Monetary Regimes and Real Exchange Rates: Long-Run Evidence at the Product Level

Jason Kim[†] Marco Mello[‡] Cosimo Petracchi[§]

May 1, 2024

Abstract

Compiling a novel dataset of prices for products sold in sixteen European countries starting in 1972, we establish that monetary-regime breaks, from peg to floating regimes, increase not only the volatility of nominal exchange rates, but also the volatility of product-level real exchange rates. Our result holds for any type of products—tradables versus nontradables—although the volatility of the real exchange rates of tradables responds less to breaks than the volatility of the real exchange rates of nontradables. Overall, the law of one price is less likely to hold under floating regimes for both tradables and nontradables.

[†]Department of Economics, Brown University; jason_kim@brown.edu.
[‡]Economics Department, Business School, University of Aberdeen; marco.mello@abdn.ac.uk.
[§]Department of Economics and Finance, Tor Vergata University of Rome; cosimo.petracchi@uniroma2.eu.
Cosimo Petracchi thanks the Orlando Bravo Center for Economic Research at Brown University for financial support. We are grateful to Andrey Alexandrov, Pierpaolo Benigno, Alessandro Casini, Alberto Dalmazzo, Fernando Duarte, Gauti B. Eggertsson, Konstantin Egorov, Giampiero M. Gallo, Oded Galor, Amy Handlan, Matteo Maggiori, Pascal Michaillat, Valerio Nispi Landi, Luca Riva, Edoardo Tolva, and seminar participants at Tor Vergata University or Rome for helpful comments and insightful suggestions. We thank Amil Mumssen for outstanding research assistance. We offer particular thanks to Frank Donnelly and Emily Ferrier of the Brown University Library for their generous help and support with the project. Our analysis makes use of data that are proprietary to the Confederation of British Industry, The Economist Group, and/or their content providers. Neither the Confederation of British Industry, The Economist Group, nor their content providers are responsible for any of the views expressed in this article.

1 Introduction

This paper establishes three facts about the relationship between nominal exchange rates, domestic prices, and foreign prices, which is crucial to understand the dynamics of the real exchange rate in general equilibrium models (see, for example, Gabaix and Maggiori, 2015). First, monetary-regime breaks—from peg to floating regimes—have an impact on the volatility of real exchange rates at the product level, leaving the volatility of the relative prices unchanged. Second, the volatility of the product-level real exchange rates of tradables responds less to monetary-regime breaks than the volatility of the product-level real exchange rates of nontradables, because of a stronger negative correlation between the prices of tradables and nominal exchange rate fluctuations. Finally, the law of one price is less likely to hold under floating regimes.

One fundamental hypothesis connecting nominal exchange rates, domestic prices, and foreign prices of two countries is that of purchasing power parity (PPP). In its absolute version, the PPP hypothesis argues that the aggregate price levels of the two countries should be equal when converted into a common currency. In its relative version, the PPP hypothesis states that the changes in the aggregate price levels between the two countries should be equal when converted into a common currency. Both versions of the PPP can be empirically tested. Once a nominal exchange rate between the two countries is observed on the financial markets, it is always possible to compare the relative prices of a basket of products through the real exchange rate, which is constructed using the two countries' aggregate price levels. Indeed, deviations in the absolute and relative version of the PPP over long-run horizons are well documented both within a monetary regime—see, for instance, Froot and Rogoff (1995), Engel (1999), Burstein et al. (2005, 2006), Bache et al. (2013), and Burstein and Gopinath (2014)—and across different monetary regimes—see, for instance, Mussa (1986) and Petracchi (2022).

However, a deeper understanding of the relationship between nominal exchange rates, domestic prices, and foreign prices requires to look at cross-country product-level prices, rather than aggregate price levels. Indeed, comparing aggregate price levels across countries can be uninformative due to the different compositions of the underlying baskets of products. This implies a change of focus from aggregate price levels to product-level prices and brings to a different hypothesis, which has been studied for hundreds of years by international economists, called the law of one price (LOP).[1] The LOP says that the prices of identical products in two countries should be equal when converted into a common currency. Similarly to the PPP hypotheses, the more recent empirical literature documents deviations from the LOP over a short-run horizon, e.g. less than five years, and considering only time periods within a same monetary regime—see, for instance, Cavallo et al. (2014, 2015). Our contribution is to complement this body of research, studying how nominal exchange rates, domestic prices, and foreign prices behave over an long-run horizon, from 1972 to 2019, and when considering time periods across different monetary regimes.

[1] Karl G. Persson, from "The Law of One Price" in the EH.Net Encyclopedia: "The intellectual history of the concept can be traced back to economists active in France in the 1760-70's, which applied the "law" to markets involved in international trade."

Using the prices of twenty-five products for sixteen European countries—which include novel product-level prices for the period before the 1990—and taking nineteen monetary-regime breaks into account, we establish that monetary-regime breaks change not only the volatility of the nominal exchange rates, but also the volatility of the product-level real exchange rates. Instead, monetary-regime breaks do not affect the volatility of prices significantly.

To the best of our knowledge, there is no work offering such a long-run evidence on product-level real exchange rates across different monetary regimes. Indeed, product-level prices for a large variety of products are generally missing for time periods before the nineties. To surmount this lack of data availability, we introduce a novel dataset of prices of tradables and nontradables, which come from a booklet series published by the *Confederation of British Industry* (CBI) since January 1972. Combining this dataset with the one of the *Economist Intelligence Unit* (EIU) results in twenty-five consistent series of prices for sixteen European countries from 1972 to 2019. Figure 1 offers examples of three prices from the 1972 CBI booklet *European Living Costs Compared*.

This setting represents an ideal empirical framework to study the relationship between nominal exchange rates, domestic prices, and foreign prices and test the LOP. First, thanks to their history of economic integration starting with the *Treaty of Rome* in 1957, European countries have experienced reductions of barriers to arbitrage as no other countries in the world, culminating in the *European Single Market* in 1993, which guarantees the complete free movement of goods and the complete freedom to establish and provide services nowadays. In this context—very low or no barriers to arbitrage—product-level prices should be approximately equal when converted in a common currency. Second, prices in our dataset are at annual frequency and, given the horizon of about fifty years we are considering, firms should be able to reset them optimally at will without being constrained by long-term contracts, or other time frictions, preventing price adjustments. Third, considering time periods with nineteen monetary-regime breaks gives us the opportunity to understand how product-level exchange rates adjust in the presence of *large* changes in the volatility of nominal exchange rates. Specifically, our results suggest that passing from a peg to a floating regime involves a 5.3% increase in the annual volatility of the nominal exchange rate on average. Thus, firms should have all the incentives to reset their prices given such *large* changes in the nominal exchange rates.

