Inflation and Trade Deficits in U.S. Agriculture: The Minor Role of Exchange Rates in the Aggregate*

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Abstract

In the United States, exchange rate fluctuations do not drive the bulk of aggregate fluctuations in import prices, import volumes, the trade balance, producer prices, or consumer prices, for the agricultural sector or for the economy as a whole. Exchange rates affect these variables in other countries, but the unique role of U.S. dollar in the global trade network attenuates the relationship between exchange rates and U.S. markets and trade of agricultural products. Even within the United States, exchange rates may impact the prices and trade of particular commodities, but these effects dissipate when data are aggregate to the sector- or country-level. The loose connection between exchange rates and agricultural trade and markets suggests that the appreciation of the U.S. dollar would not significantly contribute to the deterioration in the U.S. trade balance, either in agriculture or economy-wide, and any further dollar appreciation is unlikely to significantly attenuate food inflation or general inflation.

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Introduction

In the United States, annual inflation hit a historic 40-year high in 2022[1], reflecting price increases among most major consumer goods including daily household necessities. Food prices increased particularly quick outpacing all major consumption categories other than transportation. At the same time, the U.S. dollar greatly appreciated against other currencies throughout 2022, continuing a trend beginning in 2012. Historically, economists have identified exchange rates as an important factor impacting domestic inflation[2]. Exchange rate pass-through measures the transmission of exchange rate movements to domestic prices. This study extends this literature by estimating the connection between the high inflation observed during the COVID-19 pandemic and exchange rate appreciation, both in agriculture and in the broader general U.S. economy.

In addition to being linked to inflation, (Carter and Pick, 1987) also drew and association between exchange rate movements and trade balances. The U.S. trade balance in agriculture has been trending downward in recent years. For the first time in the Agency's history, the U.S. Department of Agriculture (USDA) forecasted an agricultural trade deficit for the fiscal year 2023 (Kenner et al., 2022). The trade deficit in the broader U.S. economy also rose sharply near the end of 2022. These developments are widely attributed in part to a stronger dollar along with slowing global demand. We extend our analysis to identify this relationship and quantify the impact of exchange rates on the U.S. trade balance.

In this report, we evaluate the extent to which exchange rates impact inflation by investigating whether movements in the real exchange rate index, calculated using trade-weighted bilateral exchange rates for the United States, are passed through into domestic prices at the border, producer, and consumer stage by analyzing the impact of exchange rates on import prices, the producer price index (PPI), and the consumer price index (CPI), respectively. We then investigate to what extent exchange rates affect the trade balance by estimating the impact of changes in the real exchange

[1] According to the Bureau of Labor Statistics, U.S. Department of Labor (2022*b*,*c*), prices overall increased 9.1 percent over the last 12 months since June 2022, the largest increase since 1981, while prices for food peaked at 13.4 percent since August 2022, the largest increase since 1979.

[2] During the period of low inflation from 1983–2019, much of the literature focused on correlating import prices with exchange rates to help explain the coexistence of low inflation and economic expansion. A significant portion of the decline in U.S. inflation in the late 1990s is attributed to the disinflationary impacts of exchange rate appreciation and import price deflation.(Mccarthy, 2007).

rate index on changes in the U.S. trade ratio and import quantities for agriculture and the general economy. We focus on agriculture and food prices and agricultural trade due to the fact that U.S. food price inflation significantly affects household budgets, particularly among lower-income households and the already food insecure, and agriculture plays a disproportionate role in U.S. trade[3].

In examining exchange rate pass-through into prices, we focus our efforts on aggregate domestic price indices because previous studies investigating exchange rate pass-through into specific agricultural crops or inputs mostly find evidence of low (Baquedano and Liefert, 2014) or mixed (Gervais and Khraief, 2007) exchange rate pass-through. We investigate whether previous product-specific findings of low exchange rate pass-through hold in agriculture more broadly by analyzing the pass-through of an agricultural trade-weighted exchange rate index into two broad agricultural price indices—the prices received index from the National Agricultural Statistics Service (NASS) and the food Consumer Price Index (all-food CPI). We examine changes over time in exchange rate pass-through, from 1970 to 2022, using rolling window regressions, as well as regressions computed separately for different four-year time bins. We control for changes in wages or producer prices, depending on the specification, following standard practice in the literature (Burstein and Gopinath, 2014). In regards to examining the impact of exchange rates on the trade balance, we also use rolling window regressions to capture changes in the effects over time.

Our estimates of exchange-rate pass-through into the food CPI, the agricultural prices received index, and the agricultural import index are often not significantly different from zero throughout the sample period. To compare these agricultural findings with those of the general economy, we estimate the exchange rate pass-through of a U.S. trade-weighted exchange rate index into import prices, producer price index, and consumer price index and also find low pass-through. These findings follow empirical results from previous macroeconomic literature (Burstein and Gopinath, 2014). Our estimates of the impact of exchange rate movements on the trade balance are also mostly low or not significantly different from zero. These findings suggest that changes in the real

[3]In the United States in 2020, imports of agricultural goods were 14.3 percent of total agricultural GDP, compared with 10.8 percent for imports of non-agricultural goods as a percent of total non-agricultural GDP. Source: authors' calculations using data from the U.S. Bureau of Economic Analysis (2021), and the Trade Profile for the United States from the World Trade Organization (2021)

exchange rate index are unlikely to impact domestic prices at the aggregate level, regardless of the border, producer, or consumer stage. Furthermore, these changes are also unlikely to impact the aggregate trade balance.

Our findings of low or insignificant pass-through, while perhaps surprising, are not inconsistent with the current literature. Low exchange rate pass-through for developed countries, especially the United States (Goldberg and Knetter, 1997, Mccarthy, 2007) has been explained through various mechanisms. Parsley and Popper (1998) argue that low observed pass-through is due in part to endogenous responses by central banks to exchange rate fluctuations. Gopinath, Itskhoki and Rigobon (2010) emphasize the fact that many international transactions are priced in U.S. dollars, and hence are unaffected by changes in U.S. exchange rates. Moreover, until recently, inflation was low for most developed countries, and one important implication of a broad class of menu cost models is that in a low-inflation environment, firms have little incentive to change prices in response to most shocks, including shocks to exchange rates (Jašová, Moessner and Takáts, 2016). Similarly, Bailliu, Dong and Murray (2010) attribute low pass-through in the U.S. to low and stable inflation and credible monetary policy. They also argue that greater openness of the U.S. economy leads to increased competition among retailers, including additional foreign retailers, which leads to low pass-through as retailers absorb fluctuations into their profit margins.

Historical Overview of Exchange Rates in the U.S. Economy

Most countries, including the United States, currently allow for floating exchange rates, meaning the value of one currency against another is allowed to fluctuate due to market forces. However, this has not always been the case. From 1879 until 1976, the United States and many other countries followed the gold standard, meaning the U.S. dollar and other currencies were directly convertible to a fixed quantity of gold (Cooper, 1982). In 1944 this was formalized internationally under the Bretton Woods system, in which the value of the U.S. dollar was pegged at 35 dollars per ounce of gold, and other currencies were pegged to the dollar (Kenen, 2008).

This system allowed for predictable exchange rates, but by the late 1960s, there were concerns in the United States about a growing trade deficit, increasing inflation, and declining gold reserves. In response, under President Nixon, the United States unilaterally announced in August 1971 a suspension of the U.S. dollar's convertibility to gold (Lehrman, 2011). In order for other countries to coordinate a response to this change in policy, representatives of each of the world's major economies convened in December 1971 at the Smithsonian Institution in Washington, D.C. They reached an agreement, known as the Smithsonian Agreement, in which the value of currencies was allowed to fluctuate in response to market forces, but only within a certain range (specifically, 2.25 percent) of agreed-upon values (Harrod, Wonnacott and Pierce, 2023).

