,690	74,690	74,690	74,690	74,690	74,690
R-squared	0.037	0.006	0.038	0.038	0.039	0.017	0.040	0.041
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf.)	1.34***		1.55***	2.14***	1.00***		0.91***	1.17***
	(0.090)		(0.110)	(0.181)	(0.099)		(0.147)	(0.202)
FX growth (fx.)		0.23***	-0.12***	0.06		0.22***	0.04	0.07
		(0.029)	(0.033)	(0.059)		(0.025)	(0.038)	(0.052)
Inf.*fx.				-0.06***				-0.02
				(0.016)				(0.015)
Exp.inf	0.20**	0.14*	0.18**	-0.06	1.35***	2.48***	1.45***	1.25***
	(0.080)	(0.081)	(0.081)	(0.067)	(0.232)	(0.209)	(0.275)	(0.297)
Constant	12.50***	14.54***	12.59***	11.86***	10.82***	10.06***	10.70***	10.66***
	(0.200)	(0.158)	(0.202)	(0.312)	(0.394)	(0.415)	(0.433)	(0.432)
Observations	6,238	6,238	6,238	6,238	7,452	7,452	7,452	7,452
R-squared	0.131	0.029	0.136	0.143	0.135	0.117	0.135	0.135
F test	0	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . Both *inflation* and *FX growth* are monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

professional forecasters, presents results consistent with Panel B, with expected inflation showing significant effects, roughly ten times larger than the FX coefficients.

The findings in Table 3 provide valuable new insights and can be described in a manner similar to those in Table 2:

1. As in Table 2, the inflation coefficient in Table 3 is both positive and significant. This finding corroborates the results of Nakamura and Steinsson (2008) and Gagnon (2009), who demonstrate that inflation increases the absolute size of price changes[1].

[1] Nakamura and Steinsson (2008) found a positive correlation between inflation and the absolute size of

In our dataset, price decreases account for a small share of total price changes, suggesting that the main driver of the inflation effect on the absolute size of price changes is due to price increases (see Figure 3).

2. Similar to Table 2, the FX coefficient is positive and significant, though its magnitude is 10 times smaller than that of inflation (Table 3, Panel A, columns 1 and 2).

3. Unlike Table 2, the interaction term between inflation and FX is not significant in Table 3.

4. In Table 3, Panel C, columns 1-3, the coefficients for expected FX growth are positively significant. This suggests that expected FX growth increases the absolute size of price changes, unlike the frequency of price changes in Table 2.

5. According to these results, inflation and expected inflation affect the absolute size of price changes simultaneously, and these measures do not cancel one another out.

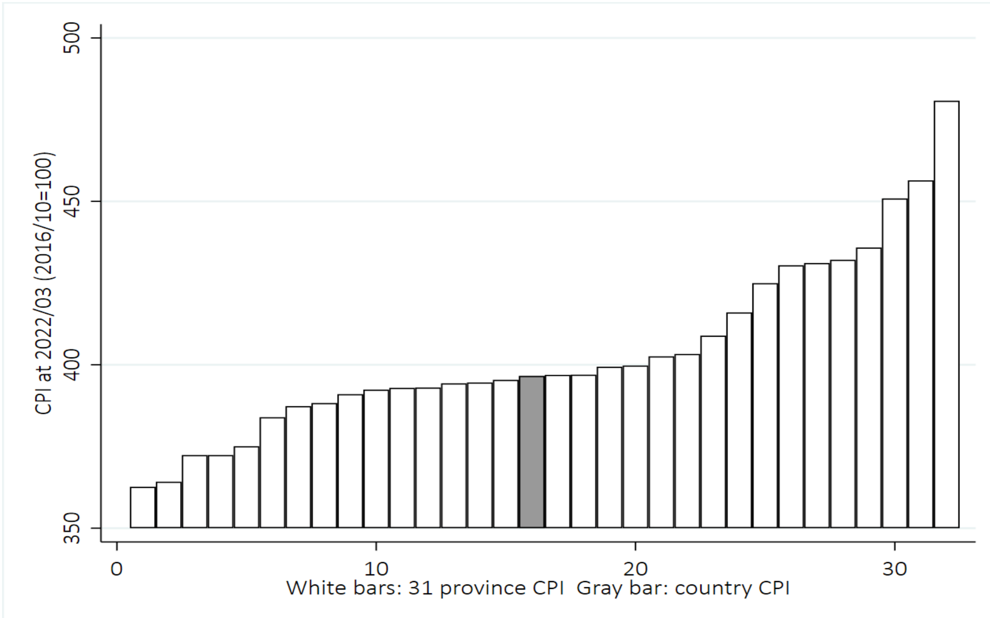
5.2 Province-product level fixed effects

Tables 4 and 5 present the province-product level fixed effects estimation for the frequency and absolute size of price changes, respectively, based on equations 7 and 8. These tables confirm the patterns observed in Tables 2 and 3, incorporating data from all 31 provinces and using provincial weights and inflation measures. While Tables 2 and 3 use 453 product fixed effects, Tables 4 and 5 employ 13,324 province-product fixed effects, offering a better regional detail and capturing heterogeneity across different provinces.

To the best of our knowledge, province-level inflation has not been explored in this literature. Most studies on the relationship between pricing behavior and inflation rely on country-level inflation data. When using country-level inflation (as shown in Equation 6 and in Tables 2 and 3), The variation in all explanatory variables—except for product fixed effects—occurs only over time, without accounting for differences at the sub-national level. Introducing province-level inflation introduces regional variation, enabling a more precise analysis of inflation's impact. This approach improves identification by capturing regional differences in inflation, providing a clearer picture of pricing behavior that is not possible when using only country-level data.

price changes in the US during 1988-1997, but did not observe this pattern during 1998-2005.

Figure 7: Provincial CPI



Notes: This table shows the provincial CPI (including housing rent) reported by SCI at 2022/03. CPI for each province was 100 in 2016/10.

5.2.1 Province-product level: frequency of price changes

In Table 4, we incorporate both province-level and country-level inflation. Province-level inflation reflects variations in how common shocks impact different provinces, offering a more comprehensive view of pricing behavior (Figure 7). Panel A, columns 1 and 2, show that a 1 ppt increase in country-level and provincial-level inflation raises the frequency of price changes by 3.2 and 2.5 ppt, respectively. The coefficient of 3.2 is consistent with Table 2, Panel A, column 1. In column 3, both country-level and province-level inflation are included, and their coefficients remain positive, significant, and substantial in magnitude. Although each store faces provincial inflation, the significant coefficient of country-level inflation suggests that outlet pricing decisions are not solely driven by local Information. Consequently, in columns 5 and 6, FX growth is not significant when compared to country-level inflation but becomes significant when compared to provincial inflation, as the country-level information from FX growth is not fully captured by province-level inflation. In Panel B, we control for expected inflation using the Alvarez et al. (2019) method, and the pattern observed in Panel A remains unchanged.

Table 4: Frequency of price changes in province-product level fixed effects estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: frequency of price changes								
Panel A								
Inflation (inf.)	0.032***		0.019***		0.031***		0.029***	
	(0.0020)		(0.0020)		(0.0021)		(0.0023)	
Prov. inf.		0.025***	0.014***			0.023***		0.020***
		(0.0014)	(0.0013)			(0.0013)		(0.0014)
FX growth (fx.)				0.004***	0.0003	0.001***	-0.001***	-0.001***
				(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)
Inf.*fx.							0.0004**	
							(0.0001)	
Prov.inf*fx.								0.001**
								(0.0001)
Constant	0.273***	0.280***	0.266***	0.324***	0.273***	0.280***	0.278***	0.285***
	(0.0036)	(0.0030)	(0.0038)	(0.0006)	(0.0037)	(0.0030)	(0.0040)	(0.0030)
Observations	1,583,232	1,583,232	1,583,232	1,583,232	1,583,232	1,583,232	1,583,232	1,583,232
R-squared	0.058	0.058	0.068	0.017	0.058	0.060	0.059	0.063
F test	0	0	0	0	0	0	0	0
Panel B: Exp.inf: Alvarez et al (2019)								
Inflation (inf.)	0.028***				0.029***		0.025***	
	(0.0015)				(0.0017)		(0.0019)	
Prov. inf.		0.022***				0.021***		0.018***
		(0.0012)				(0.0013)		(0.0013)
FX growth (fx.)			0.002***	0.002***	-0.0002	0.001***	-0.002***	-0.002***
			(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0004)	(0.0004)
Inf.*fx.							0.001**	
							(0.0001)	
Prov.inf*fx.								0.001**
								(0.0001)
Exp.inf	0.009***		0.022***		0.010***		0.011***	
	(0.0018)		(0.0024)		(0.0019)		(0.0019)	
Exp.Prov.inf		0.012***		0.018***		0.010***		0.011***
		(0.0016)		(0.0019)		(0.0017)		(0.0017)
Constant	0.261***	0.261***	0.285***	0.288***	0.260***	0.264***	0.264***	0.268***
	(0.0054)	(0.0049)	(0.0047)	(0.0040)	(0.0059)	(0.0049)	(0.0059)	(0.0049)
Observations	1,583,232	1,534,006	1,583,232	1,534,006	1,583,232	1,534,006	1,583,232	1,534,006
R-squared	0.061	0.062	0.030	0.029	0.061	0.063	0.062	0.065
F test	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices within each province (equation 7 and 8). All regressions include 13324 province-product fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *Prov. inf.* is the weighted average of product price growth within each province. *FX growth* shows the growth of the USD cash price at the unofficial market. *Exp.inf* and *Exp.Prov.inf* are expected inflation measures calculated according to Alvarez et al. (2019) method based on country-level and provincial-level inflation, respectively. *inflation*, *Prov. inf. FX growth* are monthly. *Exp.inf* and *Exp.Prov.inf* are monthly scale. Standard errors are reported in parentheses and adjusted for clusters at province-product level. Observations are weighted by the importance provincial weights. *, **and *** significant at 10, 5, and 1 percent levels.