Still, our analysis systematically documents persistent deviations from the LOP, especially under floating regimes when fluctuations of the nominal exchange rate are more pronounced. This finding holds regardless of the type of the product we consider, that are tradables and nontradables. However, using the prices of 220 tradables and 77 nontradables over a subperiod from 1990 to 2019, we show that tradables' real exchange rates react 0.6% less to breaks in the monetary regimes than nontradables' ones, as a result of a stronger negative correlation between the prices of tradables and nominal exchange rate fluctuations.

The rest of the paper is structured as follows. Section 2 introduces the data we use in the empirical analysis; Section 3 presents the empirical models and results; and Section 4 concludes indicating how the paper informs general equilibrium models of exchange rate determination.

FOOD

	1 kg flour	1 kg butter	1 litre cooking oil (best quality)
BELGIUM B. Fr	25.20	112	41
DENMARK D.Kr	1.60	13.60	5.10
FRANCE Fr	1.70	12.50	4.00
GERMANY (WEST) D.M.	0.70/1.00	3.80	4.50
HOLLAND F	1.60	9.60	6.0
ITALY L	180	1800	seed 600/700 olive 800/1000
NORWAY N.Kr	1.25	12.30	21.40
SPAIN Ptas	16	150	45
SWEDEN S.Kr	1.90	10.38	9.40
U.K. £	0.13	0.66	0.38

Figure 1: Food Prices from the CBI Booklet *European Living Costs Compared* of 1972

2 Data

In our analysis, we use data covering sixteen European countries—Austria, Belgium, Denmark, Finland, France, Germany (West Germany before October 1990), Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom—from 1972 to 2019. We combine four different sources of information to examine how nominal exchange rates, domestic prices, and foreign prices behave over a long-run horizon that includes time periods across different monetary regimes.

The first source is the Exchange Rates Portal of the Bank of Italy, from which we obtain the bilateral nominal exchange rates. Second, we adopt the classification of monetary regimes from Petracchi (2022) to pose the monetary regimes—peg (fixed) exchange-rate regime or floating (flexible) exchange-rate regime–for each year and country in our sample. Third, we take the product-level prices before the 1990 from the booklet series published by the *Confederation of British Industry* (CBI). The fourth data source is the *Economist Intelligence Unit* (EUI), which provides us with the product-level prices for the period from 1990 to 2019. In what follows, we discuss each data source more in detail.

2.1 Nominal Exchange Rates

We use annual bilateral nominal exchange rates, obtained by averaging monthly bilateral nominal exchange rates, in order to match the annual frequency of product prices. We download the monthly bilateral nominal exchange rates from the Exchange Rates Portal of the Bank of Italy. To obtain the bilateral nominal exchange rates for each European country f (foreign country) against Germany, which is our reference country (home country), we combine the US-dollar/Deutsche-Mark time series, and the US-dollar/euro time series after December 2001, with the various US-dollar/country-f-currency time series. If a currency was renominated—for example, the French franc in 1960—we normalize the series accordingly, in order to remove the ensuing jump.

2.2 Monetary Regimes

For all the sixteen European countries in our analysis, Petracchi (2022) establishes a classification of monetary regimes where the reference country is Germany and the monetary regimes—peg or floating exchange-rate regime—are defined for the nominal exchange rates between Germany and each of the other fifteen European countries.[2] We report the nineteen monetary-regime breaks we use in our analysis in Table A1 in the Appendix.

[2]The classification is obtained using two approaches: a narrative approach and an econometric approach. The narrative approach is based on several historical sources, whereas the econometric approach is based on two structural-break tests and a generalized autoregressive conditional heteroskedasticity (GARCH) model.

2.3 Prices from the *Confederation of British Industry* (CBI)

The *Confederation of British Industry* (CBI) published booklets to compare the living costs in sixteen European countries from 1972 to 1987.[3] These booklets reported surveyed prices of tradables and nontradables in countries' capital cities, aimed at filling "an information gap for those preparing to establish industrial or sales operations in the countries surveyed".[4] From the booklets, we extract twenty-five series of prices—eighteen tradables and seven nontradables—which we use in our analysis. Whenever the prices are reported as an interval range, we take the mid point as reference price. The overall number of price records from the *Confederation of British Industry* (CBI) used in the analysis is 5,376.

2.4 Prices from the *Economist Intelligence Unit* (EIU)

Since 1990, the *Economist Intelligence Unit* (EIU) has surveyed the prices of tradables and nontradables in several countries' cities to compare the cost of living worldwide. From this dataset, we use the prices of the same products we have from the the *Confederation of British Industry* (CBI) to construct twenty-five consistent price series from 1972 to 2019 for the sixteen European countries in our analysis.[5] For these twenty-five products, the overall number of price records from the *Economist Intelligence Unit* (EIU) used in the analysis is 11,709. In addition, we rely on EIU price time series for 272 products—202 tradables and 70 nontradables—from 1990 to 2019 to validate our results with a larger variety of products and, most importantly, to better investigate any heterogeneity between tradables and nontradables. For this additional analysis, the overall number of price records from the *Economist Intelligence Unit* (EIU) used in the analysis is 137,569.

3 Empirical Evidence

3.1 Model

Since we are interested in studying how monetary-regime breaks affect the volatility of the product-level real exchange rates, we compute the product-level real exchange rates for a wide range of products using Germany as the reference (home) country.

[3] The booklets were published yearly from 1972 to 1984 and from 1986 to 1987.

[4] The quote is from the Introduction of the 1987 CBI booklet *West European Living Costs*. In the case of Germany, the surveyed cities were Bonn from 1972 to 1978 and Cologne from 1979 to 1987; in the case of Italy, the surveyed city was Milan for the entire sample period; in the case of the Netherlands, the surveyed cities were Amsterdam from 1972 to 1976 and Hauge from 1977 to 1987; in the case of Switzerland, the surveyed city was Zurich for the entire sample period.