However, this agreement gradually broke down, and by 1973, most countries were allowing for freely floating exchange rates. This was formalized in 1976 in the Jamaica Accords, which marked the formal end of the gold standard around the world and allowed for the value of currencies to freely fluctuate under market forces (Halm, 1977). This system is still in place today. It is often called a managed float regime because even though currency fluctuations are mostly driven by markets, the U.S. Federal Reserve and other central banks can still influence exchange rates by buying or selling currencies or adjusting interest rates (Frankel, 2017). Indeed, recently in the United States, inflation concerns have prompted the Federal Reserve to raise interest rates. Since March 2022, the Fed has announced 10 consecutive rate hikes, the most recent one in May 2023, which will bring the federal funds rate to more than 5%. While these interest rate hikes are aimed at reducing inflation, they also can cause movements in the real exchange rate. In particular, in theory, these increases in the interest rate, in the absence of other effects, would raise demand for the dollar in the foreign market, causing the dollar to appreciate and the real exchange rate index to increase.

Theory: Effects of Exchange Rates on Prices and Trade

Changes in countries' exchange rates can substantially change the prices of goods faced by producers and consumers and affect incentives to export and import goods. However, these exchange rate changes might not be completely transmitted into domestic prices, due to trade policies or market imperfections. This transmission, which is often known as exchange-rate pass-through, is defined as the extent to which a change in exchange rates translates into a change in domestic prices.

In the absence of policy distortions or market imperfections, pass-through of exchange rate fluctuations into domestic prices of imported goods is complete—meaning, for example, that a 10% stronger U.S. dollar translates into U.S. imports being 10% cheaper. On the other hand, incomplete pass-through would mean that a 10% stronger dollar translates into a less than 10% decrease in prices.

If there were complete pass-through from changes in exchange rates to prices, we could define the domestic price of the exported good by the equation

$$P^d = P^w * X, \tag{1}$$

where P^w is the world price of the good, X is the exchange rate, and P^d is the domestic price of the good. If P^d did not equal $P^w * X$, we would say that there is incomplete pass-through from exchange rates into domestic prices.

We can also measure the degree of pass-through by computing the pass-through elasticity and measure the degree to which a change in the exchange rate is passed through into domestic prices. This equation is defined as the percent change in the domestic price divided by the percent change in the exchange rate:

$$P^E = \%\Delta P^d / \%\Delta X \tag{2}$$

where X is the exchange rate, P^d is the domestic price, and P^E is the pass through elasticity. If the elasticity is 1, then we can say there is complete pass-through. If the elasticity is 0, we would say instead that there is no pass-through, and if the elasticity is between 1 and 0, we could say that there is incomplete pass-through.

To illustrate this theory with an example, assume that $P^d = \$50$. Then, suppose that X increases from 1 to 3. We can calculate $\%\Delta X = 200\%$. If P^d were to increase to \$150, then $\%\Delta P^d = 200\%$ such that $P^E = 1$ and we have complete pass-through. If instead, say P^d were only to increase to \$100, then $\%\Delta P^d = 100\%$ such that $P^E = 0.5$ and we would say that pass through is incomplete but not zero.

For indices of U.S. consumer or producer prices, we would expect exchange rate pass-through to be incomplete, due to the relatively small fraction of imported U.S. goods.

Given how real exchange rates can impact domestic prices, they can also have impacts on trade volumes. In theory, an appreciation of a country's currency is expected to increase the country's imports, decrease its exports, and hence decrease its trade balance (and vice versa for a depreciation of the country's currency). The reasoning behind this is that as the currency becomes stronger, exports become relatively more expensive to other countries, while imports become relatively cheaper, prompting import quantities to increase and export quantities to decrease, which decreases the trade balance. Carter and Pick (1987) discuss this theory in the context of U.S. agriculture, noting that the relationship between exchange rates and agricultural trade could be diminished due to tariffs and other trade barriers.

Exchange Rate Pass-Through into Commodity Prices

A number of studies examine the relationship between exchange rate fluctuations and agricultural trade, including pass-through of exchange rates into agricultural prices, in the context of specific crops or inputs into agricultural production. For example, Gervais and Khraief (2007) find that exchange rate fluctuations have significant effects on prices and quantities of Canadian pork imports from the U.S. and Japan.

Most of the literature, however, finds pass-through to be low or finds that the evidence is mixed. Baquedano and Liefert (2014) provide evidence of low transmission of changes in exchange rates into urban market prices of wheat, rice, maize, and sorghum in a number of developing countries. Luckstead (2018) finds that, on average, fluctuations in exchange rates do not have a significant effect on U.S. cocoa import volumes, although he finds a mix of significant and insignificant effects when allowing for asymmetries across trading partners and asymmetries between dollar appreciation vs. depreciation. Nakamura and Zerom (2010) estimate marginal cost pass-through in the U.S. coffee industry, which they argue allows for direct inferences on exchange rate pass-through.

They find pass-through to be small (around one-tenth) in the short run, and still incomplete (but larger, around one-third) in the long run (six quarters). Wiseman, Luckstead and Durand-Morat (2021) find, in general, low exchange rate pass-through in the rice industry in Southeast Asia, attributing this to the prevalence in their empirical setting of non-profit-maximizing state trading enterprises. Xu and Orden (2002) look at exchange rate pass-through in the U.S. and Canada for five agricultural outputs (wheat, soybeans, corn, and feeder and slaughter steers) and four inputs (fertilizer, pesticides, oil, and machinery). They find larger pass-through for outputs than for inputs, with no significant pass-through for farm machinery. Yeboah, Shaik and Allen (2009) estimate pass-through of U.S.-Mexico exchange rates into U.S. prices of four agricultural inputs (fertilizer, chemicals, machinery, and feed). They find that pass-through is limited for all four inputs, even after four quarters.

The fact that prior estimates of crop- and input-specific estimates of exchange rate pass-through are mostly but not always low raises the question of whether this may hold true at the aggregate level. In this study, we provide evidence that suggests that it does, by examining pass-through into general indices of agricultural prices.

Empirical Studies of Exchange Rates and Trade Volumes

The empirical literature so far has found mixed results regarding the relationship between the real exchange rate and trade volumes for a country, often depending on the country studied and the type of model used. Among the studies that fail to find significant effects, Miles (1979) examines 16 episodes of currency devaluations for 14 countries in the 1960s and finds no significant effect on trade balances. Rose and Yellen (1989), Rose (1990), and Rose (1991) find no effects of real exchange rate fluctuations on trade balances in the short or long run for the U.S., developing countries, and five OECD countries, respectively. Kharroubi (2011) examines the effect of real effective exchange rates on trade balances for 20 OECD countries over the period 1985–2008. They find the effects are insignificant when country-fixed effects are included.

Some empirical studies, however, do indeed find significant impacts of exchange rate fluctuations on exports, imports, and trade balances, in line with theoretical predictions. Gopinath, Pick and Vasavada (1998) find that a 1% rise in the real value of the U.S. dollar is associated with a 0.13% fall in U.S. food processing exports as a share of GNP. Baek, Koo and Mulik (2009) fail to find any significant effects in the short run, but they do find a positive and significant long-run effect of dollar depreciation on the U.S.'s agricultural trade balance with its 15 major trading partners. Chinn (2004) finds "borderline significant" effects of exchange rate fluctuations on U.S. imports but larger effects on exports. Boz, Gopinath and Plagborg-Møller (2017) find that changes in exchange rates have significant effects on import volumes for countries in general, but with the U.S. being a stark exception. They estimate that the contemporaneous impact of a 1% depreciation of the dollar is a 0.003% increase in U.S. imports, whereas the effect is much larger for other countries. They argue this discrepancy is due to the dominance of dollar invoicing in U.S. trade. Haynes and Stone (1982) use level data with import value divided by the export value and find that exchange rate devaluation improves the trade balance.

More recent studies look at how the exchange rate impacts the trade balance using a nonlinear approach and find asymmetric effects in which the trade balance is positively impacted by a real depreciation of the exchange rate, while appreciation does not have a significant effect. Arize, Malindretos and Igwe (2017) look at the impact of the real exchange rate on eight countries using several nonlinear techniques including the nonlinear auto-regressive distributed lag model (NARDL) and find that depreciation has significant positive effects on the trade balance.