5.2.2 Province-product level: absolute size of price changes

Similar to Table 4, Table 5 includes both province-level and country-level inflation. Panel A, columns 1 and 2, show that a 1 ppt increase in country-level and provincial-level inflation increases the absolute size of price changes by 1.13 and 1.21 ppt, respectively.

In column 3, when both country-level and province-level inflation are included simultaneously, the coefficient for country-level inflation becomes insignificant, unable to compete with provincial inflation. This contrasts with Table 4, where both country-level and province-level inflation are significant in column 3. The insignificance of country-level inflation suggests that price setters consider both national and local information when deciding whether to change prices. However, after deciding to change prices, they primarily rely on local information to determine the absolute size of price changes. Since FX growth, like country-level inflation, is a national variable, it too cannot compete with provincial inflation, as shown by the insignificant FX coefficient in column 6. This outcome differs from Table 4, Panel A, column 6, where the FX coefficient was positive and significant. In Panel B, we control for expected inflation using the Alvarez et al. (2019) method, and the observed pattern in Panel A remains unchanged.

5.3 Outlet-product level fixed effects

Table 6 presents the estimation results for outlet-level fixed effects using equation 9. These regressions control for over one million outlet-product fixed effects without aggregating micro data.

Columns 1-4 measure the effects of inflation and FX on the frequency of price changes. The dependent variable in these regressions is a dummy variable (equation 1), so we use a linear probability model. Each estimation includes over 34 million observations. The coefficients in columns 1-4 confirm the findings from Table 2, Panel A. These results indicate that inflation has a stronger impact on the frequency of price changes than FX, and when inflation is controlled for, the effect of FX is not significantly positive.

Columns 5-8 estimate the effects of inflation and FX on the absolute size of price changes. Because these regressions include only observations where prices have changed, the sample size is reduced to over 8 million observations per regression. As in columns 1-4, the coefficients in columns 5-8 confirm the results in Table 3, Panel A, columns 1-4.

Table 5: Absolute size of price changes in province-product level fixed effects estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: absolute size of price changes							
	Panel A							
Inflation (inf.)	1.13***		0.08		1.23***		1.21***	
	(0.075)		(0.355)		(0.092)		(0.116)	
Prov. inf.		1.21***	1.17***			1.24***		1.23***
		(0.214)	(0.404)			(0.244)		(0.279)
FX growth (fx.)				0.11***	-0.05***	-0.03	-0.06***	-0.03
				(0.010)	(0.014)	(0.029)	(0.020)	(0.018)
Inf.*fx.							0.003	
							(0.007)	
Prov.inf*fx.								0.000
								(0.010)
Constant	11.68***	11.20***	11.14***	13.63***	11.59***	11.19***	11.63***	11.20***
	(0.146)	(0.479)	(0.261)	(0.025)	(0.160)	(0.483)	(0.196)	(0.553)
Observations	1,279,221	1,279,221	1,279,221	1,279,221	1,279,221	1,279,221	1,279,221	1,279,221
R-squared	0.024	0.044	0.044	0.004	0.024	0.044	0.024	0.044
F test	0	0	0	0	0	0	0	0
	Panel B: Exp.inf: Alvarez et al (2019)							
Inflation (inf.)	1.06***				1.16***		1.12***	
	(0.086)				(0.099)		(0.129)	
Prov. inf.		1.19***				1.22***		1.21***
		(0.240)				(0.254)		(0.292)
FX growth (fx.)			0.04***	0.04***	-0.06***	-0.04**	-0.09***	-0.05*
			(0.009)	(0.009)	(0.012)	(0.022)	(0.023)	(0.027)
Inf.*fx.							0.01	
							(0.007)	
Prov.inf*fx.								0.001
								(0.011)
Exp.inf	0.18**		0.77***		0.27***		0.28***	
	(0.072)		(0.059)		(0.064)		(0.071)	
Exp.Prov.inf		0.14		0.67***		0.21**		0.21**
		(0.126)		(0.056)		(0.094)		(0.101)
Constant	11.46***	10.94***	12.22***	12.28***	11.22***	10.81***	11.27***	10.81***
	(0.154)	(0.305)	(0.124)	(0.125)	(0.166)	(0.360)	(0.181)	(0.414)
Observations	1,279,221	1,237,947	1,279,221	1,237,947	1,279,221	1,237,947	1,279,221	1,237,947
R-squared	0.024	0.045	0.009	0.009	0.025	0.046	0.025	0.046
F test	0	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred within each province (equation 7 and 8). All regressions include 13293 province-product fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *Prov. inf.* is the weighted average of product price growth within each province. *FX growth* shows the growth of the USD cash price at the unofficial market. *Exp.inf* and *Exp.Prov.inf* are expected inflation measures calculated according to Alvarez et al. (2019) method based on country-level and provincial-level inflation, respectively. *inflation*, *Prov. inf. FX growth* are monthly. *Exp.inf* and *Exp.Prov.inf* are monthly scale. Standard errors are reported in parentheses and adjusted for clusters at province-product level. Observations are weighted by the importance provincial weights. *, **and *** significant at 10, 5, and 1 percent levels.

Table 6: Pricing behavior in outlet-product level fixed effects estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: frequency of price changes				Dependent variable: absolute size of price changes			
Inflation (inf.)	0.029***		0.03***	0.028***	1.41***		1.55***	1.66***
	(0.0001)		(0.0001)	(0.0002)	(0.008)		(0.009)	(0.011)
FX growth (fx.)		0.003***	-0.0003***	-0.001***		0.13***	-0.06***	0.006**
		(0.0000)	(0.0000)	(0.0000)		(0.001)	(0.001)	(0.003)
Inf.*fx.				0.0003***				-0.01***
				(0.0000)				(0.000)
Constant	0.232***	0.279***	0.231***	0.234***	10.34***	12.91***	10.20***	10.02***
	(0.0003)	(0.0000)	(0.0003)	(0.0003)	(0.017)	(0.004)	(0.018)	(0.02)
Observations	34,312,301	34,312,301	34,312,301	34,312,301	8,758,759	8,758,759	8,758,759	8,758,759
R-squared	0.016	0.003	0.016	0.016	0.023	0.004	0.023	0.023
Number of FEs	1,196,474	1,196,474	1,196,474	1,196,474	1,024,663	1,024,663	1,024,663	1,024,663
F test	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the dummy variable for each outlet-product (equation 1). Absolute size of price changes is absolute value of price growth condition on price change occurred (equation 3). *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . Both *inflation* and *FX growth* are monthly. Standard errors are reported in parentheses and adjusted for clusters at outlet level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

6 Robustness evidence

In this section, we present three sets of robustness evidence regarding the effect of FX growth on pricing behavior. In the menu cost model (e.g., Golosov and Lucas Jr (2007)), the common shock plays an essential role in determining pricing behavior. Our evidence in Section 5 shows that FX growth contains significant information related to the common shock for price setters. While other variables could potentially influence this relationship, they do not alter our main findings. In this section, we evaluate three mechanisms to demonstrate that the effect of FX growth on pricing behavior remains robust.

6.1 Macro variables lags

In Tables 7 and 8, we include three lags of inflation and FX growth to capture the information relevant to each stage of the pricing decision process. As shown in Table 1, the mean frequency of price changes is 0.24, indicating an average duration of four months—covering the current month and the three preceding months. This suggests that pricing decisions typically consider information from this four-month period. Including three lags ensures that we account for this range of information in each pricing step. For longer-term effects of inflation and FX growth, refer to Section 6.2, where we examine the impact of three-month and twelve-month inflation and FX growth.

Table 7: Frequency of price changes and lags of inflation and FX growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dependent variable: frequency of price changes											
Inflation (inf.)	0.024***	0.023***	0.022***				0.022***	0.020***	0.018***	0.020***	0.018***	0.016***
	(0.0010)	(0.0010)	(0.0010)				(0.0011)	(0.0010)	(0.0010)	(0.0013)	(0.0012)	(0.0013)
L1.inf.	0.010***	0.004***	0.005***				0.009***	0.005***	0.004***	0.010***	0.006***	0.005***
	(0.0015)	(0.0014)	(0.0014)				(0.0015)	(0.0013)	(0.0013)	(0.0015)	(0.0014)	(0.0013)
L2.inf.		0.010***	0.007***					0.010***	0.007***		0.010***	0.007***
		(0.0011)	(0.0010)					(0.0013)	(0.0011)		(0.0013)	(0.0011)
L3.inf.			0.006***						0.008***			0.007***
			(0.0008)						(0.0011)			(0.0011)
FX growth (fx.)				0.002***	0.005***	0.002***	0.001***	0.001***	0.001***	-0.001***	-0.0001*	-0.0001*
				(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
L1.fx.				0.003***	0.001***	0.002***	-0.0001**	0.0001	0.0001*	-0.001***	0.0001	0.0001*
				(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
L2.fx.					0.002***	0.001***	0.0002	-0.0001**	0.0001	0.0001	-0.0001**	0.0001
					(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
L3.fx.						0.002***	0.001***	0.001***	-0.0001	0.001***	0.0001**	-0.0001
						(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
inf.*fx.										0.0001***	0.0001***	0.0001***
										(0.0001)	(0.0001)	(0.0001)
Constant	0.177***	0.171***	0.168***	0.227***	0.225***	0.223***	0.181***	0.174***	0.168***	0.181***	0.174***	0.171***
	(0.0040)	(0.0044)	(0.0046)	(0.0007)	(0.0009)	(0.0011)	(0.0038)	(0.0043)	(0.0049)	(0.0038)	(0.0043)	(0.0046)
Observations	76,696	75,502	74,382	76,696	75,502	74,382	74,382	74,382	74,382	74,382	74,382	74,382
R-squared	0.140	0.151	0.158	0.048	0.061	0.074	0.152	0.158	0.161	0.152	0.158	0.162
F test	0	0	0	0	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . Both *inflation* and *FX growth* are monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

In Table 7, columns 1-3 and 4-6, we include three lags of inflation and FX growth, respectively. The coefficients for these lags are all positively significant, and the cumulative effect—the sum of current and lagged coefficients—is greater than the effect of the current inflation or FX growth alone (Table 2, Panel A, columns 1 and 2). This suggests that both inflation and FX growth lags provide additional information for pricing decisions, beyond what is captured by their current values.

