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Pass-through of International Food Prices to Domestic Inflation During and After the Great Recession: Evidence from a Set of Latin American Economies*

Transmisión de precios internacionales de alimentos a la inflación local durante y después de la Gran Recesión: evidencia de un conjunto de economías latinoamericanas

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Abstract

We looked at how international food price shocks have impacted local inflation processes in Brazil, Chile, Colombia, Mexico, and Peru in the past decade. Using impulse-response analysis coming from cointegrated VARS, we find that international food inflation shocks take from one to six quarters to pass through to domestic headline inflation, depending on the country. In addition, by calculating the elasticity of local prices to an international food price shock, we found that this pass-through is not complete. We also take a closer look at how this

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type of shock affects local food and core prices separately, and asses the possibility second round effects over core inflation stemming from the shock. We find that a transmission to headline prices does occur, and that part of the transmission is associated with rising core prices both directly and through possible second round effects, which implies a role for monetary policy when such a shock takes place. This is especially relevant given that international food prices have recently followed an upward trend after falling considerably during the Great Recession.

Key words: Food inflation, FAO food price index, Latin American inflation, second round effects.

JEL *classification*: E31, E50, C32.

Resumen

Miramos cómo los choques en los precios internacionales de alimentos han tenido un efecto sobre los procesos inflacionarios en Brasil, Chile, Colombia, México y Perú en la última década. Usando análisis de impulso-respuesta tomados de modelos VAR cointegrados, encontramos que un choque a la inflación internacional de alimentos se toma de uno a seis trimestres para transmitirse a la inflación doméstica, según el país. Además, al calcular la elasticidad de los precios locales ante un choque en los precios internacionales de alimentos encontramos que la transmisión no es completa. Miramos también más de cerca como este tipo de choques afectan los precios locales de alimentos y los precios básicos de manera separada, y estudiamos la posibilidad de efectos de segunda ronda sobre los precios básicos provenientes del choque. Encontramos que sí hay una transmisión a los precios locales, y que parte de esta está asociada con aumentos de precios básicos, tanto directamente y a través de posibles efectos de segunda ronda, lo cual implica un papel para la política monetaria ante estos choques externos. Esto es especialmente relevante dado que los precios internacionales de los bienes básicos han comenzado una tendencia al alza recientemente, después de presentar una caída considerable durante la Gran Recesión.

Palabras clave: inflación de alimentos, índice de precios de la FAO, inflación latinoamericana, efectos de segunda ronda.

Clasificación JEL: E31, E50, C32.

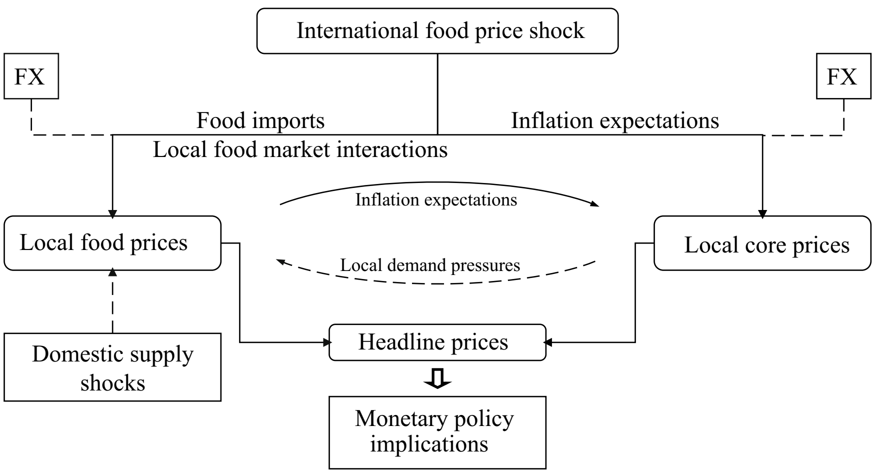
Introduction

Latin American economies are all well known as commodity producers. Over the past decades, most countries have gone through periods in which the direction of capital flows has been determined up to a good extent by international basic good prices. More recently, the Great Recession brought about a drop in world demand for commodities, causing considerable declines in world commodity and food prices. In the aftermath of the Great Recession, world commodity and food prices have once again been increasing at unprecedented rates. This whole situation should have an effect over commodity exporters like most Latin American economies. Regarding the latter, the association of the income stream generated by the sale of commodities to the rest of the world and the ability to meet external debt payments has been well documented in the literature (Calvo, Leiderman and Reinhart, 1993; Medina, 2010), but the link and the effects of changes in these goods' prices over domestic inflation in the region has just recently began to be studied.

One of the reasons we believe this has not been a topic of study in the past lies on the fact that, from a monetary policy perspective, there is not much that can be done in terms of influencing international prices of commodities on one hand, or mitigating supply shocks stemming from these goods on the other. However, if these price movements lead to changes in core and local headline inflation and inflation expectations, either directly or through second round effects, Central Banks should thus have a reason to react to international food price changes accordingly. Taking this idea into account, and considering changes in international food prices before, during, after the Great Recession, in this paper we provide a quantitative link between movements in international food prices and headline inflation for a group of Latin American economies.

Following the diagram in Figure 1, we take a closer look at possible evidence of a transmission of international food price shocks to headline inflation processes.

Figure 1. International food inflation transmission to local prices.



Source: Authors' rendering.

Local headline price movements are expected to be affected by changes in international food prices, which could take place through several channels. First, a rise in international food prices leads to a rise in prices of imported foodstuffs, which is directly reflected in local food and headline consumer price indices. Second, when such a rise in imported food prices takes place, local consumers are bound to substitute away toward similar locally produced goods, increasing their demand and hence adding to inflationary pressures for this group of goods. Furthermore, foodstuff producers should observe their own goods could be sold abroad at higher prices, leading them to allocate a greater share of their total production for export purposes, thus reducing the supply of these goods to the local market in the process. These interactions are represented by the continuous arrow connecting "International Food Price Shocks" and "Local Food Prices" in Figure 1.