[5] For all the European countries, we use the prices from the capital cities with the exception of Italy (Milan) and Switzerland (Zurich) for consistency with the *Confederation of British Industry* (CBI). For the countries in our sample which introduced the euro in 1999—namely, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain—the *Economist Intelligence Unit* (EIU) reports the product prices in European Currency Unit (ECU), which was a unit of account used by the European Economic Community before the introduction of the euro, from 1990 to 1998. We covert such prices for these countries from the ECU to the local country's currency.

We define with $Q_{f,k,t}$ the product-level real exchange rate in year t between Germany (home country) and country f (foreign country), based on the prices of product k:

$$Q_{f,k,t} = E_{f,t}\frac{P^*_{f,k,t}}{P_{k,t}}. \tag{1}$$

Here, $Q_{f,k,t}$ is defined as the price of the foreign-country product k in terms of the home-country product k. $E_{f,t}$ is the nominal exchange rate, which is the amount of Deutsche marks bought by one unit of currency in country f. $P^*_{f,k,t}$ and $P_{k,t}$ denote the yearly prices in local currency of product k in country f and Germany at time t, respectively. Hence, our product-level real exchange rate is nothing but the product between the nominal exchange rate and the ratio of prices, in local currency, for product k between a given country f and Germany. We denote this ratio of prices by $\tilde{P}_{f,k,t}$, that is $\tilde{P}_{f,k,t} \equiv \frac{P^*_{f,k,t}}{P_{k,t}}$.

Taking the natural logarithm of both sides, we obtain the following:

$$q_{f,k,t} = e_{f,t} + \tilde{p}_{f,k,t}. \tag{2}$$

Here, $q_{f,k,t}$ is the natural logarithm of the product-level real exchange rate for product k, $e_{f,t}$ is the natural logarithm of the nominal exchange rate, and $\tilde{p}_{f,k,t}$ is the natural logarithm of the price ratio for product k. Then, we compute the first-difference transformation ($\Delta x_t \equiv x_t - x_{t-1}$) of Equation (2) and, formally, we can define the following relationships:

$$\Delta q_{f,k,t} = \Delta e_{f,t} + \Delta\tilde{p}_{f,k,t}. \tag{3}$$

This equation is pivotal to our analysis as it establishes, for product k, a relation between the percentage change of the product-level real exchange rate and the percentage changes of the nominal exchange rate and the price ratio. Finally, we take the absolute value of $\Delta q_{f,k,t}$ in order to measure the volatility of the product-level real exchange rate. Importantly, to remove the influence of measurement errors, we discard from our analysis any value of $|\Delta q_{f,k,t}|$ (and $|\Delta\tilde{p}_{f,k,t}|$) obtained starting from an extremely high volatility in the price ratio, that is when $|\Delta\tilde{p}_{f,k,t}|$ is higher than the 99% percentile in the overall sample distribution.[6]

Now, we are able to investigate how monetary-regime breaks impact on the product-level exchange rates, using the following specification:

$$|\Delta q_{f,k,t}| = \beta FLOATING_{f,t} + \lambda_{k,t} + \alpha_f + \alpha_f * I(t \geq 1990) + \epsilon_{f,k,t}. \tag{4}$$

[6]This removal implies a loss of 155 observations out of a total of 15,572.

The main covariate of our model is $FLOATING_{f,t}$, which corresponds to a dummy variable taking the value of one if country f had a floating monetary regime in year t. Thus, our focus of interest will be the parameter β, measuring whether and to what extent passing from a peg to a floating monetary regime affects the volatility of the product-level real exchange rates.

$\lambda_{k,t}$ is a vector of dummy variables for each product-year pair. The inclusion of $\lambda_{k,t}$ is particularly important; not only it controls for the idiosyncratic volatility of the prices of product k, but also for its evolution over time. More specifically, $\lambda_{k,t}$ controls for all possible product-specific yearly shocks to price volatility, such as the oil shocks in the seventies or the grain embargo of the 1980.

Similarly, α_f are country-level fixed effects, which we interact with a dummy variable for the 1990-2019 period—$I(t \geq 1990)$—when our price data come from the EIU dataset rather than the CBI dataset. By doing so, we account for all the unobservable country traits that separately influence the volatility of the product-level real exchange rates over our two time windows, thus also for any difference in the price collection between the EIU and CBI datasets. Finally, $\epsilon_{f,k,t}$ denotes the error term, which absorbs all the residual factors explaining the volatility of the real exchange rate.

We estimate Equation (4) by ordinary-least squares (OLS) and by clustering the standard errors at the country level, which provides us with the source of variation in our variable of interest $FLOATING_{f,t}$. However, because inference may be misleading when the number of clusters is small (MacKinnon and Webb 2017, MacKinnon and Webb 2018, Djogbenou et al. 2019), we also validate our findings via a series of wild cluster bootstrap using the procedure described in Roodman et al. (2019).

3.2 Baseline Results

We begin by providing descriptive evidence on the average volatility of the product-level real exchange rates across monetary regimes, by pooling together all the observations in our sample. This information is summarized in Figure 2, which documents a volatility of the real exchange rate *for each product* that is always higher under floating regimes than under peg regimes. Overall, the average volatility of the product-level real exchange rates in our sample is 16% under the floating regimes and 14% under the peg regimes.

Although already highlighting a difference in the real exchange rates across the two regimes, these annual averages do not account for neither country-specific heterogeneity in the volatility of the product-level real exchange rates, nor for shocks to prices in local currency. Ultimately, they risk of identifying the effects of monetary-regime breaks improperly. Indeed, these effects are better identified by Equation (4), the OLS estimates of which are provided in Table 1.