In columns 7-9, where both inflation and FX growth lags are included, the coefficients for current FX growth and its first lag remain positively significant. This contrasts with Table 2, Panel A, column 3, where the FX growth coefficient was insignificant when inflation was controlled for. This finding suggests that caution is needed when interpreting the effect of FX growth in the presence of inflation.

Columns 10-12 introduce an interaction term between inflation and FX growth. The interaction term is positively significant, consistent with the findings in Table 2, Panel A, column 4.

Table 8 uses the same lag structure as Table 7. In columns 1-6, the coefficients for both inflation and FX growth are positively significant, and their cumulative effects exceed the immediate effects observed in Table 3, Panel A, columns 1 and 2.

In columns 7-9, where both inflation and FX growth lags are included, the coefficients for current inflation and its lags remain positively significant, but most FX growth coefficients and their lags are not significant, except for the third lag in column 7. This pattern persists in columns 10-12, where an interaction term between inflation and FX growth is introduced. Overall, the results in columns 7-12 are consistent with those in Table 3, Panel A, columns 3 and 4, where the coefficients for FX growth and interaction terms become insignificant when inflation is controlled for.

Tables 7 and 8 highlight key insights into pricing behavior:

1. The cumulative effects of inflation and FX growth in columns 1-6 of both tables are larger than the immediate effects observed in Tables 2 and 3, Panel A, columns 1 and 2. This suggests that the impact of inflation and FX growth extends beyond their immediate effects, similar to findings in the pass-through literature (Gopinath et al. (2010)).

2. In Table 7, introducing lags of inflation and FX growth changes the pattern observed in Table 2, where the effect of FX growth on the frequency of price changes was offset by inflation. In contrast, in Table 8, the pattern of insignificant FX growth coefficients when competing with inflation reappears. This indicates that while FX growth is informative for deciding whether to change prices, it has less influence on the size

Table 8: Absolute size of price changes and lags of inflation and FX growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dependent variable: absolute size of price changes											
Inflation (inf.)	0.85***	0.80***	0.73***				0.87***	0.77***	0.67***	0.81***	0.72***	0.62***
	(0.083)	(0.071)	(0.067)				(0.085)	(0.095)	(0.109)	(0.096)	(0.103)	(0.115)
L1.inf.	0.53***	0.30***	0.31***				0.63***	0.41***	0.39***	0.65***	0.43***	0.40***
	(0.060)	(0.041)	(0.040)				(0.096)	(0.067)	(0.066)	(0.094)	(0.063)	(0.062)
L2.inf.		0.44***	0.28***					0.51***	0.38***		0.50***	0.37***
		(0.078)	(0.054)					(0.124)	(0.094)		(0.125)	(0.094)
L3.inf.			0.30***						0.31***			0.30***
			(0.061)						(0.087)			(0.087)
FX growth (fx.)				0.06***	0.07***	0.05***	0.001	0.02	0.03	-0.03	-0.01	0.001
				(0.012)	(0.011)	(0.011)	(0.016)	(0.018)	(0.020)	(0.028)	(0.030)	(0.032)
L1.fx.				0.10***	0.06***	0.08***	-0.05***	-0.02	-0.01	-0.06***	-0.02	-0.01
				(0.011)	(0.009)	(0.009)	(0.016)	(0.013)	(0.014)	(0.015)	(0.013)	(0.013)
L2.fx.					0.08***	0.03***	-0.02**	-0.06***	-0.03**	-0.02**	-0.06***	-0.03**
					(0.010)	(0.008)	(0.011)	(0.016)	(0.012)	(0.011)	(0.016)	(0.012)
L3.fx.						0.10***	0.03***	0.001	-0.03	0.02**	-0.001	-0.03
						(0.010)	(0.011)	(0.016)	(0.022)	(0.011)	(0.016)	(0.022)
inf.*fx.										0.01*	0.01	0.01
										(0.006)	(0.006)	(0.006)
Constant	12.28***	12.00***	11.87***	14.45***	14.37***	14.29***	12.17***	11.86***	11.72***	12.25***	11.93***	11.78***
	(0.134)	(0.150)	(0.166)	(0.025)	(0.034)	(0.040)	(0.149)	(0.192)	(0.220)	(0.169)	(0.213)	(0.241)
Observations	73,689	72,696	71,730	73,689	72,696	71,730	71,730	71,730	71,730	71,730	71,730	71,730
R-squared	0.044	0.048	0.050	0.009	0.012	0.015	0.046	0.050	0.051	0.047	0.050	0.051
F test	0	0	0	0	0	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . Both *inflation* and *FX growth* are monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

of those changes. This is consistent with the findings in Table 5, where the absolute size of price changes is primarily driven by local factors rather than country-level variables.

3. Except for the significant FX growth coefficients in Table 7, columns 7-9, the results in Tables 7 and 8 are consistent with the main findings and do not present any contradictory evidence.

6.2 Long run horizon

In this subsection, we examine how medium-term and long-term inflation and FX growth influence the frequency and absolute size of price changes. Unlike the previous sections, which focused on monthly data, this analysis considers broader time horizons—three-month and twelve-month periods—to capture the longer-term factors that may shape price-setting behavior. We apply equation \ref{eq FE product}, adjusting the calculations of inflation and FX growth to reflect the three-month and twelve-month periods\footnote{The expected inflation measures are scaled to ensure compatibility with the inflation and FX growth data.}.

Table 9 presents the results for three-month inflation and FX growth. In Panel A, columns 1 and 2, both inflation and FX growth have positive and significant coefficients, consistent with the findings in Table 2. However, in column 3, both coefficients remain positively significant, unlike in Table 2, where FX growth was unable to compete with inflation. In column 4, the interaction term between inflation and FX growth is not significant, differing from Table 2. This interaction term becomes significant again in Panel B when expected inflation is included as a control.

In Panel C, we incorporate MBRI's expected FX growth. Except for column 2, where expected FX growth is positive at the 90% confidence interval, the general pattern remains unchanged compared to Table 2. In Panel D, using MBRI's expected inflation, the results mirror those of Panel B.

Table 10 analyzes the impact of twelve-month inflation and FX growth on the frequency of price changes. Although the general pattern of coefficients observed in Table 9 remains consistent, a notable difference emerges in Panel D, columns 7 and 8. Here, the inflation coefficients are not significant, while the coefficients for FX growth and expected inflation are positively significant.

Table 11 examines the effect of three-month inflation and FX growth on the absolute size of price changes. Panels A, B, and C show patterns similar to Table 3. However, in

Table 9: Frequency of price changes and 3-month horizon

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: frequency of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf)	0.011***		0.01***	0.01***	0.01***		0.009***	0.009***
	(0.0007)		(0.0007)	(0.0007)	(0.0006)		(0.0006)	(0.0006)
FX growth (fx)		0.002***	0.0005***	0.0005***		0.001***	0.0002***	0.0001
		(0.0001)	(0.0001)	(0.0001)		(0.000)	(0.000)	(0.0001)
inf*fx				0.0001				0.0001**
				(0.0001)				(0.0001)
Exp.inf					0.003***	0.00532***	0.002***	0.003***
					(0.0005)	(0.000660)	(0.0005)	(0.0005)
Constant	0.172***	0.224***	0.175***	0.174***	0.16***	0.195***	0.163***	0.164***
	(0.0043)	(0.0009)	(0.0041)	(0.0043)	(0.0058)	(0.0042)	(0.006)	(0.005)
Observations	75,628	75,628	75,628	75,628	75,628	75,628	75,628	75,628
R-squared	0.142	0.064	0.146	0.146	0.151	0.086	0.151	0.152
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf)	0.012***		0.011***	0.01***	0.011***		0.008***	0.006***
	(0.0008)		(0.0008)	(0.001)	(0.0008)		(0.001)	(0.0009)
FX growth (fx)		0.002***	0.0002	-0.0001		0.001***	0.0006***	-0.0001
		(0.0002)	(0.0001)	(0.0003)		(0.0001)	(0.0002)	(0.0003)
inf*fx				0.0001				0.0001***
				(0.0001)				(0.0001)
Exp.inf	-0.0001	0.001*	0.0001	0.0005	0.003*	0.019***	0.007**	0.008***
	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0022)	(0.002)	(0.0027)	(0.0026)
Constant	0.172***	0.227***	0.172***	0.176***	0.159***	0.128***	0.15***	0.153***
	(0.0076)	(0.0057)	(0.0078)	(0.0089)	(0.0116)	(0.0123)	(0.0131)	(0.0133)
Observations	6,456	6,456	6,456	6,456	7,703	7,703	7,703	7,703
R-squared	0.307	0.128	0.309	0.310	0.288	0.256	0.293	0.297
F test	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). All regressions include 453 products fixed effects. *Inflation* is calculated by the 3-month growth of the urban CPI (excluding housing rent). *FX growth* shows the 3-month growth of the USD cash price at the unofficial market. Expected inflation proxies are scaled to 3-month CPI growth. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

Panel D, the FX growth coefficients in columns 7 and 8 are positive and significant, which is not observed in Table 3.