Data

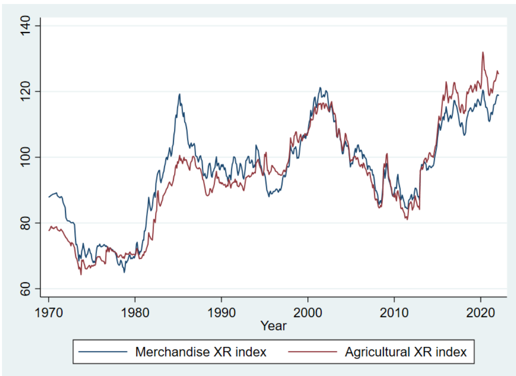
To measure the change in exchange rates relevant to the U.S. economy, we follow the standard approach to look at an index of bilateral exchange rates weighted by import volume for agricultural or general goods. The exchange rates are defined as the foreign currency per unit of U.S. currency. The import indices come from the Economic Research Service, United States Department of Agriculture (2022) Agricultural Exchange Rate Data Set for Real Monthly Commodity Exchange Rates. We use the importer-weighted agricultural exchange rate index for agricultural goods and the competitor-weighted merchandise exchange rate index for all goods. The data product does not include an importer-weighted index for merchandise; the competitor-weighted index is the closest substitute. Export-weighted exchange rate indices for both agriculture and merchandise and competitor-weighted agricultural exchange rate index are also available in the data set and used in subsequent robustness checks.

To measure changes in domestic prices, we use price indices for agricultural and general goods. We use price indices at three stages, the import price index at the border stage, Producer Price Index (PPI) for the producer stage, and the Consumer Price Index (CPI) for the consumer stage, all with agricultural and general specifications. We use data on agricultural and general import price indices from the Bureau of Labor Statistics, U.S. Department of Labor (2023). The general import price data are from the Imports, All Commodities series, while the agricultural import price data are from the Imports - Foods, Feeds, and Beverages series. The agricultural PPI is an index for prices received for approximately 100 livestock and crop commodities, published by the National Agricultural Statistics Service, United States Department of Agriculture (2022) (NASS). The data for general PPI, general CPI, and food CPI come from the Bureau of Labor Statistics, U.S. Department of Labor (2022*a*). PPI measures the producer price index commodity data for all commodities, not seasonally adjusted. For general CPI, the CPI-U measures the average change in prices over time for all items in the U.S. city average, all urban consumers, not seasonally adjusted. For agricultural CPI, the food CPI is the closest match. Food CPI measures all food items in the U.S. city average, all urban consumers, not seasonally adjusted.

We include wage data for some regressions as a control variable, following specifications from Burstein and Gopinath (2014). For economy-wide wage data, we use the data series Compensation of Employees, Received: Wage and Salary Disbursements (U.S. Bureau of Economic Analysis, retrieved from FRED, Federal Reserve Bank of St. Louis, 2022). The data is in units of billions of dollars and seasonally adjusted annual rate and provided at a monthly frequency. Agricultural wages come from the National Agricultural Statistics Service.

Data on the dollar value of U.S. agricultural imports are from the U.S. Department of Agriculture, Economic Research Service (2023), taken from the data series "Total value of U.S. agricultural trade and trade balance, monthly.” The data on the dollar value of U.S. imports for all general goods are from the U.S. Department of Commerce, Bureau of the Census (2023), taken from the data series “Trade in Goods with World, Seasonally Adjusted.”

All of the data used in the regressions have a monthly frequency.



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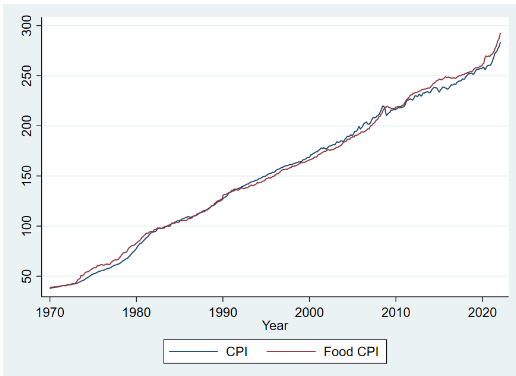

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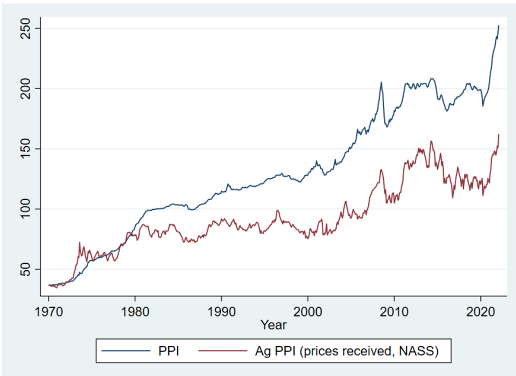

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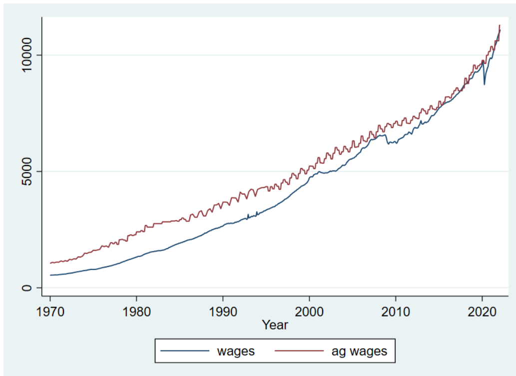

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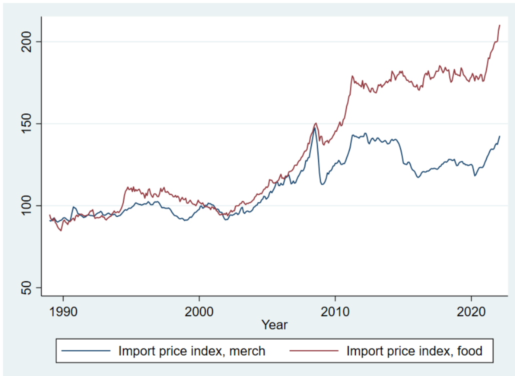
Figure 1: *Plots of the variables in our regressions, all for the United States: CPI, food CPI, PPI, wages (from FRED), wages in agriculture (from NASS), agricultural PPI (the prices received index from NASS), and the USDA's merchandise (merch) and agricultural (ag) exchange rate indices.*



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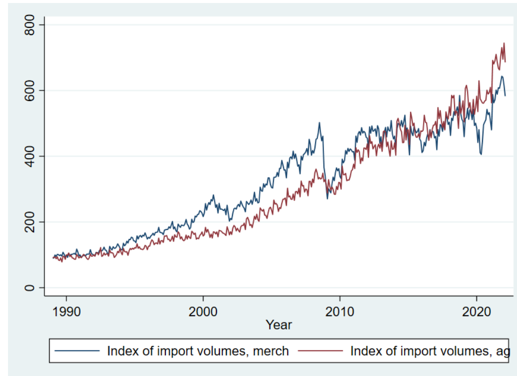

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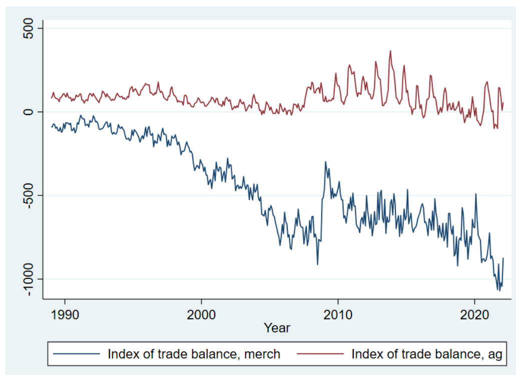

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Figure 2: *Plots of the variables in our regressions, all for the United States: import price indices (from BLS) and trade volumes and balances for agricultural goods and for all goods (from the USDA and the Census, respectively).*

Figures 1 and 2 plot each of the variables used in our analysis. The agricultural and merchandise exchange rate indices move in tandem with each other over the medium term, but their short-run fluctuations vary from one another. CPI and Food CPI both increase steadily over our sample time period. PPI and agricultural PPI also increase steadily, with similar fluctuations, although agricultural PPI increases at a lower rate. Producer prices are more volatile than consumer prices, suggesting that shocks to firms' costs (including exchange rate shocks) do not pass through entirely into consumer prices. Wages and agricultural wages both increase steadily over the years, growing very close together, particularly for the last 5-10 years of our data. There has been no trend upward in the index of merchandise import prices since 2010, while the index of agricultural import prices has continued to increase. The dollar value of imports has increased for both agricultural goods and general goods throughout our data period. The U.S. has had a trade deficit during this entire period, and it has been increasing over time. In agriculture, however, the U.S. has had a trade surplus during most of this period, although in recent years there have been occasional monthly deficits recorded, and the year 2023 marks the first year in which the USDA has ever projected an agricultural trade deficit.