Local food prices are also influenced by other variables and effects, as depicted by the dotted arrows in Figure 1. First, the intensity of the whole transmission process is bound to be shaped by movements

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in the country's exchange rate, as international price pass-through must necessarily be linked to a currency conversion that could either multiply or mitigate the transmission's magnitude. Next, local food inflation processes are also subject to domestic supply shocks, such as particular weather conditions or transportation setbacks in the country. Shifts in demand for food products listed in a country's Consumer Price Index's (CPI's) food component, which can potentially be triggered by the evolution of core prices, also play a role in food price fluctuations. Finally, an inflation targeting central bank has the obligation to keep inflation under control, and thus monetary policy variables must also be considered when looking at transmission to total headline inflation. While these additional effects are taken into account here when looking at international food price transmission, a detailed description and quantification of each goes beyond the scope of this paper.

Core prices are also potentially prone to be affected by an international food price shock, with the main channel being changes in inflation expectations, as mentioned by Van Duyne (1982). Expected inflation is considered when price setting strategies for both food and non-food products are decided upon. Hence, if inflation expectations increase as a result of a rise in food prices, producers of non-food goods and services could also revise their own prices in order to bring them in line with their new inflation expectations. Considering the latter, core prices are vulnerable to rise directly as a result of an international food price shock if the rise in international food prices manages to increase local inflation expectations, as shown in Figure 1 by the continuous arrow joining the "International Food Price Shock" and "Local Core Prices". This process is also affected by changes in the exchange rate. Furthermore, an increase in inflation expectations could also result from a rise in local food prices, which in turn was caused by the international food price shock, thus possibly generating a rise in core prices as a second round effect. This is depicted in Figure 1 by the continuous arrow connecting "Local Food Prices" and "Local Core Prices".

It is worth mentioning that the magnitude of a transmission of an international food price shock to local inflationary processes should differ through the different channels depicted in Figure 1. We expect the transmission's magnitude to be greater through the local food price channel than through the core price channel given its direct link between international and local prices, as mentioned above. However, given that local food price indices only include some imported goods, and track goods that are produced only locally, we do not expect this transmission to be complete in any case. Regarding the core price channel, the transmission's magnitude should be dependent on how controlled inflation expectations are. An inflation targeting central bank should help anchor inflation expectations, and would thus suggest a smaller transmission magnitude. Nonetheless, we do expect a transmission through this channel to be observable, as inflation expectations should not be totally anchored when faced with a supply shock.

All in all, considering these transmission channels from international food prices to local food and core prices, the overall effect of an international food price shock should be an increase in domestic headline prices. It is in this aspect that monetary policy could play a role when faced with international food price shocks. Given that a monetary policy reaction should mitigate increases in inflation expectations and core prices, a policy response should ultimately be warranted in order to prevent higher inflation resulting from the food price shock.

Using data from a set of five Latin American economies, we identify a direct link from international food prices to local headline inflation processes. In addition, we estimate the long-run elasticity of local headline prices to international food prices particular to each economy, and calculate the time an international food price shock takes to transmit into each local inflation process.

Having identified the complete international food price pass-through process, we dig a little deeper into each segment of the transmission described above. Hence, we take a closer look at the transmission of international food price fluctuations to domestic food inflation, as this variable stands to be the most affected by an international food price shock. We also look at the direct transmission from the shock to core prices. In both cases, we calculate their own long-run elasticities to international food price shifts. We then turn our attention to possible second round effects of the shock by looking at how core inflation processes respond to shocks in local food prices. We believe each step in the transmission to be worth looking at separately in order to gain a better understanding of the whole transmission process.

We asses the particular cases of five Latin American countries with inflation targeting central banks, namely, Brazil, Chile, Colombia, Mexico, and Peru. We look at economies currently following an inflation targeting scheme, as we seek to draw monetary policy implications from our results. Hence, if international food price shocks ultimately do have an effect over core and headline price, inflation targeting central banks are left with the responsibility of dealing with the additional inflationary pressures. This makes the exercise undertaken in this paper pertinent for countries that have such a scheme in place. The five aforementioned countries not only have inflation targeting central banks, but are also the largest Latin American economies, along with Argentina and Venezuela. The latter were excluded from this study, as they do not run their monetary policy through an inflation targeting scheme. Thus the policy implications drawn here are not as relevant in their cases, since a shift in their inflationary processes does not require an assessment or revision of the current monetary policy stance. In addition, both economies have been undergoing high inflationary processes in recent years, which we consider to be driven by situations very particular to each country, and thus the effect stemming from international food prices, while existent, is likely not a main driver for the evolution of headline prices in these economies.

We find evidence supporting a relationship between international food prices and local headline inflation processes in all countries in the sample. Furthermore, we find that effects over local food and core prices stemming from the international food price shock are also evident, with the effect over food prices being more prominent. Additionally, we find that there is a possibility of second round effects from the shock. Hence, our results suggest regional central banks have a reason to respond to international food price shocks in order to keep their mandate of low and stable inflation.

I. Some lessons regarding world commodity prices' effect on macroeconomic variables

Most countries in Latin America have traditionally been producers and exporters of commodities, including foodstuffs, with these types of goods making up an important part of their trade balances. As such, fluctuations in world commodity and food prices have been an important determinant for economic performance in countries in the region (Reinhart and Wickman, 1994). Several examples in the literature show that Latin American economies are prone to shocks from global commodity prices, as they play a role in the determination of the behavior of important local macroeconomic variables like GDP, the balance of payments, and inflation.