Table 12 presents new findings not seen in Tables 3 or 11. In Panel A, column 3, the FX growth coefficient is positively significant, indicating that FX can compete with inflation, contrary to the results in Tables 3 and 11. Additionally, in Panel C, columns 1-4, the coefficients for expected FX growth are not positive, suggesting that the effects of twelve-month inflation and FX growth offset the impact of expected FX growth. In Panel D, column 7, the inflation coefficient is insignificant, while FX growth and expected inflation remain significant. In column 8, both inflation and FX growth are significant, but the FX growth

Table 10: Frequency of price changes and 12-month horizon

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: frequency of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf)	0.002***		0.001***	0.002***	0.002***		0.001***	0.002***
	(0.0002)		(0.0001)	(0.0002)	(0.0001)		(0.0001)	(0.0002)
FX growth (fx)		0.0008***	0.0005***	0.001***		0.0007***	0.0004***	0.001***
		(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)
inf*fx				0.0001***				0.0001***
				(0.000)				(0.000)
Exp.inf					0.001***	0.0007***	0.0007***	0.0004***
					(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0.171***	0.210***	0.18***	0.164***	0.15***	0.194***	0.164***	0.159***
	(0.0051)	(0.002)	(0.0048)	(0.0059)	(0.0071)	(0.0039)	(0.0068)	(0.0067)
Observations	77,944	77,944	77,944	77,944	77,944	77,944	77,944	77,944
R-squared	0.101	0.115	0.139	0.149	0.131	0.126	0.150	0.152
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf)	0.003***		0.002***	0.002***	0.002***		-0.0006*	0.0001
	(0.0002)		(0.0003)	(0.0004)	(0.0003)		(0.0003)	(0.0006)
FX growth (fx)		0.001***	0.0006***	0.001***		0.0007***	0.0008***	0.001***
		(0.0001)	(0.0001)	(0.0002)		(0.0001)	(0.0001)	(0.0003)
inf*fx				0.0001***				0.0001
				(0.000)				(0.0001)
Exp.inf	-0.0006***	-0.0005***	-0.0007***	-0.0007***	0.001**	0.003***	0.003***	0.003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0006)	(0.0004)	(0.0006)	(0.0006)
Constant	0.186***	0.218***	0.18***	0.159***	0.167***	0.14***	0.135***	0.131***
	(0.0073)	(0.0048)	(0.0074)	(0.0118)	(0.0109)	(0.0111)	(0.0111)	(0.0129)
Observations	6,546	6,546	6,546	6,546	7,797	7,797	7,797	7,797
R-squared	0.188	0.233	0.294	0.306	0.163	0.286	0.288	0.290
F test	0	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). All regressions include 453 products fixed effects. *Inflation* is calculated by the 3-month growth of the urban CPI (excluding housing rent). *FX growth* shows the 12-month growth of the USD cash price at the unofficial market. Expected inflation proxies are scaled to 12-month CPI growth. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

magnitude is larger, and both have smaller magnitudes than expected inflation.

Using three-month and twelve-month inflation and FX growth provides novel insights about the role of inflation and FX growth in pricing decisions:

1. The significance of FX growth in pricing behavior becomes more pronounced with three-month and twelve-month indices, reducing the gap between the effects of FX growth and inflation compared to monthly indices. While in short-term analysis, the FX growth coefficients are often insignificant and smaller relative to inflation, long-term FX growth shows positively significant coefficients with considerable magnitudes, sometimes even larger than those of inflation. In certain cases (Panel D), FX

Table 11: Absolute size of price changes and 3-month horizon

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: absolute size of price changes								
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf)	0.48***		0.49***	0.49***	0.44***		0.46***	0.44***
	(0.024)		(0.033)	(0.043)	(0.024)		(0.031)	(0.041)
FX growth (fx)		0.06***	-0.004	-0.003		0.035***	-0.014*	-0.02**
		(0.004)	(0.006)	(0.01)		(0.006)	(0.007)	(0.011)
inf*fx				-0.0001				0.0001
				(0.001)				(0.001)
Exp.inf					0.08***	0.22***	0.1***	0.11***
					(0.019)	(0.026)	(0.023)	(0.022)
Constant	12.11***	14.36***	12.09***	12.08***	11.8***	13.17***	11.66***	11.7***
	(0.140)	(0.032)	(0.157)	(0.207)	(0.173)	(0.146)	(0.218)	(0.241)
Observations	72,712	72,712	72,712	72,712	72,712	72,712	72,712	72,712
R-squared	0.045	0.012	0.045	0.045	0.046	0.019	0.047	0.047
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf)	0.4***		0.38***	0.41***	0.29***		0.15***	0.14***
	(0.02)		(0.034)	(0.036)	(0.035)		(0.057)	(0.052)
FX growth (fx)		0.07***	0.008	0.02		0.06***	0.03***	0.03*
		(0.007)	(0.007)	(0.016)		(0.006)	(0.01)	(0.017)
inf*fx				-0.001				0.001
				(0.001)				(0.001)
Exp.inf	0.07***	0.14***	0.08***	0.07***	0.39***	0.8***	0.58***	0.59***
	(0.024)	(0.025)	(0.027)	(0.023)	(0.083)	(0.067)	(0.114)	(0.110)
Constant	12.22***	14.1***	12.2***	12.05***	10.98***	10.15***	10.51***	10.52***
	(0.230)	(0.154)	(0.23)	(0.267)	(0.394)	(0.4)	(0.453)	(0.458)
Observations	6,173	6,173	6,173	6,173	7,384	7,384	7,384	7,384
R-squared	0.128	0.053	0.128	0.129	0.129	0.131	0.135	0.135
F test	0	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the 3-month growth of the urban CPI (excluding housing rent). *FX growth* shows the 3-month growth of the USD cash price at the unofficial market. Expected inflation proxies are scaled to 3-month CPI growth. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

growth can even offset the effect of inflation. This suggests that over the long term, the difference in the information content between FX and inflation decreases. At the twelve-month horizon, FX growth may even provide more relevant information than inflation (Tables 10 and 12, column 8).

2. Expected inflation consistently exerts a positive and significant effect, and controlling long-term inflation and FX growth cannot fully offset it. It is noteworthy that expected inflation can mitigate the impact of inflation in some cases (Table 10, Panel D, column 8), while inflation cannot fully counteract the effect of expected inflation

Table 12: Absolute size of price changes and 12-month horizon

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: absolute size of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf)	0.12***		0.08***	0.12***	0.1***		0.08***	0.11***
	(0.006)		(0.01)	(0.016)	(0.006)		(0.01)	(0.015)
FX growth (fx)		0.03***	0.01***	0.05***		0.02***	0.01***	0.04***
		(0.002)	(0.003)	(0.005)		(0.002)	(0.003)	(0.006)
inf*fx				-0.001***				-0.001***
				(0.0001)				(0.0001)
Exp.inf					0.03***	0.03***	0.03***	0.01***
					(0.003)	(0.005)	(0.005)	(0.005)
Constant	11.95***	13.83***	12.18***	11.36***	11.20***	13.15***	11.51***	11.22***
	(0.157)	(0.063)	(0.178)	(0.302)	(0.203)	(0.121)	(0.276)	(0.319)
Observations	74,690	74,690	74,690	74,690	74,690	74,690	74,690	74,690
R-squared	0.035	0.027	0.040	0.044	0.041	0.030	0.043	0.045
F test	0	0	0	0	0	0	0	0
	Panel C: Exp.inf: MBRI's fx.				Panel D: Exp.inf: MBRI's inf.			
Inflation (inf)	0.13***		0.1***	0.16***	0.04***		-0.02	0.04**
	(0.009)		(0.01)	(0.01)	(0.015)		(0.016)	(0.024)
FX growth (fx)		0.02***	0.01***	0.08***		0.02***	0.02***	0.06***
		(0.00238)	(0.002)	(0.013)		(0.002)	(0.002)	(0.014)
inf*fx				-0.001***				-0.001***
				(0.0003)				(0.0004)
Exp.inf	-0.01**	-0.002	-0.01**	-0.01**	0.1***	0.14***	0.17***	0.11***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.026)	(0.014)	(0.027)	(0.027)
Constant	12.37***	14.25***	12.25***	10.78***	11.34***	10.69***	10.51***	10.06***
	(0.237)	(0.103)	(0.234)	(0.411)	(0.394)	(0.367)	(0.405)	(0.452)
Observations	6,238	6,238	6,238	6,238	7,452	7,452	7,452	7,452
R-squared	0.106	0.064	0.121	0.144	0.092	0.123	0.124	0.131
F test	0	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the 12-month growth of the urban CPI (excluding housing rent). *FX growth* shows the 12-month growth of the USD cash price at the unofficial market. Expected inflation proxies are scaled to 3-month CPI growth. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

under any conditions.

6.3 Aggregate demand shocks

The observed effect of FX growth and inflation on pricing behavior may be influenced by aggregate demand shocks. If there is a positive relationship between FX growth and pricing behavior, it could be attributed to these shocks. Consequently, controlling for indices that represent aggregate demand shocks could potentially remove the positive effect of FX growth.