Methodology

Our baseline methodology for estimating pass-through is to use rolling regressions since these allow for changes over time in the estimated amount of pass-through, which some previous literature has found. In particular, some recent studies suggest that exchange rate pass-through is declining over time, particularly in regards to pass-through into import prices or for developing countries (Marazzi et al., 2005, Bailliu, Dong and Murray, 2010)). Jašová, Moessner and Takáts (2016) find that pass-through after the 2008 financial crisis decreased in emerging economies due to declining inflation, and remained low and stable for advanced economies. However, Campa and Goldberg (2005, 2006) find increases over time in the pass-through of exchange rates into consumer prices, due to increases in the usage of imported inputs.[4]

Rolling regressions of the following form are estimated using a rolling window of ten years:

$$\Delta p_t = \alpha + \sum_{k=0}^{T} \beta_k \Delta e_{t-k} + \gamma \Delta X_t + \epsilon_t \quad (3)$$

where α is the constant, Δp_t denotes log changes in a U.S. domestic price index (CPI, food CPI, PPI, or NASS prices received index), Δe_{t-k} denotes log changes in a U.S. real exchange rate index (merchandise or agricultural), and ΔX_t denotes log changes in a control variable (PPI, NASS prices received index, wages, or agricultural wages). In our baseline specification, $T = 11$; that is, one year of lagged log changes in exchange rates are included, consistent with specifications from prior

[4]This echoes earlier work that compared across industries and found that exchange rate pass-through is higher in industries that rely more on imported inputs (Feinberg, 1986, 1989).

literature (Burstein and Gopinath (2014)). $\hat{\beta}_0$ is our estimate of short-run (that is, contemporaneous) pass-through, while $\sum_{k=0}^{T} \hat{\beta}_k$ captures long-run pass-through.

In order to examine economy-wide pass-through, the merchandise exchange rate index is the independent variable when the dependent variable is CPI or PPI. In order to examine pass-through within agriculture, the agricultural exchange rate index is the independent variable when the dependent variable is the food CPI or the NASS prices received index.

In order to examine pass-through into consumer prices, PPI is used as a control variable when the dependent variable is CPI, and the NASS prices received index is used as a control variable when the dependent variable is food CPI. In order to examine pass-through into producer prices, economy-wide wages are controlled for when the dependent variable is PPI, and agricultural wages are controlled for when the dependent variable is the NASS prices received index.

For robustness, we also run regressions in which the data are separated into different time bins, as an alternative to a rolling window. These regressions take the following form:

$$\Delta p_t = \sum_{h=1}^{H} \mathbb{1}\{t \in \tau_h\}[\alpha_h + \sum_{k=0}^{T} \beta_{hk} \Delta e_{t-k} + \gamma_h \Delta X_t] + \epsilon_t \tag{4}$$

where the time span of the data is divided into H equal-sized bins, with the set τ_h denoting the hth bin in chronological order, and the rest of the notation is the same as above. For each span of time captured by bin h, $\hat{\beta}_{h0}$ is our estimate of short-run pass-through, while $\sum_{k=0}^{T} \hat{\beta}_{hk}$ is our estimate of long-run pass-through.

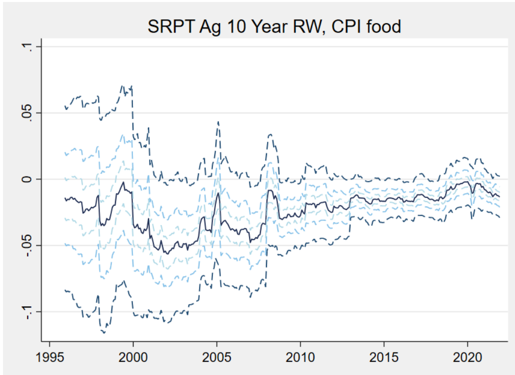
Results: Exchange Rate Pass-Through to Prices and Impact on Trade

Exchange Rates and Inflation: Consumer Price Indices

As mentioned previously, U.S. inflation hit a 40-year high in 2022, driven by price increases for many daily necessities including food, transportation, and housing. Between the mid-1980s and up until 2019 before the pandemic hit, inflation remained relatively low compared to the era of the 1970s and early 1980s, despite economic expansion and low unemployment levels often associated with higher inflation. Along with the appreciation of the U.S. dollar—as can be seen in the exchange rate indices plotted in Figure 1, we think it is important to examine the possible connection between the two trends by estimating the pass-through of exchange rate movements into measures of the U.S. CPI.

Exchange rate pass-through has long been a topic of intense interest from academics, forecasters, and policymakers(Mccarthy, 2007). Low pass-through indicates a lack of efficiency in international trade (Liefert and Persaud, 2009), but allows for greater scope for domestic monetary policy effectiveness (Campa and Goldberg, 2005). With the U.S. dollar continuing to appreciate, an important question is the extent to which this dollar appreciation curbs inflation, measured by changes in the consumer price index (CPI). High exchange rate pass-through would indicate a stronger U.S. dollar and, therefore, cheaper imports would lead to disinflation due to the substitution from domestic goods to imported goods. Conversely, incomplete or zero exchange rate pass-through would lead to small to no changes in domestic prices and inflation despite a stronger dollar.

For the analysis of pass-through into prices, we invert the exchange rate index in our data so that a higher value implies a weaker dollar. If this inverted index correlates with higher import prices, we will see a positive coefficient. A positive estimate would imply the existence of a positive pass-through, in which a weaker currency is being transmitted into higher domestic prices.



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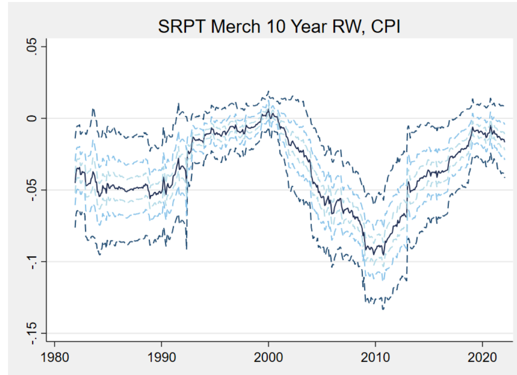

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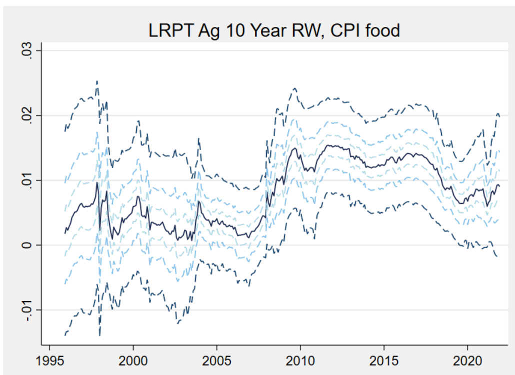

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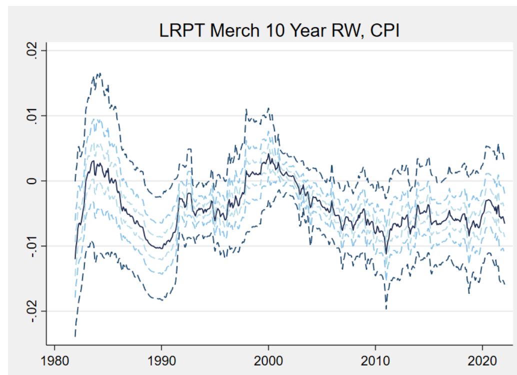

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Figure 3: *Short run (contemporaneous) and long run (one year) pass-through using 10-year rolling window regressions, with one-year lags, for the U.S. merchandise and agricultural real exchange rate indices, monthly data, and log differencing all variables. Controls changed according to dependent variables: PPI for CPI and NASS prices received index for food CPI. Dashed lines are 95%, 66%, and 33% confidence intervals, with standard errors calculated using the Newey-West (1987) HAC estimator. Note that if the pass-through from real exchange rates into domestic prices is* β*, the implied pass-through from nominal exchange rates into domestic prices is* $\frac{\beta}{1-\beta}$.