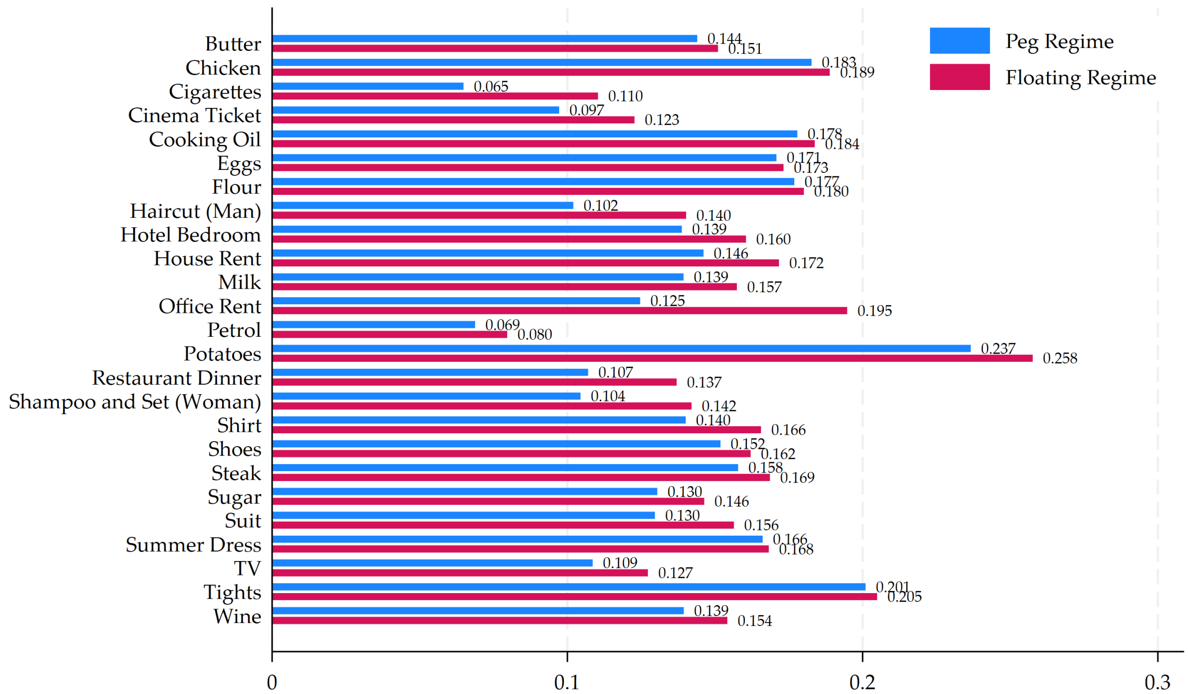

Figure 2: Average Volatility of the Product-Level Real Exchange Rates Across Monetary Regimes

Column 1 of Table 1 focuses on the effects of monetary-regime breaks, from peg regimes to floating regimes, on the volatility of the nominal exchange rate. To compute the volatility of the nominal exchange rate, we follow the same approach described in Section 3.1 and use the first difference of the natural logarithm of the nominal exchange rate in absolute value, that is $|\Delta e_{f,t}|$. Because this analysis does not involve any product price, it is performed at the country level only, relying on a total of 660 observations. For the same reason, the specification that we estimate to study the effect of monetary-regime breaks on the volatility of the nominal exchange rate relies on a single vector of country dummy variables α_f, which does not get interacted with any dummy variable for the 1990-2019 period. The coefficient associated with floating regimes is positive and statistically significant at the 1% level. This result indicates that the nominal exchange rate fluctuates much more under floating than peg regimes, a finding which is consistent with Petracchi (2022)'s classification of monetary regimes. More specifically, the annual volatility of the nominal exchange rate is 5.3% higher under floating regimes than under peg regimes.

Replicating the exercise for the volatility of the relative prices, that is $|\Delta \tilde{p}_{f,k,t}|$, does not return the same result. The coefficient of the dummy variable $FLOATING_{f,t}$, reported in Column 2 of Table 1, is in fact positive but not statistically significant at any conventional level. Hence, monetary-regime breaks appear to increase the volatility of the nominal exchange rate, but not that of the relative prices $\tilde{P}_{f,k,t}$.

	Volatility		
	Nominal Exchange Rate ($\lvert\Delta e_{h,t}\rvert$) (1)	Relative Prices ($\lvert\Delta \tilde{p}_{h,k,t}\rvert$) (2)	Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (3)
Floating Regime	0.053***	0.007	0.018**
	(0.010)	(0.007)	(0.008)
Asymptotic P-Values	0.000	0.344	0.037
Wild Boostrap P-Values	0.000	0.387	0.039
Year-Product Fixed Effects	✓	✓	✓
Country Fixed Effects	✓	✓	✓
Observations	660	15,417	15,417

Notes: The table reports the OLS estimates of the effect of monetary-regime breaks (from peg to floating regimes) on the volatility of the nominal exchange rate (Column 1), the relative prices (Column 2) and the product-level real exchange rates (Column 3). The analysis window goes from 1970 to 2019. Standard errors, clustered at the country level, are reported in parenthesis. Asymptotic p-values and p-values computed following the wild bootstrap procedure of Roodman et al. (2019), using normal weights and 9999 replications, are reported at the bottom of the table. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table 1: Results from Equation (4)

Finally, the coefficient displayed in Column 3 of Table 1 indicates that moving from peg to floating regimes translates into a higher volatility of the product-level real exchange rates. Specifically, the coefficient suggests that the volatility of the product-level real exchange rates increases by 1.8% when the monetary regime change from peg to floating. Although this effect is smaller in magnitude than that on the nominal exchange rate, it is still positive and, importantly, statistically significant at the 5% level, regardless of whether we compute p-values using the wild bootstrap procedure of Roodman et al. (2019).

Overall, the set of findings summarized by Table 1 suggests that firms may actively absorb the higher volatility of the nominal exchange rate induced by monetary-regime breaks, resulting in a significant increase in the volatility of the product-level real exchange rates only. Similar conclusions can be drawn from the results displayed in Table A2 in the Appendix, which replicates the analysis described in this section without the inclusion of the country-level fixed effects α_f (and their interactions with the 1990-2019 dummy variable) on the right-hand side of Equation (4). If anything, failing to control for cross-country heterogeneity makes the estimated effects smaller in magnitude. As robustness check, Table A3 in the Appendix reports the estimates of Equation (4) after removing one product at a time from the sample to make sure that dropping even a small proportion of our sample, that is a product, does not change our results. Again, the results are qualitatively similar to those provided in Table 1, with the (positive) effect of monetary-regime breaks on the volatility of the product-level real exchange rates that ranges from 1.7% to 1.9% on average.

3.3 Tradables and Nontradables

In this section, we focus on a period that goes from 1990 to 2019, therefore exclusively on the time series from the *Economist Intelligence Unit* (EIU), in order to investigate the robustness of our findings when computing product-level real exchange rates using a larger cross-section of 297 products. Furthermore, a larger cross-section permits us to explore the heterogeneity of our results by the type of products we consider. For instance, we investigate the implications of our empirical model—Equation (4)—when separately estimated for tradables and nontradables which, due to their different exposure to international markets, may uncover considerable and relevant heterogeneity.