In this section, we review the evolution of commodity prices over the past three decades, with a particular focus on food prices, accounting for their observed trends, fluctuations, and their links with macroeconomic performance. It is worth pointing out that, while we look at the evolution of commodity prices, which include goods other than foodstuffs, more broadly in this section, the point we want to make is that Latin American economic performance has been guided, in part, by the evolution of prices of goods that are determined in global markets. More specifically, we have found that the literature on the subject has focused on two subcategories of commodities. Most of the literature, especially before the turn of the century, has focused on energy-related commodity price fluctuations and their effects on commodity exporting country's balance of payments and activity indicators. The other group, namely non-energy commodities, and the effect of their own price fluctuations has been less extensively studied. In our view, the latter group's effect should be more related to inflation than to other macro variables. We look first at the literature on general commodity price fluctuations, which focuses mainly on energy-related commodities. Then, we take a closer look at commodity price behavior over the last decade, focusing on non-energy commodities, as swings in international food prices have been identified as having a strong correlation with the business cycle and domestic inflation for Latin America (World Bank, 2009).

Up until the advent of the 21st century, real commodity prices were found to follow a downward trend. For example, Cashin and McDer-

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mott (2002) analyze commodity price data spanning from 1862 through 1999, finding that real commodity prices have been declining at an average rate of about one percent per year in that period. However, the authors do mention the fact that there have been episodes in which price changes in a single year have been as large as fifty percent. A previous study by Grilli and Yang (1988) uses data spanning from 1900 through 1988 and identifies a similar downward trend in commodity prices, documenting a structural break taking place in 1921, a point from which the falling real price trend accelerated. Both studies confirm the Prebisch-Singer hypothesis, which states that basic good prices should fall in relation to manufacturing good prices, given commodities' low income elasticity of demand. This should thus be reflected in a deterioration of the terms of trade for countries that are mainly commodity producers and exporters, a situation that was observed in Latin American economies during the 1980s and 1990s.

The relation between this falling trend in commodity prices and macroeconomic variables can be found by looking at the commodity exporting countries' balance of payments. Latin American economies had been running current account deficits since the 1970s, in part guided by declining commodity prices and terms of trade. As Calvo *et al*. (1993) point out, this was the case in the 1970s, 1980s, and early 1990s. Given that a negative current account balance requires countries to finance it either with a financial account surplus or a reduction in international reserves, the 1980s and 1990s presented cases of economic vulnerability when capital inflows to Latin American countries running current account deficits decelerated or stopped altogether. Two specific cases were the so-called Latin American debt crisis in the 1980s and the sudden stops of capital inflows observed in the late 1990s. In these situations, falling commodity prices and deterioration in commodity producing countries' terms of trade served as triggers and amplifiers of economic downturns.

Regarding the debt crisis in Latin America, both its beginning and its evolution are linked to commodity price fluctuations. The beginning of the crisis has been attributed to the oil shocks that took place earlier in 1973-74 and 1979-80 which took by surprise both developed and developing countries (Orlando and Teitel, 1986). Kahler (1985) mentions that the second oil shock in the late 1970s triggered inflation bursts in developed countries, implying a policy response that, in the case of the United States for example, was aimed at generating disinflation, which resulted in interests rate increases. In addition, the economic contraction in developed countries translated into a drop in demand for all types of commodities coming from developing nations, thus affecting both oil and non-oil producing countries' terms of trade (Orlando and Teitel, 1986).

So, while rising interest rates made the debt burden unbearable for several Latin American countries, leading to defaults around the region early in the 1980s, the deterioration in terms of trade that stemmed from lower world commodity demand worsened the situation, as a reduction in inflows to these countries had a negative effect over government revenues and overall economic activity. The combination of higher interest payments with lower fiscal revenues made it harder for governments to deal with and resolve their fiscal woes, deepening the recessions in these countries. Addressing the particular case of Mexico, which was the first country in the region to declare a moratorium on its debt obligations at the time, Dornbusch (1988) mentions that "a large external debt and unfavorable terms of trade have, for the time being, put an end to growth and aggravates financial instability far beyond anything Mexico has experienced in the post-war period."

Economic performance in the early 1990s seemed to be treading along fine in Latin America. The beginning of the decade came with debt restructuring endeavors by Latin American countries that had suffered debt and fiscal malaise just a few years earlier. The latter, coupled with a downturn in economic activity in the United States and other developed countries, generated a shift in attention toward Latin American economies once again, leading to a resumption of capital inflows to the region (Calvo *et al*., 1993). As suggested above, when capital inflows were healthy, negative current account balances linked to falling commodity prices were sustainable, and did not generate considerable economic hardships, so commodity price fluctuations were not utterly determinant for economic activity's evolution in the early 1990s. However, Calvo *et al*. (1993) identified this situation as being potentially dangerous for economic performance later in the century if considerable capital outflows were to take place once again.

This potential danger materialized by the end of the 1990s as scattered crisis around the world began taking place, especially in several Southeast Asian countries[1], generating a worldwide rise in risk aversion. As a result, investors across the globe began a reversal of their capital transfers to emerging markets, a situation that was not the exception for Latin American countries. These sudden stops in capital inflows triggered recessions in Brazil and Mexico, and deteriorated economic conditions in other economies in the region. Once again, low commodity prices set the stage for recessions being deeper than they would otherwise have been. With capital inflows dwindling and foreign-currency denominated income falling, as the price of these countries' exports dropped along with world commodity prices, Latin American commodity exporters' economic setbacks were exacerbated by this situation.

These negative effects of international commodity prices over activity in the 1980s and 1990s received most attention in the literature, but the beginning of the century would put the effects over inflation at center stage, due to a shift in the direction of commodity price evolution, and food prices stepped into the spotlight as the most relevant commodity subset given their price swings in global markets. The World Bank (2009) highlights that commodity prices increased markedly from 2003 through to mid-2008. More specifically, non-energy commodities rose 8.3% from 2000 through 2005, and later increased 29.1% and 17.0% in 2006 and 2007, respectively. In addition, food prices increased 6.0% from 2000 through 2005, picking up the pace in 2006 and 2007, as the yearly price changes stood at 10.0% and 25.6%, respectively.