Figure 3 plots our baseline estimates of exchange rate pass-through, using rolling regressions with a 10-year rolling window, the specification of these regressions given in Equation 3. Note that on the right-hand side of each of these regressions, log changes in a real exchange rate index are used, and if the pass-through from real exchange rates into domestic prices is β, the implied pass-through from nominal exchange rates into domestic prices is $\frac{\beta}{1-\beta}$. This means that in the specification given by Equation 3, complete pass-through corresponds to a β of 0.5. All of this can be derived using the equation that relates real to nominal exchange rates:

$$R \equiv N(P^d/P^f) \tag{5}$$

where R is the real exchange rate, N is the nominal exchange rate, P^d is a domestic price index, and P^f is a foreign price index.

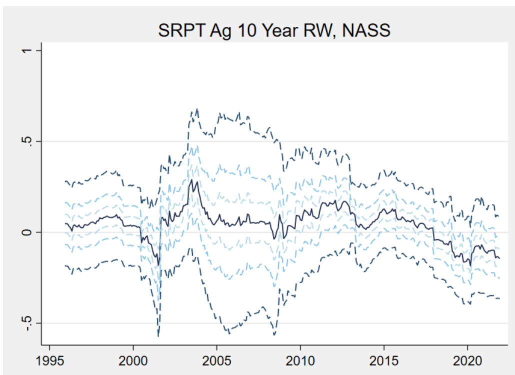
We begin with our analysis of the agricultural CPI. Short-run pass-through of the U.S. agricultural real exchange rate index into the food CPI is plotted in Figure 3a. We are unable to reject the null hypothesis that pass-through is zero at the 5% significance level throughout most of the sample period, except for a few months during which the 95% confidence interval dips slightly below zero. These estimates imply that higher foreign prices and a weaker dollar may not lead to higher measures of food inflation in the short run. In addition, we do not find any instance of complete pass-through throughout the entire sample period as the confidence interval never rises above 0.1 or drops below -0.2, so complete pass-through is rejected throughout the entire sample period.

Figure 3c plots our estimates of long-run (one year) pass-through from the U.S. agricultural real exchange rate index to the food CPI. From 1995 to 2009, pass-through was not statistically different from zero, implying again that a weaker dollar may not lead to higher food prices in the long run either. From 2009 onwards, pass-through estimates are statistically significantly positive, but still very small, between 0.005 and 0.015, implying that there is slight price transmission into higher food prices when the dollar is weaker.

Next, we analyze the pass-through of exchange rate movements into the general CPI. Short-run pass-through of the U.S. merchandise real exchange rate index into the general CPI is plotted in Figure 3b. Our estimate of pass-through is slightly statistically significantly below zero during the 1980s, statistically indistinguishable from zero during the 90s, then gradually decreases during the 2000s and increases during the 2010s, reaching a trough of around -0.1 during 2010. Complete pass-through is rejected throughout the entire sample period.

Long-run pass-through from the U.S. merchandise real exchange rate index to the CPI is plotted in Figure 3d. The estimates are not statistically significantly different from zero during most months, except for a few months in which the estimate is statistically significantly below zero, but very small in magnitude (never greater than 0.01 in absolute value). These estimates imply that movements in the exchange rate for the most part do not lead to changes in general inflation measures.

Exchange Rates and Inflation: Producer Price Indices



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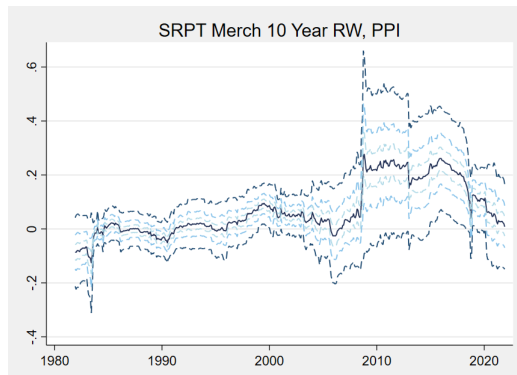

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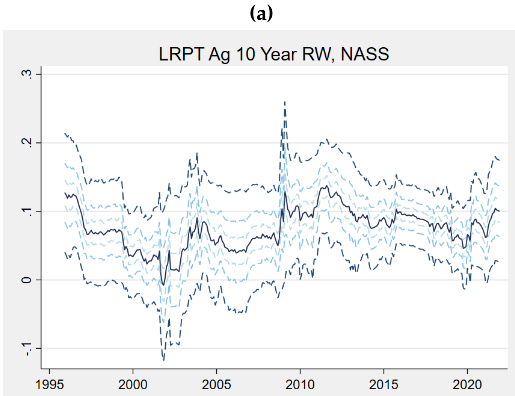

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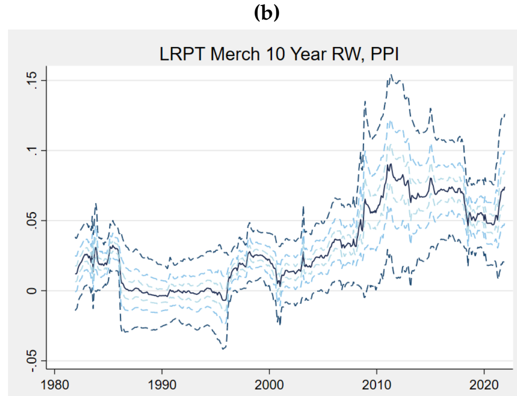


(d)

Figure 4: *Short run (contemporaneous) and long run (one year) pass-through using 10-year rolling window regressions, with one-year lags, for the U.S. merchandise and agricultural real exchange rate indices, monthly data, and log differencing all variables. Controls changed according to dependent variables: wage for PPI and ag wages for the NASS price index. Dashed lines are 95%, 66%, and 33% confidence intervals, with standard errors calculated using the Newey-West (1987) HAC estimator. Note that if the pass-through from real exchange rates into domestic prices is* β*, the implied pass-through from nominal exchange rates into domestic prices is* $\frac{\beta}{1-\beta}$.

Following our estimates of exchange rate pass-through into CPI, we estimate the pass-through into producer price indices, for both agriculture and the general economy. Our estimates are shown in figure 4 for both short-run and long-run specifications.

Figure 4a plots short-run pass-through from the U.S. agricultural real exchange rate index into the agricultural prices received index from NASS. Our estimates are statistically indistinguishable from zero throughout the entire sample period, meaning that exchange rate movements may not lead to changes in the PPI either. However, the 95% confidence interval is consistently wide enough that we cannot rule out sizable pass-through for most of the sample period. In fact, during the mid-2000s we cannot rule out complete pass-through (which, as noted above, corresponds to $\beta = 0.5$).

In figure 4c, our estimates of long-run pass-through are significantly positive at the beginning of the sample period in the 1990s, statistically indistinguishable from zero in the 2000s, and positive again after around 2010 for most of the sample period. The implication is that pass-through into the agricultural PPI may be for the most part either none or very low.

Short-run pass-through from the U.S. merchandise real exchange rate index to the PPI is plotted in Figure 4b. Our estimates are statistically indistinguishable from zero during most of the sample period, except during 2016 when the lower bound of the 95% interval is around 0.1. We can rule out complete pass-through during most of the sample period, the exception being 2009 when pass-through spikes upward.