Table 13: Frequency of price changes and aggregate demand

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: frequency of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)		0.028***		0.029***		0.025***		0.026***
		(0.002)		(0.002)		(0.001)		(0.001)
FX growth (fx.)			0.003***	-0.0001			0.002***	-0.001***
			(0.0002)	(0.0002)			(0.0002)	(0.0002)
NGDP growth	0.008***	0.002***	0.006***	0.002***	0.004***	0.002***	0.004***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exp.inf					0.021***	0.009***	0.018***	0.010***
					(0.002)	(0.002)	(0.002)	(0.002)
Constant	0.222***	0.182***	0.218***	0.182***	0.186***	0.172***	0.190***	0.170***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.005)	(0.005)	(0.005)	(0.006)
Observations	76,696	76,696	76,696	76,696	76,696	76,696	76,696	76,696
R-squared	0.030	0.133	0.052	0.133	0.071	0.138	0.077	0.139
F test	0	0	0	0	0	0	0	0
	Panel C				Panel D: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)		0.030***		0.030***		0.026***		0.027***
		(0.0017)		(0.0019)		(0.0012)		(0.0015)
FX growth (fx.)			0.004***	-0.000			0.002***	-0.001***
			(0.0002)	(0.0002)			(0.0002)	(0.0002)
M1 growth	0.001***	0.0001	0.0001	0.0001	-0.001**	-0.0001	-0.001***	-0.0001
	(0.0005)	(0.0004)	(0.0001)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Exp.inf					0.0253**	0.0099**	0.0217**	0.0105**
					(0.0021)	(0.0017)	(0.0022)	(0.0018)
Constant	0.235***	0.184***	0.231***	0.184***	0.189***	0.172***	0.193***	0.171***
	(0.0010)	(0.0037)	(0.0011)	(0.0039)	(0.0046)	(0.0052)	(0.0047)	(0.0057)
Observations	76,696	76,696	76,696	76,696	76,696	76,696	76,696	76,696
R-squared	0.002	0.130	0.031	0.130	0.063	0.137	0.069	0.138
F test	0.006	0	0	0	0	0	0	0

Notes: Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market. *NGDP growth* is nominal GDP growth rate reported by SCI. We calculate monthly nominal GDP by interpolating quarterly SCI's nominal GDP. *M1 growth* is M1 growth rate reported by CBI. *Exp.inf* shows expected inflation based on Alvarez et al. (2019). *inflation*, *FX growth* and *M1 growth* are also monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

To address this concern, we use nominal Gross Domestic Product (NGDP) and M1 as proxies for aggregate demand, incorporating the growth rates of these variables as controls in our regression. The M1 growth rate is calculated based on the monthly growth of money, as reported by CBI. For NGDP, we use quarterly data from SCI and estimate monthly NGDP through linear interpolation of the quarterly values[1]. Tables 13 and 14

[1]NGDP is reported at the end of each quarter. To estimate monthly NGDP, we apply linear interpo-

present the results for the frequency and absolute size of price changes, respectively.

In Table 13, Panel A, column 1, a 1 ppt increase in NGDP growth leads to a 0.8 ppt increase in the frequency of price changes. Although this coefficient is statistically significant, its magnitude is relatively small compared to the 3 ppt effect of inflation in Table 2, Panel A, column 1.

In column 2, when both inflation and NGDP growth are included as explanatory variables, the coefficient for NGDP growth remains positive but decreases. The inflation coefficient remains similar to its value without NGDP growth control (2.8 vs. 3), indicating that NGDP represents mechanisms not entirely captured by inflation.

In column 3, where both FX and NGDP growth are included, the coefficient for FX growth remains unchanged from Table 2, indicating that NGDP growth does not influence the role of FX, suggesting that FX reflects mechanisms independent of NGDP growth. In column 4, where inflation, NGDP, and FX growth are included together, NGDP growth remains significant but with a small magnitude, while the FX coefficient remains insignificant, consistent with the results in this table and Table 2.

In Panel B, where expected inflation is controlled using the Alvarez et al. (2019) method, the patterns remain consistent with Panel A.

In Panel C and D, using M1 growth rate as an aggregate demand proxy, a positive and significant coefficient is observed only in column 1. In columns 2-8, M1 growth is not positively significant when competing with variables like inflation, FX growth, and expected inflation.

In Table 14, Panel A, column 1, a 1 ppt increase in NGDP growth leads to a 0.26 ppt increase in the absolute size of price changes. Although this effect is statistically significant, its magnitude is small compared to the 1.18 ppt effect of inflation in Table 3, Panel A, column 1.

In column 2, where both inflation and NGDP growth are included, the NGDP growth coefficient becomes insignificant, while the inflation coefficient remains similar to its value in Table 3, Panel A, column 1, suggesting that the impact of NGDP is fully captured by inflation.

In column 3, both FX and NGDP are significant, but the FX coefficient remains similar to when NGDP is not controlled, suggesting that NGDP does not capture mechanisms linking FX to the absolute size of price changes. In column 4, where all three variables are included, neither NGDP nor FX growth achieve positive significance against inflation. In

lation to distribute the quarterly values proportionally across the three months within each quarter. This method assumes a steady growth rate within each quarter, providing a smooth transition between quarterly observations.

Table 14: Absolute size of price changes aggregate demand

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: absolute size of price changes							
	Panel A				Panel B: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)		1.14***		1.24***		1.03***		1.14***
		(0.088)		(0.101)		(0.104)		(0.098)
FX growth (fx.)			0.09***	-0.04***			0.03***	-0.06***
			(0.011)	(0.012)			(0.010)	(0.013)
NGDP growth	0.26***	0.057	0.23***	0.057	0.14***	0.030	0.14***	0.02
	(0.026)	(0.036)	(0.027)	(0.036)	(0.028)	(0.036)	(0.028)	(0.036)
Exp.inf					0.82***	0.30***	0.76***	0.39***
					(0.077)	(0.067)	(0.076)	(0.066)
Constant	14.22***	12.60***	14.10***	12.52***		12.23***	12.89***	12.02***
	(0.056)	(0.114)	(0.056)	(0.121)		(0.187)	(0.142)	(0.176)
Observations	73,689	73,689	73,689	73,689		73,689	73,689	73,689
R-squared	0.007	0.039	0.011	0.040		0.040	0.019	0.042
F test	0	0	0	0		0	0	0
	Panel C				Panel D: Exp.inf: Alvarez et al (2019)			
Inflation (inf.)		1.19***		1.28***		1.04***		1.14***
		(0.072)		(0.083)		(0.073)		(0.082)
FX growth (fx.)			0.11***	-0.046***			0.042***	-0.06***
			(0.009)	(0.011)			(0.009)	(0.011)
M1 growth	0.01	-0.02	-0.02	-0.01	-0.07***	-0.05**	-0.08***	-0.04
	(0.025)	(0.026)	(0.025)	(0.025)	(0.026)	(0.026)	(0.026)	(0.025)
Exp.inf					1.00***	0.37***	0.92***	0.43***
					(0.071)	(0.066)	(0.074)	(0.068)
Constant	14.76***	12.70***	14.61***	12.60***	12.93***	12.27***	13.02***	12.06***
	(0.0525)	(0.135)	(0.0571)	(0.143)	(0.144)	(0.166)	(0.144)	(0.180)
Observations	73,689	73,689	73,689	73,689	73,689	73,689	73,689	73,689
R-squared	0.000	0.039	0.006	0.040	0.018	0.041	0.019	0.042
F test	0.588	0	0	0	0	0	0	0

Notes: Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market . *NGDP growth* is nominal GDP growth rate reported by SCI. We calculate monthly nominal GDP by interpolating quarterly SCI's nominal GDP. *M1 growth* is M1 growth rate reported by CBI. *Exp.inf* shows expected inflation based on Alvarez et al. (2019). *inflation*, *FX growth* and *M1 growth* are also monthly. Standard errors are reported in parentheses and adjusted for clusters at product level. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.

Panel B, controlling for expected inflation shows no change in the observed patterns.

In Table 14, Panel C, the M1 growth rate is not positively significant, similar to the results in Table 13, Panel C. The coefficients for inflation and FX are consistent with those in Table 3, suggesting that the insights from the analysis in Table 13, Panel C and D, are applicable here as well.

Tables 13 and 14 highlight several key insights into the determinants of pricing behavior:

1. The overall patterns observed in Tables 2 and 3 remain robust even after controlling for NGDP and M1 growth as proxies for aggregate demand shocks, suggesting that FX growth captures mechanisms that are only weakly related to aggregate demand.

2. NGDP growth shows significant and positive effects, unlike M1 growth, likely due to M1's inclusion of both product and asset demand, where asset demand exerts a stronger influence.

3. The coefficients for inflation and FX remain significant, even when controlling for aggregate demand, indicating they capture factors beyond aggregate demand shocks.

7 Conclusion

This paper presents new evidence on the impact of FX growth on pricing behavior in Iran under varying macroeconomic conditions. In stable economic environments, nominal variables such as inflation, FX, and expected inflation remain relatively constant, allowing any one of these variables to adequately represent the nominal state of the economy. Under such conditions, recent studies like Nakamura and Steinsson (2008), Gagnon (2009), and Alvarez et al. (2019) have examined the influence of inflation on pricing behavior, providing valuable insights into steady-state conditions.

However, in the aftermath of aggregate shocks, the information content of the nominal state becomes dispersed across multiple macroeconomic variables. In these contexts, inflation alone may not capture the full picture, and price setters may rely on additional variables such as FX growth and expected inflation to make decisions.

Our study focuses on FX growth for three primary reasons. First, empirical evidence suggests that FX pass-through significantly influences inflation (Devereux and Yetman (2010)). Second, FX growth can act as a source of cost shocks, thereby affecting pricing decisions directly (Alvarez and Neumeyer (2020)). Third, in economies with weakly anchored expectations and persistent high inflation, FX growth acts as a nominal anchor, providing essential macroeconomic information to economic agents (Mishkin (1999)).

We find that FX growth increases both the frequency and absolute size of price changes, although its effect is approximately ten times smaller than that of inflation. While this may seem modest, in the context of aggregate shocks that significant FX jumps occur, the resulting changes in the frequency and absolute size of price adjustments can be substantial. Additionally, our evidence shows that the impact of inflation on pricing behavior becomes more pronounced during periods of high FX growth.

In exploring the long-term effects of FX growth, we observe that as the time horizon extends from short-term to long-term, the impact of FX growth on pricing behavior becomes stronger, potentially even offsetting the influence of inflation when twelve-month horizons for inflation and FX growth are considered.

A novel aspect of this study is the province-level analysis. While common shocks affect both national and provincial levels, distinguishing between these effects offers a more precise understanding of pricing behavior. Our results indicate that both national and provincial inflation rates influence the frequency of price changes, but only provincial inflation significantly impacts the absolute size of price adjustments. This suggests that while price setters consider both national and provincial factors when deciding whether to change prices, they primarily rely on province-level information to determine the magnitude of those changes.