Table 2 summarizes the results of these two exercises. Columns 1-3 of Table 2 report the estimates of Equation (4) using the data from the *Economist Intelligence Unit* (EIU) only. The findings are consistent with those emerging from the analysis discussed in Section 3.2. Moving from a peg to a floating regime is associated with an increase in the volatility of the nominal and the product-level real exchange rates. The estimated effect associated with the product-level real exchange rates is slightly larger in magnitude than that estimated using the twenty-five price time series from 1972 to 2019. If anything, the opposite holds for the estimated effect on the volatility of the nominal exchange rate. No significant change in volatility is again detected for the relative prices.

Columns 4 and 5 of Table 2 display the estimates of an augmented empirical specification in which the dummy variable for floating regimes has been interacted with a dummy variable for tradable products. The results of this analysis suggest that monetary-regime breaks from peg to floating regimes increase the volatility of the product-level real exchange rates, especially when the latter are computed using the prices of nontradables. Indeed, the coefficient in Column 5 of Table 2, associated with the interaction term introduced above, is negative and statistically significant at the 5% level. More specifically, the estimates provided in Table 2 suggest that, on average, the volatility of the product-level real exchange rates increases by 2.8% and 2.2% when the product-level real exchange rates are computed using the prices of nontradables and tradables, respectively. Instead, the results displayed in Column 4 of Table 2 do not document any heterogeneity in the effect of monetary-regime breaks on the volatility of relative prices, which overall appear unaffected no matter whether we put the focus on nontradables or tradables.

Similar qualitative results are provided in Table A4 in the Appendix, which replicates the same heterogeneity analysis between tradables and nontradables using the long-run horizon from 1970 to 2019. Column 2 of Table A4 still indicates that the effect of monetary-regime breaks on the volatility of the product-level real exchange rates is more pronounced for nontradables, although the limited number of products included in the baseline sample (eighteen of which are tradables and seven of which are nontradables) does not make the interaction term to be statistically significant by a small margin.[7]

[7] The asymptotic and wild bootstrap p-values associated with the interaction term are 0.11.

	Volatility				
	Results from Equation (4)			Tradables versus Nontradables	
	Nominal Exchange Rate ($\lvert\Delta e_{h,t}\rvert$) (1)	Relative Prices ($\lvert\Delta \tilde{p}_{h,k,t}\rvert$) (2)	Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (3)	Relative Prices ($\lvert\Delta \tilde{p}_{h,k,t}\rvert$) (4)	Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (5)
Floating Regime	0.051***	0.008	0.023**	0.008	0.028***
	(0.012)	(0.006)	(0.008)	(0.006)	(0.009)
Floating Regime * Tradable				0.000	-0.006**
				(0.002)	(0.002)
Year-Product Fixed Effects	✓	✓	✓	✓	✓
Country Fixed Effects	✓	✓	✓	✓	✓
Observations	435	119,964	119,964	119,964	119,964

Notes: The table reports the OLS estimates of the effect of monetary-regime breaks (from peg to floating regimes) on the volatility of the nominal exchange rate (Column 1), the relative prices (Column 2) and the product-level real exchange rates (Columns 3-5). The analysis window goes from 1990 to 2019. Standard errors, clustered at the country level, are reported in parenthesis. Significance levels are based on asymptotic p-values and denoted as follows: * 0.1; ** 0.05 *** 0.01.

Table 2: Results Using 297 Products from the *Economist Intelligence Unit* (EIU)

By highlighting a more pronounced effect of monetary-regime breaks on the volatility of the product-level real exchange rates of nontradables, the findings provided in this section indicate that the prices of tradables are likely to respond more to monetary-regime breaks than the prices of nontradables. However, this response of the prices of tradables is not strong enough to compensate the corresponding fluctuations in the nominal exchange rate and make the LOP to hold. In the remainder of this section, we attempt to formally test this hypothesis.

We estimate the following specification using the entire sample and for each monetary regime separately:

$$\Delta \tilde{p}_{f,k,t} = \theta_1(\Delta e_{f,t} * NT_k) + \theta_2(\Delta e_{f,t} * T_k) + \lambda_{k,t} + \alpha_f + u_{f,k,t}. \tag{5}$$

Again, $\Delta \tilde{p}_{f,k,t}$ and $\Delta e_{f,t}$ denote the percentage changes in the relative prices and nominal exchange rate, respectively. NT_k is a dummy variable for nontradables, whereas T_k is a dummy for tradables. $\lambda_{k,t}$ and α_f are the country and year-product dummy variables defined by Equation (4). Finally, $u_{f,k,t}$ is the error term. θ_1 and θ_2 are our parameters of interest, as they identify how the relative prices respond to a fluctuation in the nominal exchange rate, respectively for nontradables and tradables.

According to the LOP, θ_1 and θ_2 should be negatively signed and close to one in magnitude, because any fluctuation in the nominal exchange rate should be offset by an opposite fluctuation in the relative prices. The estimated values of θ_1 and θ_2 are graphically summarized by Panel A of Figure 3, whereas the full set of estimates is provided in Table A5 in the Appendix. Consistently with our baseline results, under floating regimes the prices of tradables present a more pronounced response to nominal exchange rate fluctuations. Indeed, $\hat{\theta}_2$ is significantly negative, whereas $\hat{\theta}_1$ is statistically indistinguishable from zero. Specifically, we find that a 1% increase in the nominal exchange rate under floating regimes is associated with just a 0.08% negative adjustment of the price ratio of tradables.[8] Instead, the estimated values of $\hat{\theta}_1$ and $\hat{\theta}_2$ under peg regimes are imprecise for both tradables and nontradables.

[8]The Wald test in Column 2 of Table A5 (Panel A) confirms that the difference between $\hat{\theta}_1$ and $\hat{\theta}_2$ is statistically significant at the 1% level.