More recently, during the Great Recession, overall demand for commodities and foodstuffs fell, leading to negative price changes in 2008, which once again exposed Latin American economies to a negative external shock. However, the size and duration of this shock was short compared to previous episodes, and emerging market economies were able to withstand the shock to a good extent, experiencing only a short recession. One of the reasons explaining why it was different for Latin America this time around lies on the fact that, despite the

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[1] See Prakash (2001) for an account of the events and causes associated with the Asian Crisis of 1997.

fall in prices of its main exports, capital inflows continued pouring into the region, as the high yield and, more importantly, the fact that regional economic activity was able to weather the situation attracted foreign investors who were, for the first time in a while, looking at the region as a safe haven. At the same time, the advent of a middle class in some emerging markets led by Asia created a substitute for developed economies' demand for commodities. This can be illustrated by the fact that commodity prices, and particularly food prices, increased sharply once again in 2009 and 2010, rising 20.2% and 29.4%, respectively, as measured by yearly changes in the United Nations Food and Agriculture Organization's World Food Price Index, after having fallen 22.5% in 2008.

We could say that, during the last decade, the overall trend in international commodity prices has been positive, with a pause associated with the Great Recession. Regarding activity, as pointed out before, a rise in commodity prices is beneficial for countries that are exporters of such goods as their current account balances tend to turn toward positive territory. Medina (2010) finds that a standard deviation increase in commodity prices leads to an increase in real government revenues of 2% in Brazil through 14% in Ecuador, with the effect for other countries in the region standing in between. The study also finds a positive response to Latin American countries' GDP. Hence, with world commodity prices exhibiting a general upward trend in the 2000s, their effect over macroeconomic variables in Latin American countries is bound to be the opposite from those seen in the 1980s and 1990s as, in principle, they should help create positive trade balances in the region. Nevertheless, it is important to note that while export revenues increase from one side, imports expenditures could also rise from the other if the countries have to buy some foodstuffs from the rest of the world. Hence, the drawback stemming from this situation should thus be that higher international food prices could translate into higher domestic food prices and headline inflation, which could in turn have a negative effect over inflation expectations, leading to their deterioration. It is in this aspect that we believe this paper fills a gap in the literature, as we document and quantify those effects.

Considering the latter, in this paper we focus on the effect of world food price fluctuations on local inflation processes for some Latin American economies. With commodity prices on the rise, we expect

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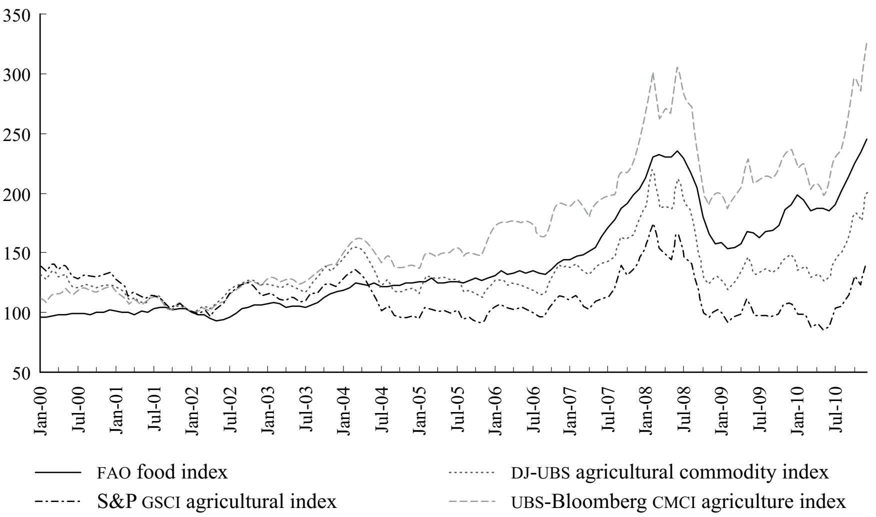
the associated positive results in fiscal and activity variables should come along with inflation as a trade off. As mentioned by the World Bank (2009) soon after the boost in world commodity prices that ended in early 2008, "with the recent rise in commodity prices, the share of commodities in the global economy, and with that, their effects on the general price level, is increasing rapidly."

II. The data

Since we want to establish the relationship between international food price shifts and local inflation processes, we used a set of four separate indices that track international food and food-related prices, all of which are constructed on a monthly basis. Figure 2 plots these indices in levels, normalized around January 2002. It can be seen that, although they are not identical, they all follow a similar path through the decade.

Figure 2. International food indices in levels.



Source: Bloomberg.

The first index we use is the United Nations Food and Agriculture Organization's (FAO's) World Food Price Index. This indicator tracks fifty five agricultural commodity prices on a trade-weighted basis, including products from categories such as meat (35%), dairy (17%), cereals (27%), oils (14%), and sugar (7%). The second index is the Dow Jones/UBS Agricultural Commodity Index, which is composed of futures contracts on goods such as coffee, corn, cotton, soybeans, soybean oil, sugar, and wheat. Third is the Standard & Poor's GSCI Agriculture Official Close Index, which tracks corn, wheat, soybeans, cotton, cocoa, coffee, and sugar, and finally the UBS/Bloomberg Constant Maturity Agriculture Commodity Index, which follows derivative prices of cocoa, coffee, corn, cotton, wheat, sugar, soybeans and soybean oil.