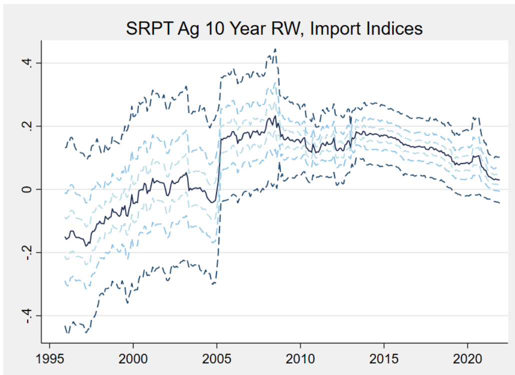
Long run pass-through for the U.S. merchandise real exchange rate index into the PPI in figure 4d follows a similar trend to the prior long run pass-through estimates, with some significantly positive estimates but mostly estimates that are statistically indistinguishable from zero prior to 2010, and statistically significant and positive estimates afterward until the end of the sample period. Overall, we again find that the pass-through of exchange rates into the general PPI is either zero or very slight.

Exchange Rate Pass-Through into Border Prices: Import Price Indices

We next estimate the exchange rate pass-through into import price indices, using the same methodology as in section with import price indices on the left-hand side of the regressions rather than domestic price indices, and with the same exchange rate indices on the right-hand side, without any control variables. Figure 5 plots our regression estimates of both short-run and long-run pass-through of exchange rate indices into import price indices. In general, pass-through estimates are either not statistically significant or slightly positive, indicating low or no pass-through.

Figure 5a plots estimates for short-run pass-through of the agricultural exchange rate index into the food import prices. From the beginning of the sample period in 1995, the estimates are not statistically significant from zero, up until around 2007, where the estimates are slightly positive, ranging around 0.2 until becoming statistically insignificant again around 2020. This means that for a brief period, where the coefficient is estimated at 0.2, we see about 20% pass-through of fluctuation in the agricultural real exchange rate index pass into food prices. In other words, for every 10% increase in the inverse of the agricultural real exchange rate index, there is about a 2% corresponding increase in import prices for food, and a weaker dollar is leading to higher foreign prices to increase the import prices for food. The longer-run pass-through trend, shown in figure 5c, shows a similar dynamic, although the magnitude is less. In the long run during that similar period of time, for every 10% increase in the inverse index, there is only about a 0.5% increase in food import prices, with the beginning and ending periods of the sample period showing statistically insignificant correlation.

For the general economy, figure 5b plots the estimates of short-run pass-through. The results are mostly statistically insignificant except for a very brief period in which the pass-through estimates dip slightly negative. In the long run, plotted in figure 5d, pass-through is mostly insignificant for much of the early sample period until around 2015, when pass-through estimates are slightly positive, hovering between 0.05 and 0.1 values. Overall, the insignificant estimates where we do not reject the hypothesis of a zero coefficient suggest that changes in the real exchange rate index may lead to no changes in import prices, until the positive estimates later in the sample period that presents evidence of a slight increase in general import prices when the inverse exchange rate index rises.



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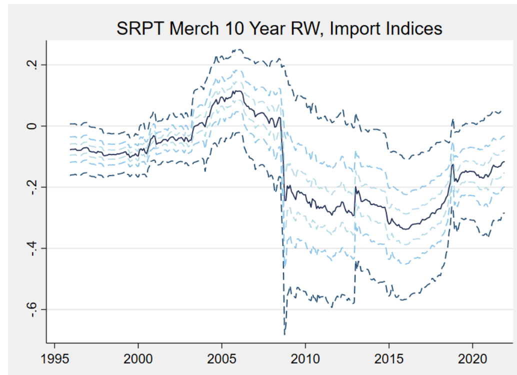

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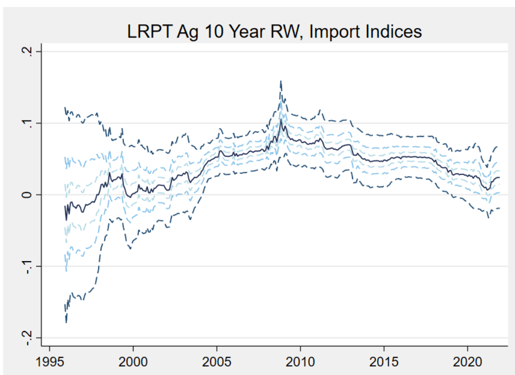

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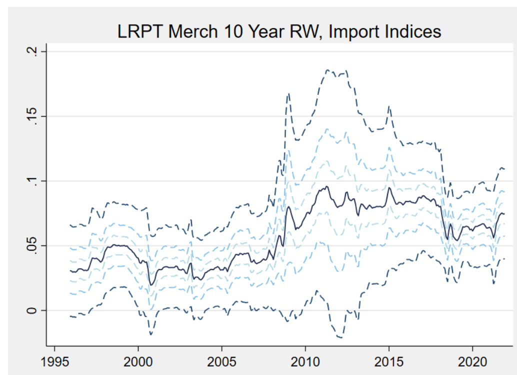


(d)

Figure 5: *Short run (contemporaneous) and long run (one year) pass-through into import price indices, using 10-year rolling window regressions with one-year lags, using the U.S. merchandise and agricultural real exchange rate indices, monthly data, and log differencing all variables. Dashed lines are 95%, 66%, and 33% confidence intervals, with standard errors calculated using the Newey-West (1987) HAC estimator. Note that if the pass-through from real exchange rates into domestic prices is* β*, the implied pass-through from nominal exchange rates into domestic prices is* $\frac{\beta}{1-\beta}$.

Relation of Exchange Rates to Trade Volumes: Imports and the Trade Deficit

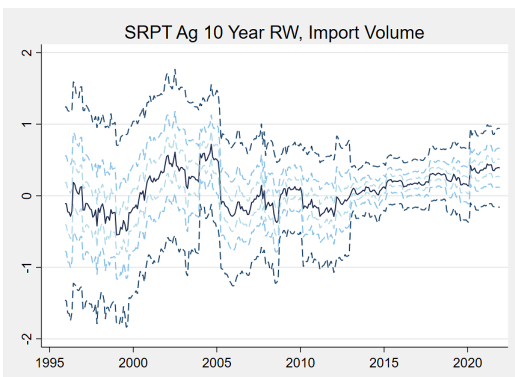
As can be seen in Figure 2, the United States has long had an economy-wide trade deficit. While the U.S. has traditionally been a major agricultural net exporter, the country has recently been trending toward a trade deficit even in agriculture. This has attracted significant attention from policymakers, and the United States has various programs aimed at increasing the agricultural trade balance. This includes the Farm Bill, which was last signed in 2018 and is undergoing revisions for 2023. This bill, among many other objectives, aims to increase the trade balance by reauthorizing several export market development programs and export credit guarantee programs. Under the export market development programs, with annual mandatory funding of $255 million through the fiscal year 2023, the largest funded program is the market access program to help build commercial markets for U.S. agricultural exports. The 2018 farm bill also included other provisions aimed at developing overseas markets and addressing non-tariff barriers, all of which aim to increase exports and raise the trade balance.

In this section, we examine the effects of fluctuations in the value of the dollar on U.S. trade volumes, using the same methodology as before − with measures of U.S. trade volumes on the left-hand side of the regressions rather than prices − with one difference. In particular, unlike the previous sections analyzing pass-through into prices, in which we invert the exchange rate indices so that positive pass-through into prices corresponds to positive estimates, in this section we use the non-inverted exchange rate indices for ease of interpretability. An increase in the exchange rate index corresponds to the U.S. dollar becoming more valuable. A positive coefficient would imply that a stronger dollar would be associated with either a greater volume of imports or a larger trade balance.

Figure 6 reports estimates of the short-run and long-run correlation between exchange rate indices and the total nominal dollar value of U.S. imports, within agriculture and economy-wide. Throughout the sample period, these correlations are not statistically significantly different from zero. This means that we are not finding any evidence that changes in the real exchange rate have an impact on the dollar value of U.S. imports.