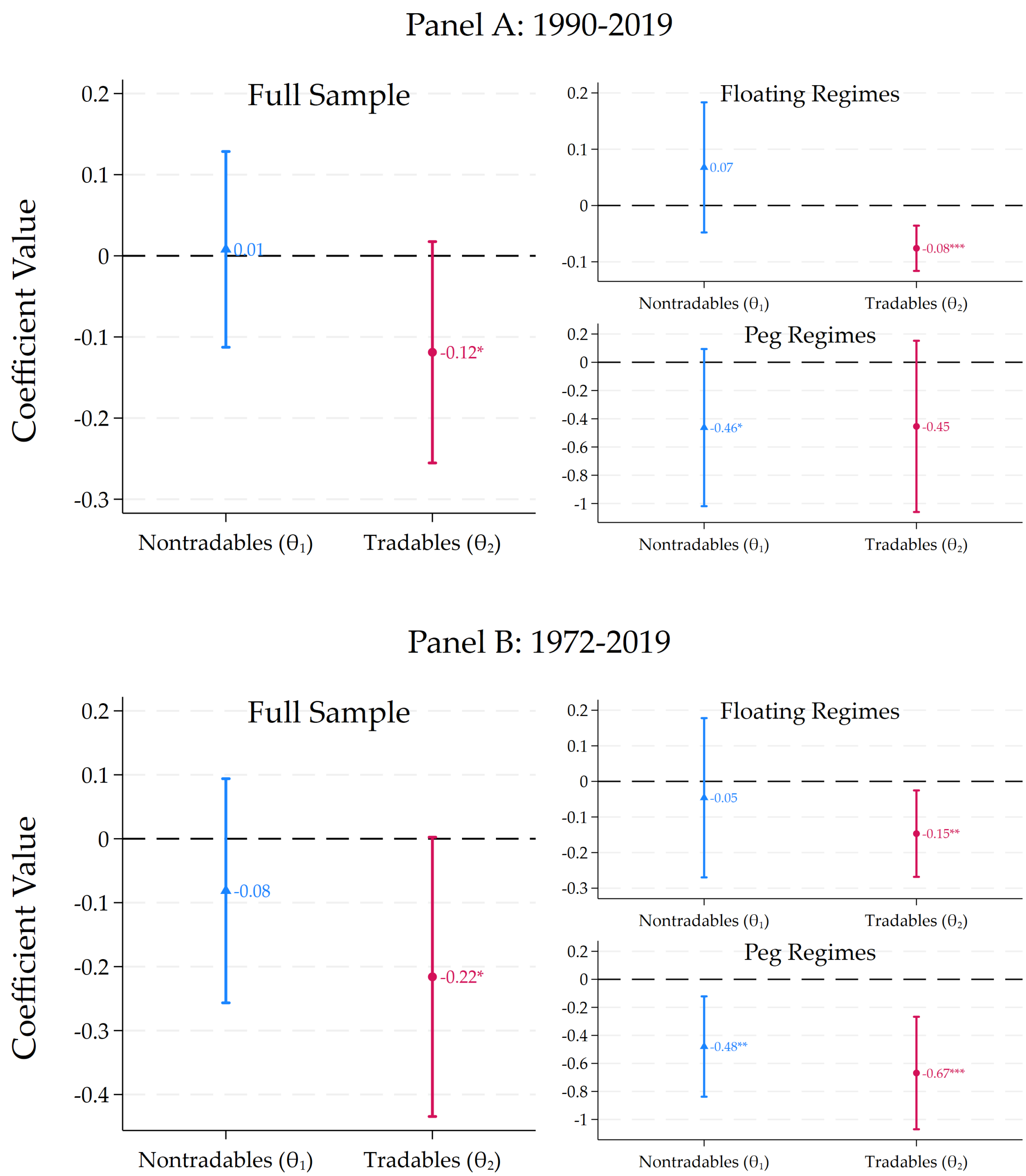

Figure 3: Estimates of θ_1 and θ_2 with 95% Confidence Intervals from Equation (5)

This finding is not surprising, since the analysis window going from 1990 to 2019 comprises only few time periods under peg regimes beyond those that followed the introduction of the euro, which has established a currency union among member states, with no fluctuations in the nominal exchange rate $\Delta e_{f,t}$.

For this reason, we perform the same exercise over the long-run horizon from 1972 to 2019. Although coming at the cost of a smaller set of tradables and nontradables, this alternative analysis sample is characterized by more time periods under peg regimes, different from a currency union, and therefore by a greater variability in $\Delta e_{f,t}$ that is crucial to estimate θ_1 and θ_2 more precisely.[9]

The point estimates of θ_1 and θ_2, obtained using the long-run horizon, are provided in Panel B of Figure 3. $\hat{\theta_1}$ and $\hat{\theta_2}$ are now always negative. Moreover, our results still indicate a stronger response of the relative prices of tradables, which is now statistically different from that of nontradables under peg regimes.

Finally, both panels of Figure 3 suggest that the response of prices to a fluctuation in the nominal exchange rate is generally larger in magnitude under peg regimes. Hence, the LOP is less likely to hold under a floating regime than under a peg regime, that is when the fluctuations of the nominal exchange rate are less pronounced and, therefore, potentially easier to absorb by the firms, especially if they sell tradable products.[10] Indeed, this result complements the findings of Cavallo et al. (2014, 2015), which shows that prices deviate from the LOP outside of a currency union, even when the nominal exchange rate is peg.

4 Conclusions

This paper uses a novel dataset including product-level prices for the period from 1972 to 2019 to study how monetary-regime breaks affect the volatility of the real exchange rates at the product level. We find that monetary-regime breaks, from peg to floating regimes, increase the volatility of real exchange rates at the product level. This result appears stronger when the product-level real exchange rates get computed using the prices of nontradables only. These facts are consistent and complement the existing literature on monetary regimes and deviations from the LOP, which in our analysis fails to hold especially in floating regimes. Still, they leave unanswered the fundamental question on how we should model these phenomena in general equilibrium models of exchange rate determination.

Ceteris paribus, monetary-regime breaks that leave the volatility of relative prices unchanged also imply constant volatility of the allocations of final consumers. This result is in line with the Backus and Smith (1993) puzzle, that is the zero (or negative) empirical comovement between the consumption difference across countries and the real exchange rate. This puzzle contradicts the prediction of complete-market models saying that, with full risk sharing, consumption difference across countries should perfectly correlate with the real exchange rate. For instance, two assumptions to replicate deviations from the LOP and the Backus and Smith (1993) puzzle in a theoretical model are local currency pricing (LCP) and imperfect international financial markets à la Gabaix and Maggiori (2015).[11]

[9] Importantly, when estimating Equation (5) over the period 1972 to 2019, we interact the country dummy variables—α_f—with a dummy variable for the period from 1990 to 2019 as done in Equation (4).