In this paper we report the main results using the FAO Food Price Index as the benchmark for our estimations, and use the remaining three indices mainly as a tool for checking the robustness of the overall results. We take the FAO Food Index as the base given that it is the only one among all four indices which tracks food prices exclusively, while the other three indices track cotton as well. Furthermore, the basket of goods tracked by the FAO Food Index is broader than the rest, which track only six or seven food related commodities that are heavily traded in international markets.

For local inflation data, we relied on consumer price indices calculated by local authorities in Brazil, Chile, Colombia, Mexico, and Peru. Furthermore, for food inflation indices and core price indicators we used subcategories of these CPIs.

Indices used for Brazil, Colombia and Mexico account for a greater variety across each country, as they rely on information from several cities. For Brazil we used the Extended National Consumer Price Index (IPCA) for headline inflation and its food and beverage component, which accounts for 29.8% of the total, as the food indicator for that country. This index is calculated by the *Instituto Brasileiro de Geografia y Estatística (IBGE)* and currently tracks prices in eleven regions in the country. In Colombia's case we used the consumer price index calculated by the *Departamento Administrativo Nacional de Estadística (DANE)*, and its food component, which accounts for 28.2% of the CPI basket[2]. Colombia's CPI is constructed with informa-

[2] This has been the case since 2008 when DANE changed the index's base year. Previously, the index's food component accounted for 29.5% of total CPI.

tion collected in twenty four cities around the country. Additionally, for Mexico we used the national CPI index calculated by the Mexican Central Bank (*Banxico*), and its food, drinks, and tobacco component, which accounts for 23.28% of the total headline index. Mexico's index tracks prices in forty six different cities.

In Chile and Peru's cases, consumer price indices used are based on information collected in and around their capital cities. For Chile we used the CPI calculated by the *Instituto Nacional de Estadística (INE)* and its food and non-alcoholic beverage component, accounting for 18.9% of the total[3]. Chile's CPI is constructed using data from the Greater Santiago area. In Peru's case we used the CPI calculated by the *Instituto Nacional de Estadística e Informática (INEI)*, which reflects prices in Greater Lima, and its food and non-alcoholic beverage component. Consumer prices have been constructed in specific components since 2002 in this case, which is why all estimations that require the use of the food component for Peru used a shorter data set, beginning in January 2002. The food and non-alcoholic beverage component accounts for 37.8% of the Peruvian Consumer Price Index.

Inflation targeting Central Banks, including those from the five countries studied here, usually look at CPI inflation as a gauge for meeting their goals. However, as food price shocks are considered to be associated with supply factors and thus usually taken to be transitory and generally out of the monetary authority's control, core inflation indicators are also closely followed and are important for monetary policy actions. Hence, for basic price indicators we used the measure of core prices that most resembles the core inflation indicator that each local central bank monitors, and would thus be the most likely measure to trigger a policy response. Given the latter, these measures are different in each country. For example, for Brazil we used a trimmed-mean smoothed series[4], while the core inflation measure for Peru is constructed from the headline indicator by excluding the most

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3 This has been the case since 2009, when INE changed the CPI's calculation methodology. We used annual changes in this component from the older CPI methodology, in which food accounted for 27.0% of total CPI, to construct an index that spanned from January, 2000 through December, 2010.

4 For a comparison of core inflation measures in Brazil see Rodrigues (2001).

volatile CPI components[5]. For Colombia we used CPI excluding food prices, which makes this the only country for which the food and core indices used account for the complete CPI basket. Finally, Chile's core price indicator is the CPI excluding food and energy prices, while the core inflation index used for Mexico is CPI excluding energy, agricultural, and regulated prices.

Figure 3 plots twelve-month inflation in each specific country along with the year-over-year change in the FAO Food Index. A first glance at this figure suggests that international food inflation appears to follow a similar trend to that of local inflation processes in most of the countries we looked at. Furthermore, not only is there a similar behavior apparent, it also seems as though international food inflation leads local inflation fluctuations. For example, as mentioned by the World Bank (2009), food prices were on the rise from 2003 through 2008, a situation which can be observed by the yearly changes in the FAO Food Index in Figure 3. It can also be seen here that a similar trend in local inflation began to take place shortly after in each of the countries in the sample, with a relation being more apparent in the 2006-2008 period, when world food prices increased the most in the decade.

Moreover, the disinflation observed in late 2008 in international food prices through the Great Recession, as global demand weakened, was followed by a similar fall in local prices later on. In the case of Brazil, this disinflation appears to have started in late 2008, before it leveled off by year-end 2009. In Colombia, the deceleration in inflation seems to have begun a little later than in Brazil. In addition, inflation in Mexico also followed a similar fall in rates, but did so later on, with a drop becoming apparent in mid-2009 and lasting until 2010's first months.