Our findings confirm the established positive relationship between inflation and pricing behavior, as shown in previous studies. Our contribution to this literature is demonstrating that the nominal state of the economy is not fully captured by a single variable such as CPI inflation. After an aggregate shock, economic agents gather information from multiple indicators, including inflation, expected inflation, and FX growth. Consequently, menu cost models that consider only one aspect of the nominal state may provide misleading predictions in the wake of aggregate shocks.

For central banks, especially in high-inflation environments, monitoring FX growth is critical due to its role as a nominal anchor (Mishkin (1999)). Our findings highlight additional reasons for this focus, as FX growth affects both the frequency and absolute size of price changes. A higher frequency of price changes reduces price rigidity (Nakamura and Steinsson (2008)), while a larger absolute size of price changes indicates greater price dispersion (Nakamura et al. (2018)) and increased welfare costs related to inflation. Therefore, closely tracking FX growth is essential for central banks to effectively manage price stability and minimize the welfare costs associated with inflation.

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Appendix A. Iran's economy in 2006-2021

Iran's economy has been experiencing several policies and shocks since 2005, resulting in a variety of macroeconomic experiments that range from negative economic growth to two-digit growth, inflation of single digits to 50%, stable FXs to unstable FXs, and sanctions.

In 2005, the new president implemented new policies and one-digit inflation in 2005 rise to 30% in 2008. With the high foreign exchange revenue, the government stabilized the FX during the two-digit inflationary period, which caused the lowering real FX from 2005-2010. Since 2011, sanctions have also been a challenge for Iran's economy. Besides increasing trade barriers and transaction costs, sanctions had been decreasing foreign exchange revenue levels and increasing its volatility. Due to these factors, the government's ability to stabilize the currency market declined, and the FX jumped several times since 2011. Although the cash price of the United States Dollar (USD) on the unofficial market [1] was less than 11000 Iran Rial (IRR) in 2010, it has increased to 35000 IRR in 2013. In 2014, macroeconomic conditions stabilized but the stability was not sustained. Since 2017, the economy has become unstable again, and USD cash prices have risen from 40000 in 2017 to 280000 in 2021.

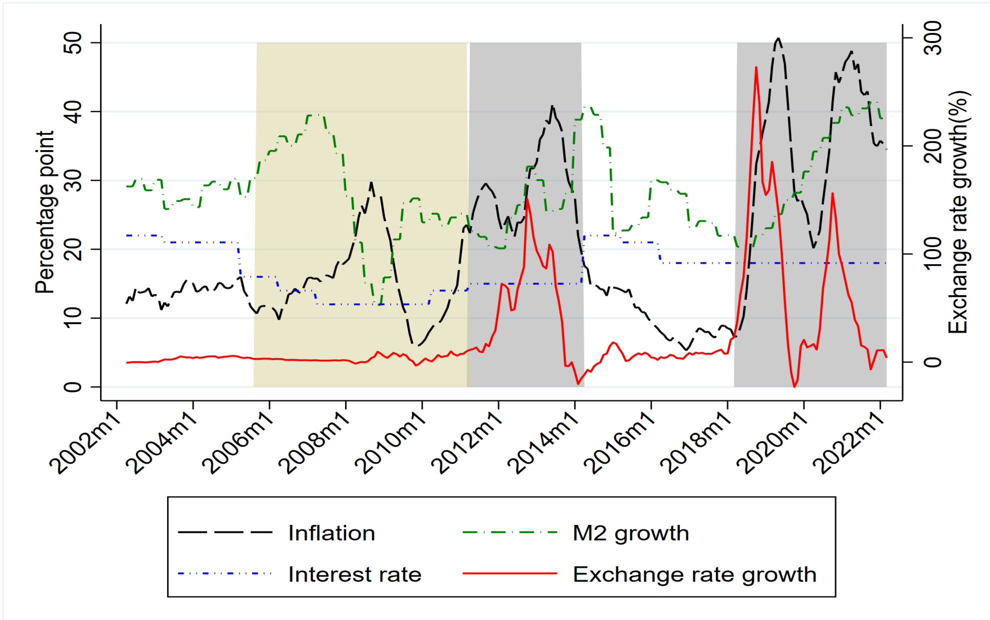
According to the stability of price index and FX, Iran's economy in these years had three distinct periods (Figure 7): The stable period in 2014-2017, inflationary periods with jumping FX in 2011-2013 and 2018-2021, and inflationary period with stable FX in 2006-2010.

Inflationary period with stable FX (2005-2010): The inflation rate stabilized at around 13% between 2000 and 2004, but under the new president's policies, it began to rise again in 2005. Due to the decline in the nominal deposit interest rate and an increase in the bank overdraft facilities, the M2 growth rate increased and the one-digit inflation rate in 2005 rose to 30% in 2008. Despite high inflation from 2005-2010, rising oil prices helped government to stabilize the FX market by increasing foreign exchange revenues. However, high inflation and the fixed FX led to a fall in real exchange, and it is not a long-run equilibrium.

Inflationary period with jumping FX (2011-2013): Sanctions in 2011 were a spark that

[1]Since 2000, Iran has changed its FX system several times between dual and single FX systems. In a single FX system, CBI can implement the official rate in the unofficial market through market mechanisms, and there is no arbitrage opportunity. In this case, the free-market price is equal to the regulated price. In a dual FX system, CBI's resources are insufficient to integrate official and unofficial markets; hence, CBI allocates most of its resources to particular foreign exchange expenditures at the governmental regulated price. In this situation, CBI cannot actively intervene in the unofficial market, and the price of this market shows a different pattern compared to the regulated price. In a single FX system and a dual FX system, the cash price of the unofficial market represents the official market's regulated price and the free market's unregulated price, respectively. Consequently, the cash price of the unofficial market serves as a helpful indicator of supply-demand dynamics.

Figure 8: Macro variables at the 2006-2022



Notes: *Inflation* is calculated by the growth of the urban CPI (base year on 2016) published by SCI. *FX growth* shows the annual growth of the USD cash price in the unofficial (non-regulated) market. *Interest rate* shows the deposit account interest rate. The gray background shows inflationary periods without jumps in the FX and the khaki background shows inflationary periods with jumps in the FX.

caused the equilibrium of high inflation and fixed FX to break down. In addition to the rise of trade barriers and transaction costs, sanctions declined the sale of oil and the foreign exchange revenue. Having limited foreign exchange income means being unable to control the currency market. After 2011, the government was not able to supply Petro-dollar, and the FX jumped, which increased the cash price of USD from 2010 to 2013, becoming 35000 IRR from 11000 IRR.

Stable period (2014-17): In 2013, Iran's president changed. The new president had a different economic and foreign policy approach. As a result, the Iran nuclear deal resulted in the Joint Comprehensive Plan of Action (JCPOA), international trade barriers and transaction costs decreased, and foreign exchange revenues returned to the levels of before sanctions. Due to high foreign exchange revenue and the believable promises of the new president to change the economic policies, inflation dropped, and the FX stabilized. Nonetheless short-term stability, the economy became unstable again in 2017. Despite the inflation was low in 2014-2017, it was high enough to cause the real FX to fall when combined with the fixed nominal FX. Iran's economy was also plagued by an unbalanced banking system in 2017. The overvaluation of assets made it difficult for banks to fulfill their obligations to depositors. Banks entered the Ponzi game in order to delay this problem and raised interest rates on deposits, thus raising the real interest rate. Because the central bank did not react accurately to this game, the banking system's overdrafts grew, causing M2 growth to increase. The falling real FXs, rising real interest rates, and growing M2 made stability impossible.

Inflationary period with jumping FX (2018-2021): A spark could break the stability of 2014-2017. In 2018, the US president announced the US withdrawal from JCPOA, and sanctions returned. As a result of incorrect policies and sanctions replacing, a new era of instability began. The unbalanced banking system and an increasing budget deficit boosted the growth of M2, price index, and FX. From 2018-2021, the urban consumer price index (CPI) rose from 100 to 500, and the FX increased from 40000 to 300000 IRR.

Appendix B. Data description

In this research, we use several macro variables, including CPI inflation, FX, and expected inflation. Below, we provide detailed descriptions of these variables:

- **CPI**: We use the monthly urban CPI inflation rate (excluding housing rent) as reported by SCI.
- **FX**: From 2006 to 2022, Iran's economy operated under a dual FX system during certain periods. In this study, we focus on the USD cash price in the unofficial (non-regulated) market, as published by the Central Bank of Iran (CBI). However, CBI's website does not report USD cash prices for the period from April to September 2018. For these months, we used the monthly average of daily USD cash prices from a reputable website that tracks the prices of gold and currency[1].
- **MBRI expected inflation**: From 2016 to 2022, MBRI conducted 18 surveys on expected inflation and expected FX growth. We have access to the average expected inflation and FX forecasts for each survey round. In each round, MBRI asks professional forecasters for their 12-month inflation expectations for the end of the current year, the next year, and two years ahead. We construct the expected inflation index based on the implied duration, calculated as the inverse of the median frequency of price changes at the country level[2]. If the remaining time to the end of the year is shorter than the implied duration, our expected inflation index reflects the forecast for the current year. If the time remaining is longer than the implied duration, the

[1] https://english.tgju.org/

[2] If the implied duration exceeds 12 months, we limit it to 12 months.

expected inflation is a weighted average of the forecasts for the current and the next year, with the weights based on the share of the implied duration within the current year. For example, if the implied duration is 6 months and we are in the 10^th month of the year, two months would be within the current year and four within the next year. Therefore, the expected inflation is calculated as the weighted average of the current year's forecast (with a weight of $\frac{1}{3}$) and the next year's forecast (with a weight of $\frac{2}{3}$)[1].

- **MBRI expected FX growth**: In each survey round, MBRI reports the average expected FX rate for the end of the current year. We calculate expected FX growth as:

$$\text{Exp. FX growth} = \left[\left(\frac{FX^e_{t+d}}{FX_t}\right)^{\frac{1}{d}} - 1\right] \times 100 \tag{10}$$

Where FX^e_{t+d} is the expected FX at the end of the year, and d is the time remaining until the end of the year. FX_t represents the FX rate at the time of the report.