[10] Another reason why the LOP might be more likely to hold under a peg regime is a "credibility" channel. If firms believe that the peg regime implemented by the central bank is fully credible, their price setting decisions are somehow tied to the nominal exchange rate target of the central bank, which is public information among agents.

[11] Local currency pricing (LCP) implies that prices of tradables are set in the currency of final consumers.

A natural conjecture following this reasoning is that firms, and in particular exporters if one assumes LCP, are the model agents which absorb the nominal exchange rate fluctuations coming from international financial markets under floating regimes. Indeed, using a dataset of Belgian exporters for the period 2000–2008, Amiti et al. (2014) empirically shows that exporters manage to not transmit nominal rate shocks to prices within a monetary regime, thanks to variable markups and operational hedging. As shown by Petracchi (2024), these two channels—in addition to LCP and imperfect international financial markets—are crucial to match the dynamics of macro variables in a general equilibrium model of exchange rate determination even across different monetary regimes.

However, there is no empirical study quantifying the importance of these two channels across different monetary regimes since such analysis requires granular firm-level data on price setting decisions over a long-run horizon. We leave these considerations for future work.

References

Amiti, Mary, Oleg Itskhoki, and Jozef Konings, "Importers, exporters, and exchange rate disconnect," *American Economic Review*, July 2014, *104* (7), 1942–78.

Bache, Ida W., Tommy S., and Kjersti N. Torstensen, "Revisiting the importance of non-tradable goods' prices in cyclical real exchange rate fluctuations," *European Economic Review*, 2013, *57*, 98–107.

Backus, David K. and Gregor W. Smith, "Consumption and real exchange rates in dynamic economies with non-traded goods," *Journal of International Economics*, 1993, *35* (3), 297–316.

Burstein, Ariel and Gita Gopinath, "International prices and exchange rates," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4, Elsevier, 2014, pp. 391–451.

_ , Martin Eichenbaum, and Sergio Rebelo, "Large devaluations and the real exchange rate," *Journal of Political Economy*, 2005, *113* (4), 742–784.

_ , _ , and _ , "The importance of nontradable goods' prices in cyclical real exchange rate fluctuations," *Japan and the World Economy*, 2006, *18* (3), 247–253.

Cavallo, Alberto, Brent Neiman, and Roberto Rigobon, "Currency unions, product introductions, and the real exchange rate," *The Quarterly Journal of Economics*, 2014, *129* (2), 529–595.

_ , _ , and _ , "The price impact of joining a currency union: evidence from Latvia," *IMF Economic Review*, 2015, *63*, 281–297.

Djogbenou, Antoine A., James G. MacKinnon, and Morten Ø. Nielsen, "Asymptotic theory and wild bootstrap inference with clustered errors," *Journal of Econometrics*, 2019, *212* (2), 393–412.

Engel, Charles, "Accounting for U.S. real exchange eate changes," *Journal of Political Economy*, 1999, *107* (3), 507–538.

Froot, Kenneth A. and Kenneth Rogoff, "Perspectives on PPP and long-run real exchange rates," in Gene M.Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 3, Elsevier, 1995, pp. 1647–1688.

Gabaix, Xavier and Matteo Maggiori, "International liquidity and exchange rate dynamics," *The Quarterly Journal of Economics*, 03 2015, *130* (3), 1369–1420.

MacKinnon, James G. and Matthew D. Webb, "Wild bootstrap inference for wildly different cluster sizes," *Journal of Applied Econometrics*, 2017, *32* (2), 233–254.

— **and** — , "The wild bootstrap for few (treated) clusters," *The Econometrics Journal*, 2018, *21* (2), 114–135.

Mussa, Michael, "Nominal exchange rate regimes and the behavior of real exchange rates: Evidence and implications," *Carnegie-Rochester Conference Series on Public Policy*, 1986, *25*, 117–214.

Petracchi, Cosimo, "The Mussa puzzle: A generalization," *European Economic Review*, 2022, *149*, 104222.

— , "The macro neutrality of exchange-rate regimes in the presence of exporter-importer firms," *Working Paper*, 2024.

Roodman, David, Morten Ø. Nielsen, James G. MacKinnon, and Matthew D. Webb, "Fast and wild: Bootstrap inference in Stata using boottest," *The Stata Journal*, 2019, *19* (1), 4–60.

A Appendix

Country	Breaks
Austria	No Break *Peg Exchange Rate Regime*
Belgium	No Break *Peg Exchange Rate Regime*
Denmark	No Break *Peg Exchange Rate Regime*
Finland	February 12, 1973 *Breakdown of the Bretton Woods System*
	January 1, 1999 *Introduction of the Euro*
France	November 20, 1978 *Introduction of the Exchange Rate Mechanism*
Greece	February 12, 1973 *Breakdown of the Bretton Woods System*
	July 1, 1985 *Accession to the Exchange Rate Mechanism*
Ireland	November 20, 1978 *Exit from the Snake*
	August 2, 1993 *Loosening of the Exchange Rate Mechanism*
	January 1, 1999 *Introduction of the Euro*
Italy	February 13, 1973 *Exit from the Snake*
	November 20, 1978 *Introduction of the Exchange Rate Mechanism*
	September 17, 1992 *Exit from the Exchange Rate Mechanism*
	November 25, 1996 *Re-accession the Exchange Rate Mechanism*
Netherlands	No Break *Peg Exchange Rate Regime*
Norway	December 12, 1978 *Exit from the Snake*
Portugal	February 12, 1973 *Breakdown of the Bretton Woods System*
	November 10, 1987 *Accession to the Exchange Rate Mechanism*
Spain	February 12, 1973 *Breakdown of the Bretton Woods System*
	January 1, 1999 *Introduction of the Euro*
Sweden	August 28, 1977 *Exit from the Snake*
Switzerland	February 12, 1973 *Breakdown of the Bretton Woods System*
United Kingdom	No Break *Floating Exchange Rate Regime*

Table A1: Monetary-Regime Breaks

	Volatility		
	Nominal Exchange Rate ($\lvert\Delta e_{h,t}\rvert$) (1)	Relative Prices ($\lvert\Delta \tilde{p}_{h,k,t}\rvert$) (2)	Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (3)
Floating Regime	0.042***	0.010	0.017**
	(0.007)	(0.007)	(0.007)
Asymptotic P-Values	0.000	0.144	0.024
Wild Boostrap P-Values	0.000	0.148	0.012
Year-Product Fixed Effects	✓	✓	✓
Country Fixed Effects	✗	✗	✗
Observations	660	15,417	15,417