5 For a similar comparison of core inflation indicators in Peru, see Valdivia and Vallejos (2000).

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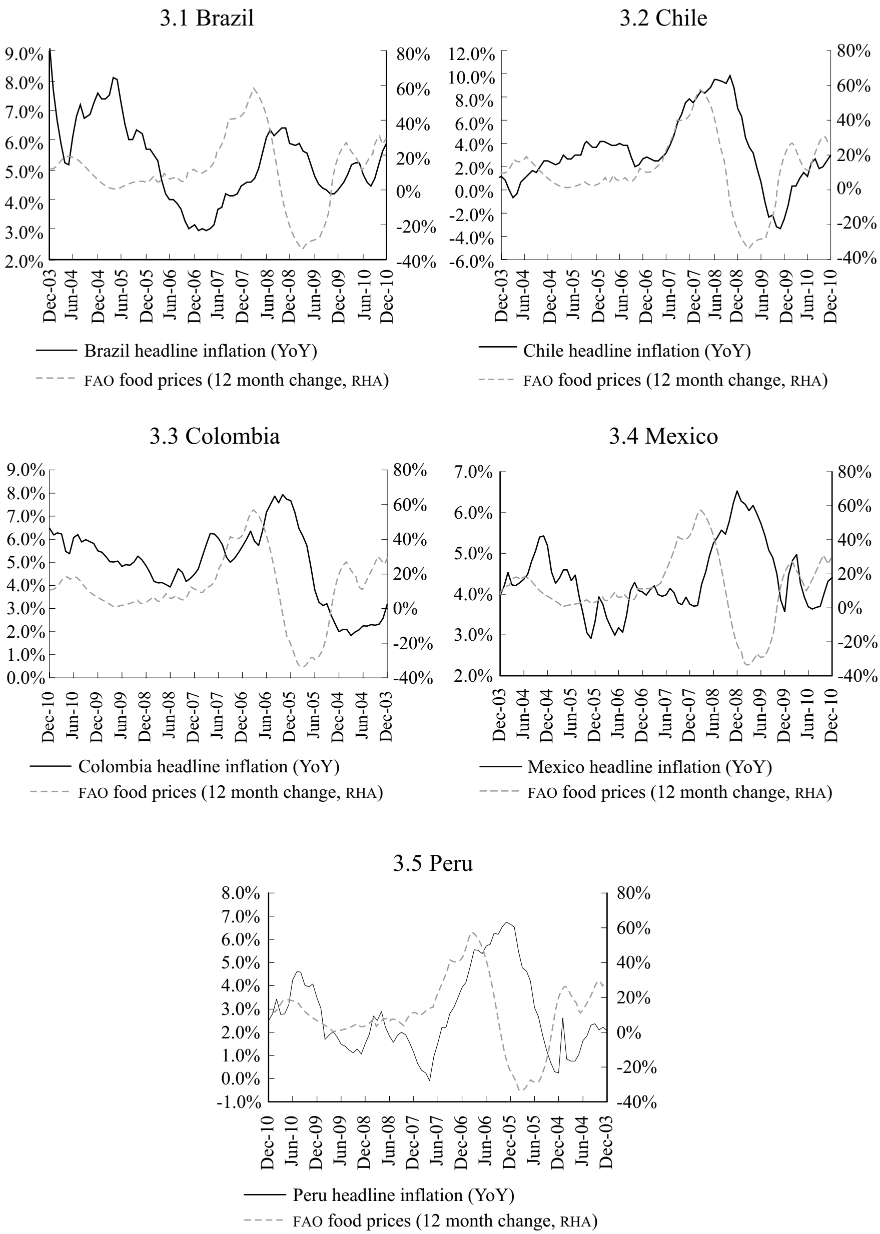
Figure 3. International food inflation and country specific inflation.



Source: Bloomberg and author's calculations for the FAO food index. National Statistics Agencies for local headline inflation. Mexican Central Bank in the case of Mexico.

In addition to local headline, food, and core inflation indices, and international food price indicators, we used quarterly GDP data for all countries, as well as monthly average exchange rates for each country, measured in units of local currency per United States Dollars. We also used an interest rate for each country in order to identify a monetary policy response variable. In the cases of Brazil, Chile and Colombia, the central bank intervention or "repo" rate was used. In the cases of Mexico and Peru we used the overnight interbank rate, as data for their respective central bank intervention rates was not available for the whole period.

III. Dynamics and magnitude of international food price pass-through to headline inflation

Considering that the data seems to suggest that international food inflation is related with local price changes, and that they could actually be a leading indicator for such processes (as seen in Figure 3), we looked at the dynamics of the transmission from international food prices to local inflation in our sample of countries. For this, we estimated unrestricted VAR systems for each local headline price index along with each international food price index, and used impulse response functions to see how local price indices respond to shocks in international food prices. These serve as our base models for looking at the general transmission from international food prices to local inflation.

In general, in order to address our main concern of identifying a transmission from international food price fluctuations to local headline inflation processes, we estimated a VAR model for each country of the general form:

$$y_t = \sum_{i=1}^{p} A_i y_{t-i} + d + u_t \tag{1}$$

Where, $\boldsymbol{y_t}$ is a vector including the variables that make up the system at time t, $\boldsymbol{d}$ includes a constant, $\boldsymbol{A_i}$ are parameter matrices, and $\boldsymbol{u_t}$ is an error term. More specifically, $y_t = \left(food_t^* \quad gdp_t \quad \pi_t \quad i_t \quad e_t \right)'$, where $food_t^*$ is the natural logarithm of the international food price index for a specific country, gdp_t is the natural logarithm of that country's GDP, π_t is the natural logarithm of the country's headline inflation index,

i_t is an interest rate closely following the central bank's policy rate, and e_t is the natural logarithm of that country's nominal exchange rate measured as units of local currency per unit of US Dollars. CPI, GDP, and FX variables were seasonally adjusted in all cases[6]. We estimated several different models for each country, in which $food_t^*$ represents the natural logarithm of a specific international food price index. As this last variable is replaced across models for each particular country with the different international food price indices, we estimated four distinct models for each country's case. The international food price indicators were not found to contain a seasonal component, and thus the natural logarithm of the original index was used. All datasets include quarterly observations, due to the inclusion of GDP, and span from the first quarter in 2000 until the end of 2010.

These types of models have previously been used in the literature to examine similar relationships. For example, Webb (1988) looks at commodity prices as a predictor of headline price fluctuations using VAR models including a money variable, stating that monetary policy is a tool for mitigating price changes, and thus the money supply should fluctuate along with both food and headline prices. This study also uses granger causality tests, finding that commodity prices do, in fact, contain information that is useful for predicting headline prices. Browne and Cronin (2007) also look at the relationship between commodity prices and CPI inflation using VAR models including a money variable, in which they find evidence that the transmission from commodity prices to headline prices is money driven, instead of being a result of cost-push inflation. Simpler bivariate VAR models are used by Furlong and Ingenito (1996) to test how well commodity prices help predict headline inflation using different commodity indices, leading the authors to claim that commodity prices served as good indicators in the 1970s and 1980s, but the relationship has deteriorated over time. In addition, they find that non-oil commodity indicators perform better as predictors of headline inflation. Finally, Marquis and Cunningham (1990) use cointegration analysis and VECMs to find long term trends

6 Models using the original variables without seasonal adjustment but including seasonal dummies were also estimated. These models yielded results which were quantitatively and qualitatively similar to those obtained from the models that used seasonally adjusted variables and no seasonal dummies. Given their similarity, we used the models with seasonally adjusted variables as these provided additional degrees of freedom for the estimation.

between commodity and headline prices, which they find only when an activity variable, such as industrial production, is included in the system.