Appendix C. Complementary evidence

We present summary statistics in section 3 by Table 1 which is brief. Detailed summary statistics is provided in Table 15, 16, 17 and 18.

Appendix D. Temporary price changes

In this section we calculate regular prices as Kehoe and Midrigan (2015) to measure the effect of temporary price changes. There is a great deal of concern in this literature regarding temporary price changes. In studying pricing behavior, it is necessary to identify which types of price changes are important and which types of price changes are being studied. Bils and Klenow (2004) show more than 22% of prices are changed each month, whereas Nakamura and Steinsson (2008) show more than half of price changes are related to sales. Changing prices temporarily is not limited to sales, and some price increases may be temporary as well. Kehoe and Midrigan (2015) introduce an algorithm designed to filter out temporary price increases and decreases. They discover that the frequency of regular price changes amounts to 6.9%.

[1]This index represents 12-month expected inflation. For the monthly macro variables in our regressions, we convert this to a monthly scale using $(1 + \pi^e_t)^{(\frac{1}{12})}$

Table 15: Frequency of price changes.

Year	Inflation	Simple Price Changes			Without Sales and Subs. Price Changes		Simple Price Increases		Simple Price Decreases	
		Mean	Sd	Med	Mean	Med	Mean	Med	Mean	Med
2006/04-07/03	13.4	0.23	0.21	0.16	0.2	0.13	0.15	0.11	0.07	0.04
2007/04-08/03	18	0.22	0.21	0.14	0.2	0.13	0.17	0.12	0.05	0.01
2008/04-09/03	18.2	0.24	0.23	0.16	0.21	0.13	0.17	0.12	0.08	0
2009/04-10/03	10.4	0.17	0.22	0.07	0.14	0.06	0.12	0.06	0.05	0
2010/04-11/03	28.8	0.19	0.23	0.09	0.17	0.08	0.14	0.08	0.05	0
2011/04-12/03	26.5	0.23	0.23	0.14	0.21	0.13	0.18	0.12	0.05	0.01
2012/04-13/03	43.7	0.3	0.26	0.24	0.28	0.22	0.25	0.19	0.05	0
2013/04-14/03	18.8	0.24	0.23	0.16	0.21	0.15	0.17	0.12	0.07	0.01
2014/04-15/03	14.1	0.21	0.24	0.1	0.19	0.09	0.14	0.09	0.06	0.01
2015/04-16/03	8.3	0.19	0.23	0.08	0.17	0.07	0.12	0.06	0.07	0.01
2016/04-17/03	10	0.18	0.23	0.07	0.16	0.06	0.13	0.06	0.06	0
2017/04-18/03	6	0.18	0.23	0.07	0.17	0.06	0.13	0.06	0.06	0
2018/04-19/03	58.2	0.31	0.28	0.23	0.27	0.18	0.26	0.19	0.04	0
2019/04-20/03	21.7	0.28	0.27	0.17	0.25	0.16	0.19	0.13	0.09	0.01
2020/04-21/03	55.2	0.34	0.28	0.29	0.32	0.26	0.28	0.23	0.07	0
2021/04-22/03	36.9	0.29	0.24	0.22	0.26	0.21	0.23	0.19	0.06	0

Notes: This table gives weighted summary statistics of the frequency of price changes at the product level for each year. In the Iranian calendar, each year starts on March 21, so each year is shown from April to March. *Inflation* is calculated based on the urban CPI (excluding housing rent) growth rate in the last month of the year. *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the frequency of price changes, respectively. *Simple Price Changes* displays the statistics without filters. *Without Sales and Subs. Price Changes* shows statistics that filter out any sales (V-shape price changes in the 1-month window) and any observation reported as substitution. *Simple Price Increases* and *Simple Price Decreases* provide statistics without any filtering out that focus on price increases and price decreases.

This[1] algorithm is based on the idea that a price is a regular price if the outlet charges it frequently in a window of time adjacent to that observation. We start by computing for each period the mode of prices in a five-month rolling window which includes prices in the previous two months, the current month, and the next two months. Then, based on the modal price in this window, we construct the regular price recursively as follows[2]:

- For initial period set the regular price equal to the modal price.
- For subsequent period, if observed price is equal to the modal price and at least one-third of prices in the window are equal to the modal price; then set the regular price equal to the modal price.
- Otherwise, set the regular price equal to the preceding period's regular price.

[1] We used the online appendix of Kehoe and Midrigan (2015) to write this paragraph.

[2] Kehoe and Midrigan (2015) provide a detailed exposition of their algorithm in the supplementary appendix available online.

Table 16: Absolute size of price changes.

Year	Inflation	Simple Price Changes Mean	Sd	Med	Without Sales and Subs. Price Changes Mean	Med	Simple Price Increases Mean	Med	Simple Price Decreases Mean	Med
2006/04-07/03	13.4	11.27	9.85	8.95	11.58	9.11	12.1	9.48	7.95	6.62
2007/04-08/03	18	12.46	8.76	9.98	12.55	10.06	12.76	10.23	7.25	5.36
2008/04-09/03	18.2	13.9	10	11.12	13.95	11.17	14.06	11.29	7.84	6.41
2009/04-10/03	10.4	12.5	9.22	9.86	12.75	10.05	13.03	10.28	6.46	5.27
2010/04-11/03	28.8	15.35	20.38	10.32	15.73	10.53	16.24	10.66	6.56	5.11
2011/04-12/03	26.5	15.38	17.37	11.41	15.82	11.53	16.2	11.77	7.26	5.26
2012/04-13/03	43.7	16.99	12.23	14.94	17.21	15.12	17.98	15.24	7.81	6.26
2013/04-14/03	18.8	15.59	13.23	12.31	15.79	12.51	16.27	12.6	7.75	5.83
2014/04-15/03	14.1	14.56	12.61	11.38	14.77	11.5	15.31	11.77	7.14	5.08
2015/04-16/03	8.3	13.04	11.06	10	13.22	10	13.59	9.98	7.32	5.32
2016/04-17/03	10	12.62	10.42	9.83	12.83	9.93	13.39	10.18	6.78	5.04
2017/04-18/03	6	12.11	9.59	9.51	12.29	9.75	12.68	9.98	6.61	4.73
2018/04-19/03	58.2	17.51	10.62	15.83	17.8	16.1	17.92	16.03	7.33	5.51
2019/04-20/03	21.7	16.64	13.5	13.79	16.41	13.88	16.99	14.19	7.85	6.5
2020/04-21/03	55.2	17.86	10.59	15.79	17.83	15.84	18.15	16.05	8.04	6.2
2021/04-22/03	36.9	17.54	10.41	15.08	17.55	14.85	18.23	15.56	6.67	5.09

Notes:This table gives weighted summary statistics of the absolute size of price changes at the product level for each year. In the Iranian calendar, each year starts on March 21, so each year is shown from April to March. *Inflation* is calculated based on the urban CPI (excluding housing rent) growth rate in the last month of the year. *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the absolute size of price changes, respectively. *Simple Price Changes* displays the statistics without filters. *Without Sales and Subs. Price Changes* shows statistics that filter out any sales (V-shape price changes in the 1-month window) and any observation reported as substitution. *Simple Price Increases* and *Simple Price Decreases* provide statistics without any filtering out that focus on price increases and price decreases.

Table 19 presents summary statistics of regular price changes[1]. This table also contains the summary reported in Table 1 to compare the behavior of regular prices and simple prices. According to table 19, the average frequency of regular price changes is 11 percent, while the average frequency of simple price changes is 24 percent. There is a smaller difference between average and median frequency of regular prices than simple prices, and median frequency is 9%. Frequency of price increases in regular has greater share than simple prices and majority of regular price changes are related to price increases.

According to table 19, the average absolute size of regular price changes is 26.74%, while for simple price changes it is 14.71%. The difference between absolute size of regular price changes and simple price changes can be seen for median size, price increases and decreases. According to Kehoe and Midrigan (2015), the mean size of regular price changes and simple price changes are 11%. Furthermore, Nakamura and Steinsson (2010b) (the

[1]Table 17 and 18 show annual summary statistics of regular price changes.

Table 17: Frequency of regular price changes.

Year	Inflation	Regular Price Change			Regular Price Increases		Regular Price Decreases	
		Mean	Sd	Med	Mean	Med	Mean	Med
2006/04-07/03	13.4	0.08	0.06	0.07	0.06	0.05	0.01	0.01
2007/04-08/03	18	0.11	0.09	0.10	0.09	0.08	0.02	0.01
2008/04-09/03	18.2	0.10	0.09	0.09	0.08	0.07	0.02	0.00
2009/04-10/03	10.4	0.08	0.07	0.07	0.06	0.05	0.02	0.01
2010/04-11/03	28.8	0.10	0.10	0.08	0.08	0.06	0.02	0.01
2011/04-12/03	26.5	0.11	0.10	0.10	0.10	0.08	0.02	0.01
2012/04-13/03	43.7	0.15	0.11	0.13	0.13	0.12	0.02	0.00
2013/04-14/03	18.8	0.12	0.09	0.11	0.10	0.08	0.02	0.01
2014/04-15/03	14.1	0.11	0.11	0.08	0.08	0.06	0.02	0.01
2015/04-16/03	8.3	0.09	0.08	0.07	0.07	0.05	0.02	0.01
2016/04-17/03	10	0.10	0.11	0.07	0.07	0.05	0.02	0.01
2017/04-18/03	6	0.09	0.09	0.07	0.07	0.05	0.02	0.01
2018/04-19/03	58.2	0.16	0.16	0.13	0.14	0.11	0.02	0.01
2019/04-20/03	21.7	0.12	0.11	0.11	0.09	0.08	0.03	0.01
2020/04-21/03	55.2	0.14	0.12	0.13	0.13	0.11	0.02	0.00
2021/04-22/03	36.9	0.11	0.13	0.08	0.09	0.06	0.01	0.00

Notes: This table gives weighted summary statistics of the frequency of regular price changes at the product level for each year. We calculate regular price changes as Kehoe and Midrigan (2015). In the Iranian calendar, each year starts on March 21, so each year is shown from April to March. *Inflation* is calculated based on the urban CPI (excluding housing rent) growth rate in the last month of the year. *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the statistics, respectively. *regular Price Changes* displays the total price changes, including price increases and decreases. *regular Price Increases* and *regular Price Decreases* provide statistics that focus on price increases and price decreases.

supplement to Nakamura and Steinsson (2008)) calculates regular price changes by Kehoe and Midrigan (2015) formula and finds that 220 out of 270 products have smaller mean size of regular price changes than simple price changes.