Notes: The table reports the OLS estimates of the effect of monetary-regime breaks (from peg to floating regimes) on the volatility of the nominal exchange rate (Column 1), the relative prices (Column 2) and the product-level real exchange rates (Column 3). The analysis window goes from 1970 to 2019. All the specifications do not include country fixed effects among the set of control variables. Standard errors, clustered at the country level, are reported in parenthesis. Asymptotic p-values and p-values computed following the wild bootstrap procedure of Roodman et al. (2019), using normal weights and 9999 replications, are reported at the bottom of the table. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A2: Results from Equation (4) without Country Fixed Effects

	Volatility			
	Relative Prices ($\lvert\Delta\tilde{p}_{h,k,t}\rvert$) (1)		Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (2)	
Excluded Product:				
Butter	0.007	(0.008)	0.018^{**}	(0.008)
Chicken	0.006	(0.007)	0.017^{**}	(0.008)
Cigarettes	0.008	(0.007)	0.018^{**}	(0.007)
Cinema Ticket	0.009	(0.007)	0.019^{**}	(0.008)
Cooking Oil	0.007	(0.007)	0.017^{**}	(0.008)
Eggs	0.006	(0.008)	0.017^{**}	(0.008)
Flour	0.007	(0.007)	0.019^{**}	(0.007)
Haircut (Man)	0.006	(0.008)	0.017^{**}	(0.008)
Hotel Bedroom	0.009	(0.007)	0.019^{**}	(0.008)
House Rent	0.007	(0.007)	0.017^{*}	(0.008)
Milk	0.008	(0.007)	0.018^{**}	(0.008)
Office Rent	0.008	(0.007)	0.018^{**}	(0.007)
Petrol	0.006	(0.007)	0.017^{**}	(0.008)
Potatoes	0.008	(0.007)	0.018^{**}	(0.008)
Restaurant Dinner	0.007	(0.007)	0.017^{**}	(0.008)
Shampoo and Set (Woman)	0.007	(0.008)	0.017^{**}	(0.008)
Shirt	0.007	(0.007)	0.017^{**}	(0.008)
Shoes	0.006	(0.007)	0.017^{**}	(0.008)
Steak	0.006	(0.007)	0.017^{**}	(0.008)
Sugar	0.009	(0.007)	0.019^{**}	(0.008)
Suit	0.007	(0.007)	0.017^{**}	(0.008)
Summer Dress	0.006	(0.007)	0.017^{**}	(0.008)
TV	0.007	(0.007)	0.017^{**}	(0.007)
Tights	0.007	(0.008)	0.018^{**}	(0.008)
Wine	0.007	(0.007)	0.017^{*}	(0.008)
Year-Product Fixed Effects	✓		✓	
Country Fixed Effects	✓		✓	

Notes: The table reports the OLS estimates of the effect of monetary-regime breaks (from peg to floating regimes) on the volatility of the relative prices (Column 1) and the product-level real exchange rates (Column 2) after excluding one product at a time from the analysis. The analysis window goes from 1970 to 2019. Standard errors, clustered at the country level, are reported in parenthesis. Significance levels are based on asymptotic p-values and denoted as follows: * 0.1; ** 0.05 *** 0.01.

Table A3: Results from Equation (4) Removing One Product at a Time

	Volatility	
	Relative Prices ($\lvert\Delta\tilde{p}_{h,k,t}\rvert$) (1)	Real Exchange Rates ($\lvert\Delta q_{h,k,t}\rvert$) (2)
Floating Regime	0.009	0.023**
	(0.008)	(0.008)
Floating Regime * Tradable	-0.003	-0.007
	(0.004)	(0.004)
Year-Product Fixed Effects	✓	✓
Country Fixed Effects	✓	✓
Observations	15,417	15,417

Notes: The table reports the OLS estimates of the effect of monetary-regime breaks (from peg to floating regimes) on the volatility of the relative prices (Column 1) and the product-level real exchange rates (Column 2). The analysis includes 18 tradables and 7 nontradables and goes from 1972 to 2019. Standard errors, clustered at the country level, are reported in parenthesis. Significance levels are based on asymptotic p-values and denoted as follows: * 0.1; ** 0.05 *** 0.01.

Table A4: Tradables versus Nontradables from 1972 to 2019

	ΔRelative Prices ($\Delta\tilde{p}_{h,k,t}$)		
	Full sample	Floating Regimes	Peg Regimes
	(1)	(2)	(3)
Panel A: Analysis window 1990-2019			
ΔNominal Exchange Rate * Nontradables (θ_1)	0.008	0.068	-0.463*
	(0.056)	(0.049)	(0.250)
ΔNominal Exchange Rate * Tradables (θ_2)	-0.119*	-0.076***	-0.454
	(0.064)	(0.017)	(0.272)
Wald test (H_0: $\theta_1 = \theta_2$)			
F-statistic	13.87	13.22	0.01
P-value	0.002	0.008	0.932
Year-Product Fixed Effects	✓	✓	✓
Country Fixed Effects	✓	✓	✓
Observations	119,964	38,421	81,502
Panel B: Analysis window 1972-2019			
ΔNominal Exchange Rate * Nontradables (θ_1)	-0.081	-0.046	-0.480**
	(0.082)	(0.100)	(0.164)
ΔNominal Exchange Rate * Tradables (θ_2)	-0.216*	-0.147**	-0.669***
	(0.102)	(0.054)	(0.184)
Wald test (H_0: $\theta_1 = \theta_2$)			
F-statistic	4.97	1.74	4.80
P-value	0.043	0.217	0.049
Year-Product Fixed Effects	✓	✓	✓
Country Fixed Effects	✓	✓	✓
Observations	15,416	5,899	9,512

Notes: The table reports the OLS estimates of θ_1 and θ_2 in Equation 5, measuring the response of the relative prices to a 1% increase in the nominal exchange rate for nontradables and tradables, respectively. The analysis window goes from 1990 to 2019 in Panel A and from 1972 to 2019 in Panel B. In Panel B, the country fixed effects are interacted with a dummy variable for the period from 1990 to 2019. Standard errors, clustered at the country level, are reported in parenthesis. Significance levels are based on asymptotic p-values and denoted as follows: * 0.1; ** 0.05 *** 0.01.

Table A5: Results from Equation (5)