We carried out augmented Dickey-Fuller and KPSS unit root tests to check whether the levels of the different time series were stationary or not, finding evidence in each case that all variables are non-stationary.

With this in mind, we explored the possibility of the variables being cointegrated. International food prices and local CPIs should share a long-term relationship as local food price indices track both locally produced foodstuffs and prices of imported goods. This pass-through from international to local prices should not necessarily be complete and immediate, as substitution between foodstuffs could, up to some extent, smooth out the transmission of changes in external prices. Even when this substitution effect is considered, a rise in international food prices would lead to a food price increase locally. This would take place directly when prices of imported goods change, while a shift away from foreign goods as their price increases would add demand pressures on local goods, shifting their prices upwards as a result as well. Furthermore, as mentioned above, a rise in local core prices due to shifts in inflation expectations and price setting strategies after shocks to external food prices can also be expected. Moreover, core prices can be affected by possible second-round effects, leading to an additional adjustment in local prices.

In addition, a country's nominal exchange rate, GDP, and policy rate should play a role as to how this pass-through effect takes place. The nominal exchange rate directly plays a role in local price inflation, as a higher nominal exchange rate (which implies a depreciation of the local currency) directly implies a rise in prices of imported food and non-food products for domestic customers. Hence, the nominal exchange rate plays the role of a buffer or an enhancer of price shifts passing through to local food prices. More specifically, the nominal exchange rate would aid in determining both the timing and the magnitude of this transmission. Similarly, a country's Gross Domestic Product reflects to some extent its capacity to produce and thus supply the local market with goods and services, which in turn affects their price formation dynamics. Regarding the interest rate, central banks use their policy rate as a tool to carry out their monetary policy, and should thus fluctuate along with other macroeconomic variables. As a result, the nominal exchange rate, the interest rate, and real GDP should share a relationship with the other variables in the system.

Considering these relationships, we needed to perform cointegration tests for each country's set of variables $\left(gdp_t,\ \pi_t,\ i_t, \text{ and } e_t\right)$ along with each of the four international food price indices $\left(food_t^*\right)$. Standard Johansen trace tests and maximum eigenvalue tests indicate the presence of cointegration for each country's particular system, thus showing that this long term relationship is in fact present in the data. Being this the case, we decided to work with the variables in levels under a cointegrated VAR framework, noting that, given the cointegration result, inference from the VAR can be done in the standard way, as shown originally by Watson (1986) and later by Stock and Watson (1993).

Regarding lag length (p), we used standard information criteria, coupled with a parsimonious argument looking for the minimum number of lags which yielded residuals with no serial autocorrelation.

We realize that international food price indices are likely exogenous by their very nature, and thus they should not be affected by local variables from any particular country. In this regard, it is worth mentioning that our estimation results from the VARS actually support this claim, as the coefficients for local variables in the international food price index's particular equation within the system are not found to be statistically significant, making this variable at least weakly exogenous. Hence, the main concern associated with including this variable in the system, which is that in principle local variables should not have an effect over it, is not an issue in this case. Furthermore, the inclusion of this variable in the VAR system implies that there is a specific equation specifying a data generation process for it in the model[7].

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[7] Additionally, we looked at univariate autoregressive models for the FAO Food Index in order to see if it was well specified by its equation in the VAR, in which only two of the index's own lags served as regressors (making it basically an AR(2) model). We found that adding additional lags to the index's equation does not provide new information and does not marginally improve the model's specification. Thus, this index is well specified within the VAR system. Nonetheless, we estimated similar VARX models for robustness including the

Impulse response functions stemming from these VARS were analyzed in order to interpret the timing and the magnitude of an international food price shock passing through to local price fluctuations, controlling for the central bank's reaction. In our analysis we used standard forecast error impulse responses to a one unit shock to the international food price index. As Lütkepohl (2006) explains, the fact that this type of impulse responses assume that the shock occurs at one variable at a time is troublesome, given that this means that when one variable receives a shock, the reasons behind that shock should not generate a contemporaneous effect in the other variables of the system, since a residual of magnitude zero for those variables has been assumed along with the one unit shock to the initial variable. This is why orthogonal impulse responses are usually used. However, the variable that is shocked in our case is the international food price index, which is weakly exogenous in the system, according to our results, and shocks to that variable are most likely exogenous to variables in each particular economy.