Figure 7 presents estimates of the short-run and long-run correlation between exchange rate indices and the dollar value of the U.S. trade ratio, within agriculture and economy-wide. The trade ratio is calculated as the logarithm of export values minus the logarithm of import values and provides an alternative measure to the trade balance, which would generate negative logarithmic values. As with all variables throughout our analysis, this log of the balance is first-differenced.

Throughout the sample period, we do not reject the null hypothesis that the estimated coefficient is equal to zero. Thus, movements in the real exchange rate also may lead to no impact on the dollar value of the U.S. trade ratio. The results show one exception to the zero estimates for the more recent years, in which the contemporaneous correlation between the U.S. merchandise exchange rate index and the economy-wide trade balance is instead negative, meaning that a stronger dollar is associated with a lower trade balance, or a higher trade deficit. This could potentially be a result of higher import values and is consistent with predictions from economic theory.



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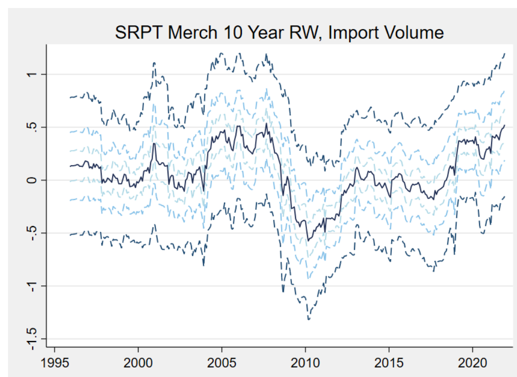

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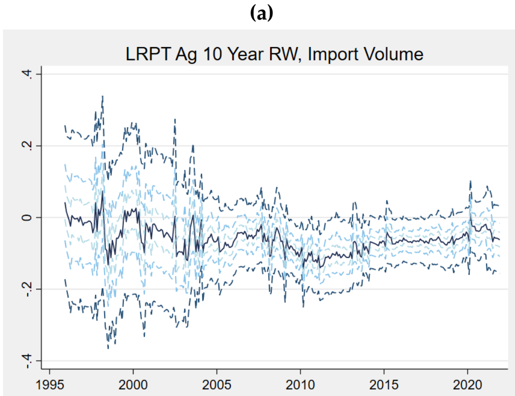

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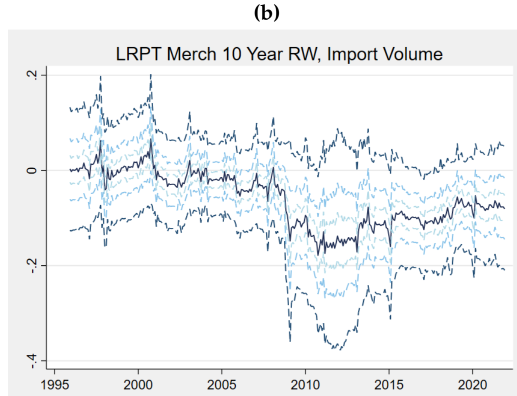

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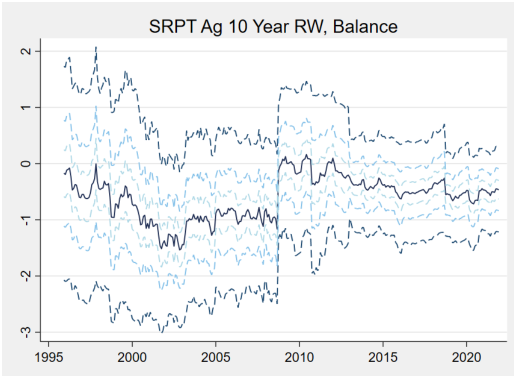
Figure 6: *Short run (contemporaneous) and long run (one year) correlation between exchange rates and import volumes, using 10-year rolling window regressions with one-year lags, using the U.S. merchandise and agricultural real exchange rate indices, monthly data, and log differencing all variables. Dashed lines are 95%, 66%, and 33% confidence intervals, with standard errors calculated using the Newey-West (1987) HAC estimator.*



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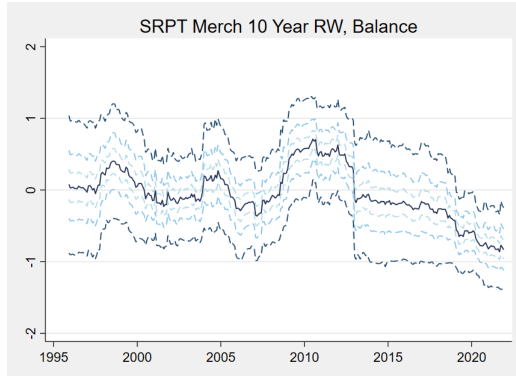

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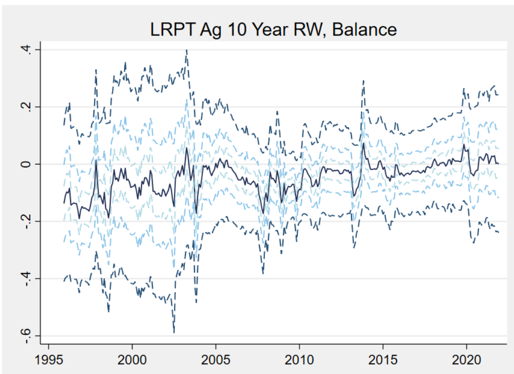

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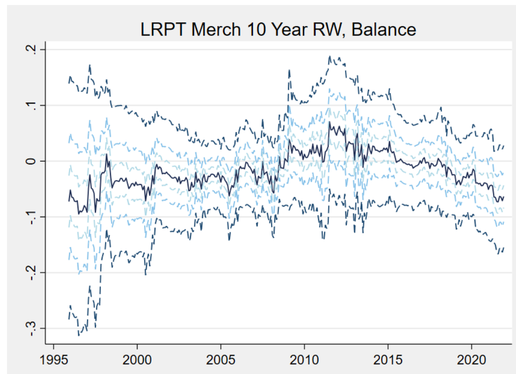

(d)

Figure 7: *Short run (contemporaneous) and long run (one year) correlation between the logarithm of exchange rates and the U.S. trade balance in logarithmic terms (log exports minus log imports), using 10-year rolling window regressions with one-year lags, using the U.S. merchandise and agricultural real exchange rate indices, monthly data, and first-differencing all variables. Dashed lines are 95%, 66%, and 33% confidence intervals, with standard errors calculated using the Newey-West (1987) HAC estimator.*

Conclusion

This study finds low to zero pass-through from exchange rates into agricultural prices, as well as general prices, over the previous several decades for the United States. These findings lead us to conclude that changes in the U.S. exchange rate would result in limited or no effects on domestic prices and inflation. In particular, even as the U.S. dollar continues to appreciate, there will be limited to no disinflationary effects through an exchange rate mechanism. Moreover, exchange rates do not appear to have significant impacts on import volumes or the trade balance for the United States, in agriculture or overall. Exchange rates have been shown to matter more for other countries and for particular commodities, but any such effects are limited for the U.S. agricultural sector as a whole and for the economy as a whole.

These findings may be of relevance to policymakers. An increase in U.S. interest rates by the Federal Reserve, which causes an appreciation of the U.S. dollar, will result in lower disinflationary effects than in the case in which the exchange rate pass-through is high. If the U.S. dollar continues to appreciate in line with its medium-term trend, one concern among agricultural policymakers is that U.S. consumers will significantly switch their consumption towards imported agricultural goods and substitute away from agricultural goods produced domestically, further worsening the U.S. trade balance in agriculture. Our findings suggest that this is less of a concern than what basic theory may suggest.