We can explain this difference between absolute price changes and simple price changes by referring to strategic complementarity. Nakamura and Steinsson (2010a) demonstrates that outlets consider strategic complementarity in pricing decisions, taking into account the pricing decisions of other outlets. A possible equilibrium in this environment is multi-step Pricing; if one outlet changes its price in one step and on a large scale, the others can change their prices in multi-steps and on a smaller scale and steal the market from the first outlet. Consequently, to change a price on a large scale, an outlet separates the process into multiple steps.

Kehoe and Midrigan (2015) algorithm to construct regular price achieves it by iden-

Table 18: Absolute size of regular price changes.

Year	Inflation	Regular Price Change			Regular Price Increases		Regular Price Decreases	
		Mean	Sd	Med	Mean	Med	Mean	Med
2006/04-07/03	13.4	17.33	15.79	13.26	17.94	13.53	11.94	9.15
2007/04-08/03	18	22.39	39.59	17.03	22.80	16.88	16.16	12.68
2008/04-09/03	18.2	24.84	31.92	19.13	25.83	19.85	16.72	13.25
2009/04-10/03	10.4	25.16	35.55	17.91	27.07	17.81	17.93	14.67
2010/04-11/03	28.8	27.23	36.06	18.49	27.74	18.07	17.38	13.38
2011/04-12/03	26.5	26.85	37.59	18.85	28.10	18.76	15.82	12.50
2012/04-13/03	43.7	30.07	23.33	25.96	32.25	27.13	17.30	14.79
2013/04-14/03	18.8	29.39	25.70	24.37	31.55	25.53	15.96	13.01
2014/04-15/03	14.1	22.99	19.78	18.44	24.11	18.78	16.61	13.05
2015/04-16/03	8.3	25.46	29.09	18.40	26.98	18.46	15.86	12.25
2016/04-17/03	10	24.73	27.05	18.54	25.97	18.05	17.69	14.30
2017/04-18/03	6	22.53	23.35	17.05	23.75	16.68	16.86	14.17
2018/04-19/03	58.2	32.58	26.78	27.11	34.18	28.00	19.19	16.39
2019/04-20/03	21.7	33.32	47.76	25.20	36.42	26.72	18.41	15.22
2020/04-21/03	55.2	32.93	25.73	27.96	34.06	28.16	19.20	15.50
2021/04-22/03	36.9	29.98	22.21	26.50	31.34	27.06	18.58	15.23

Notes: This table gives weighted summary statistics of the frequency of regular price changes at the product level for each year. We calculate regular price changes as Kehoe and Midrigan (2015). In the Iranian calendar, each year starts on March 21, so each year is shown from April to March. *Inflation* is calculated based on the urban CPI (excluding housing rent) growth rate in the last month of the year. *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the statistics, respectively. *regular Price Changes* displays the total price changes, including price increases and decreases. *regular Price Increases* and *regular Price Decreases* provide statistics that focus on price increases and price decreases.

tifying the modal price within a five-month window of prices. Due to this, prices in the process of changing are not recognized as regular prices. Instead, the algorithm identifies the modal price as the price that remains stable and unchanged. When we consider these points, we can say that if an outlet wants to change its price on a large scale, it prefers to do it in multiple stages, and prices set in medium steps are not unchanged. Therefore, our algorithm does not consider them as regular price and the price of first and final steps are considered as regular price. Consequently, our algorithm captures the difference between the current outlet price level and the previous outlet price level and ignores transitory prices[1].

In table 20, we show the estimation of product level fixed effects using indices with regular price indices as equation 6. This table is comparable with Table 2 and 3. Table 20,

[1]It may be that Kehoe and Midrigan (2015) is not the right regular price filter for an economy with high inflation like Iran.

Table 19: Simple vs regular frequency and absolute size of price changes during 2006-2022.

		Frequency		Size	
		Regular	Simple	Regular	Simple
Price Changes	Mean	0.11	0.24	26.74	14.71
	Sd	0.10	0.24	29.21	11.87
	Med	0.09	0.15	18.69	11.25
Price Increases	Mean	0.09	0.18	28.13	15.31
	Med	0.06	0.12	18.77	11.53
Price Decreases	Mean	0.02	0.06	16.98	7.29
	Med	0.00	0.00	13.77	5.34

Notes: This table gives weighted summary statistics of frequency and absolute size of price changes over 2006-2022 for simple price changes and regular price changes. We calculate regular price changes as Kehoe and Midrigan (2015). *Mean*, *Sd* and *Med* represent the weighted average, standard deviation and median of the statistics, respectively. *Price Changes* displays the total price changes, including price increases and decreases. *Price Increases* and *Price Decreases* provide statistics that focus on price increases and price decreases.

panel A, column 1 indicates that a 1 percentage point increase in inflation increases the frequency of regular price changes by 1.5 percentage points. It is half of the coefficient in Table 2, which is 3 percentage points. The results show that the average frequency of regular prices changes is half that of simple prices changes (Table 19) and that its sensitivity to inflation is also half. Table 20 Panel A, columns 2 and 3, as Table 2, show that the FX has a small correlation with the frequency of regular price changes, relative to the inflation coefficient (column 2), and the FX is insignificant when competing with inflation (column 3). Column 4 shows that interaction term of inflation and FX is insignificant which differ from Table 2. We control for expected inflation in columns 5-8 using Alvarez et al. (2019), and despite a different scale than Table 2, Panel A, Columns 5-8, the coefficient pattern is similar.

In Table 20, Panel B, the absolute size of regular price changes is the dependent variable. This panel is comparable to Table 3. Column 1 indicates that a 1 percentage point increase in inflation increases the absolute size of regular price changes by 1.7 percentage points. It is 45% larger than the coefficient in Table 3, which is 1.18 percentage points. In column 2, FX coefficient is insignificant, while in Table 3 this coefficient is positive and significant. Other columns of Panel B are similar to Table 3.

In general, Table 20 Panel A and B show weaker relationships between pricing behavior and FX, but the strength of relationship between regular pricing behavior and inflation is the similar to 2 and 3. We explore more complementarity evidence in Appendix C, where we examine the impact of FX lags, inflation lags, and aggregate demand on our findings.

Table 20: Regulr prices vs macro variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Dependent variable: frequency of price changes								
					Exp.inf: Alvarez et al (2019)			
Inflation (inf.)	0.015***		0.015***	0.014***	0.013***		0.013***	0.013***
	(0.0008)		(0.0007)	(0.0008)	(0.0007)		(0.0007)	(0.0006)
FX growth (fx.)		0.002***	-0.000	-0.000		0.001***	-0.000	-0.001**
		(0.0001)	(0.0001)	(0.0002)		(0.0001)	(0.0001)	(0.0002)
Inf.*fx.				0.0001				0.0001
				(0.0001)				(0.0001)
Exp.inf					0.004***	0.010***	0.004***	0.004***
					(0.0008)	(0.0010)	(0.0009)	(0.0009)
Constant	0.085***	0.109***	0.085***	0.086***	0.080***	0.091***	0.080***	0.080***
	(0.0013)	(0.0002)	(0.0013)	(0.0013)	(0.0021)	(0.0019)	(0.0022)	(0.0021)
Observations	75,693	75,693	75,693	75,693	75,693	75,693	75,693	75,693
R-squared	0.059	0.014	0.059	0.059	0.061	0.028	0.061	0.061
F test	0	0	0	0	0	0	0	0
Panel B: Dependent variable: absolute size of price changes								
					Exp.inf: Alvarez et al (2019)			
Inflation (inf.)	1.70***		2.17***	1.96***	1.57***		1.97***	1.70***
	(0.221)		(0.255)	(0.269)	(0.223)		(0.253)	(0.270)
FX growth (fx.)		0.04	-0.23***	-0.37***		-0.11***	-0.27***	-0.45***
		(0.030)	(0.034)	(0.058)		(0.022)	(0.032)	(0.059)
Inf.*fx.				0.04***				0.04***
				(0.010)				(0.011)
Exp.inf					0.32	1.53***	0.72***	0.80***
					(0.258)	(0.266)	(0.254)	(0.258)
Constant	23.80***	26.86***	23.43***	23.78***	23.39***	24.11***	22.46***	22.77***
	(0.409)	(0.066)	(0.432)	(0.458)	(0.575)	(0.525)	(0.620)	(0.621)
Observations	70,146	70,146	70,146	70,146	70,146	70,146	70,146	70,146
R-squared	0.011	0.000	0.013	0.014	0.011	0.005	0.014	0.015
F test	0	0.228	0	0	0	0	0	0

Notes: We calculate regular price changes as Kehoe and Midrigan (2015). Frequency of price changes is calculated as the proportion of outlets that change their prices (equation 2). Absolute size of price changes is calculated as the average size of price changes condition on price change occurred (equation 4). All regressions include 453 products fixed effects. *Inflation* is calculated by the growth of the urban CPI (excluding housing rent). *FX growth* shows the growth of the USD cash price at the unofficial market. Both *inflation* and *FX growth* are monthly. Heteroscedasticity-robust standard errors are reported in parentheses. Observations are weighted by the importance weight. *, **and *** significant at 10, 5, and 1 percent levels.