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Appendix

Unit Root Tests

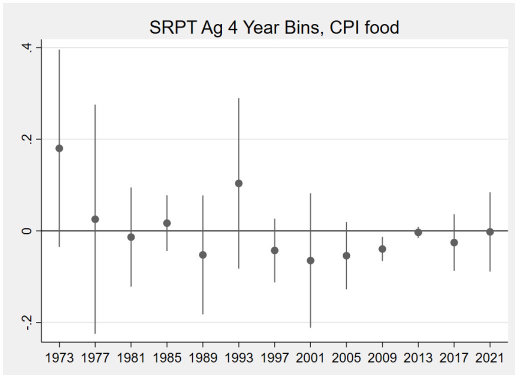
As a first step in the empirical model, we run a series of unit root tests for each model specification to test for stationarity in the time series variables. Our choice of tests is the Dickey-Fuller (DF) and Phillips-Perron (PP) unit root tests. The null hypothesis implies the existence of a unit root, and if it is not rejected, suggests that we take the first differences of our variables to address issues of non-stationarity.

When running these tests on the residuals of our regressions in levels, the null hypothesis of a unit root is not rejected, suggesting our variables of interest in levels are non-stationary but could be cointegrated. However, when running the DF and PP tests on the residuals of our regressions in first differences, as specified previously in section , the null hypothesis of the existence of a unit root is rejected, with the t-statistics reported in Table 1. This holds true for various lag specifications, and the t-statistic was highly significant each time, rejecting the null hypothesis of the existence of a unit root regardless of the number of lags, predicted residual or dependent variable, and type of dependent variable. Both tests also gave roughly similar t-statistics.

Specification	Dickey–Fuller test statistic	Phillips–Perron test statistic
CPI, residual	-14.962	-15.166
CPI, predicted	-17.077	-17.535
PPI, residual	-17.482	-17.793
PPI, predicted	-14.862	-16.113
NASS, residual	-19.187	-19.043
NASS, predicted	-14.761	-15.869
Food CPI, residual	-18.264	-18.621
Food CPI, predicted	-17.491	-18.671

Table 1: *Test statistics from Dickey-Fuller & Phillips-Peron tests on baseline regression specifications. For both tests, null hypothesis is that there is a unit root; critical values: 1%, -3.43; 5%, -2.86; 10%, -2.57. Results robust to various lag structures and to running these tests on each of the (first-differenced) variables individually.*

0.1 Robustness Checks with Bins



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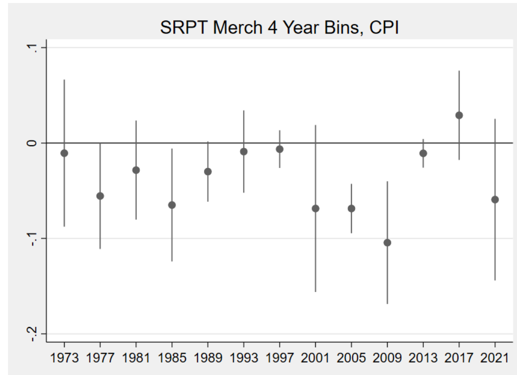

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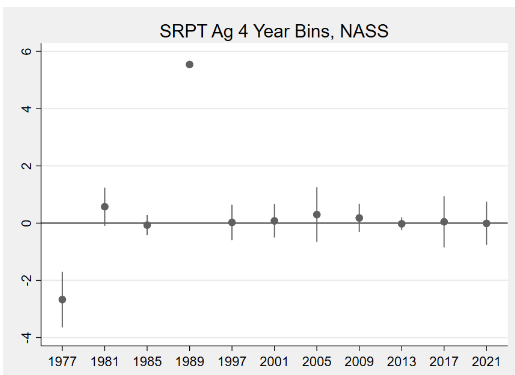

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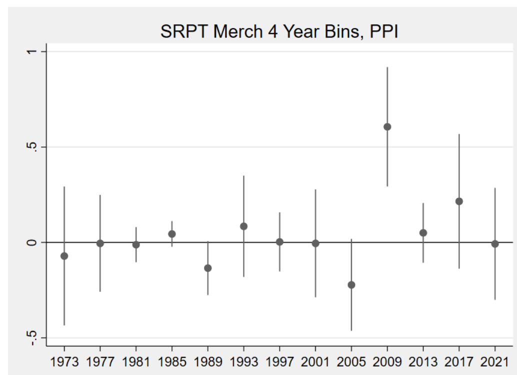

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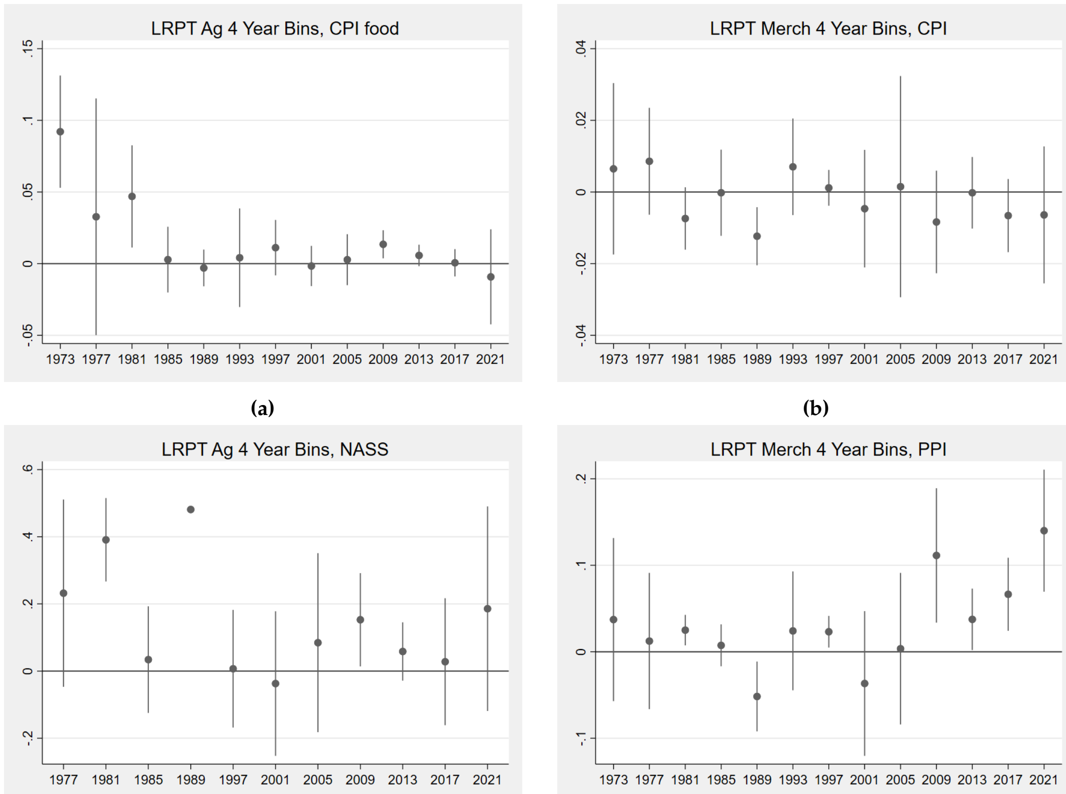
Figure 8: *Short run pass-through using regressions with 4-year bins, other specifications same as previous.*



(a) (b) (c) (d)

Figure 9: *Long run pass-through using regressions with 4-year bins, other specifications same as previous.*

Figure 8 plots the short-run pass-through coefficients when running regressions on different time bins of 4-year intervals, following the specifications of 4. pass-through is mostly statistically insignificant at the 5% level across all four specifications. We observe a brief exception in the late 2000s where pass-through is negative for general CPI in figure 8b.

Figure 9 shows the long-run pass-through coefficients. Again, pass-through is mostly insignificant at the 5% level, although pass-through is positive for some intervals in the 1980s for the agricultural price index, and positive for the later decade-plus for the general producer price index.

We repeat these regressions using no lags for both the 4-year bins and rolling window specifications, using 5-year rolling windows instead of 10-year rolling windows, including the producer prices received index in the CPI regressions for the ag specification and general specification, and changing the size of the 4-year bins to 2-year bins and 1-year bins (without lags). Overall, the results do not change significantly and the insignificance of the coefficients remains robust across these different specifications.