Non-accumulated forecast error impulse responses are used to find both the impulse response horizon (*h*), measured in quarters, at which the maximum effect over local food inflation takes place and the horizon at which this effect ceases to be significant. We used two-standard-error confidence intervals for the impulse responses to asses their significance. Hence, the maximum effect was considered to be the highest level of the response that did not include zero in its confidence interval for that horizon. In addition, the overall timing of the shock's effect was taken to be the number of quarters until the last horizon

original variables and using the international food price indices as a deterministic input, which yielded similar results. The unrestricted VAR models estimated here could be specified in a VARX form as:

$$y_t = \sum_{i=1}^{p} A_i y_{t-i} + b_1 food^*_{t-1} + b_2 food^*_{t-2} + d + u_t$$

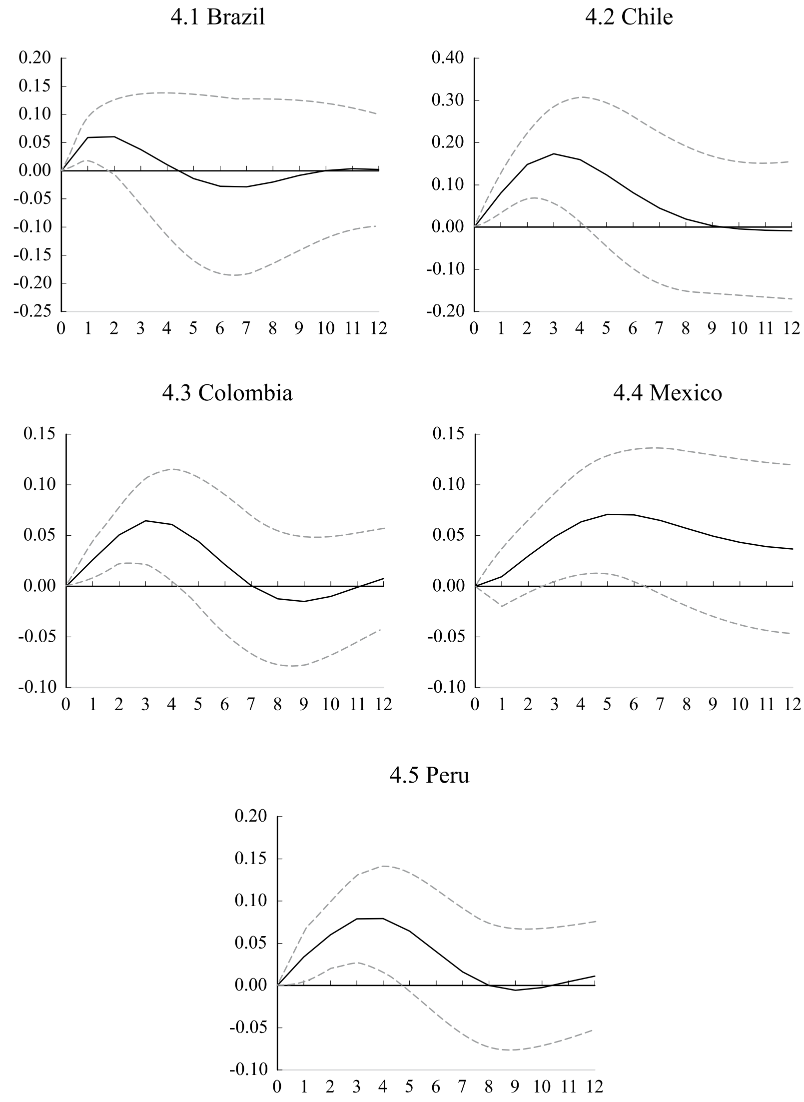
given the FAO Food Index's data generation process.

in which the response did not include zero in its confidence interval. Similarly, the calculated elasticities or long-run effects are taken to be the accumulated impulse response at the last period in which zero was not part of its own two-standard-error confidence band (Lütkepohl and Reimers, 1992). Given that a policy interest rate is included in each model, the results show the elasticity of local prices to international food prices while controlling for the central bank's reaction.

Our main results are taken from the forecast error impulse responses obtained from the model that includes the FAO Food index, which is our base case. Results from the other models, which we estimated for robustness, show a very similar evolution of the responses of headline prices to a shock in each international food price index.

The results of the unrestricted VAR estimation of our base models allowed us to asses how much of the external food price shock actually passes through to headline prices in the Latin American countries in the sample, as well as the time this process takes. In this light, we looked at impulse response functions for the different systems, concentrating on how local consumer price indices respond to a unit shock in international food prices. We found that, in general, all local CPIs have an initial positive response after the shock occurs, with the maximum response coming a few quarters afterwards, and then loosing steam. Although the effect is the expected one, the impulse response functions diverge somewhat across countries. These results are robust to the international price index being used. Figure 4 plots each country's local headline price index's response to a unit shock in the FAO Food Index. Plots of the impulse responses calculated from the models that include each of the other three international food price indices can be found in the appendix to this paper (Figures A1 through A3). In general, these impulse responses have a very similar pattern to those obtained from a shock to the FAO Food Index, and their statistical significance is similar as well.

Figure 4. Local CPI's forecast error impulse response to a one unit shock to the FAO food index (horizons in quarters).



Source: Author's calculations.

The impulse response functions of country specific CPIs to a one unit shock to the FAO Food Index indicate that the total effect over local food prices takes place over one to six quarters after the initial shock,

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depending on the country. Brazil is the country in the sample most prone to experience a quick impact on its local price indicator, with both the maximum and the total effect occurring in the quarter immediately after the shock takes place. This makes Brazil the country in the sample showing the quickest transmission from international food prices to local headline prices. Mexico, on the other hand, experiences the maximum effect from the shock five quarters after it takes place, with the total effect of the shock lasting until the sixth horizon, making Mexico the country in the sample with the slowest pass-through to consumer prices. Chile and Colombia both experience the highest effect three quarters after the shock, and both their responses are statistically significant until the fourth horizon. For the case of Peru, both the highest shock and the total effect come at the fourth quarter for the shock. These results are summarized in Table 1.

Table 1. Highest and total effect timing of local food indices' forecast error impulse response to a one unit shock to the FAO food index.

Effect timing criteria	Brazil	Chile	Colombia	Mexico	Peru
Highest effect	0,06	0,17	0,06	0,07	0,08
Horizon in which highest effect occurs	1	3	3	5	4
Last statistically significant horizon	1	4	4	6	4

Source: Author's calculations.

While the aforementioned results are based on local CPI index responses to shocks to the FAO Food Index, responses to shocks in the other three tell a similar tale in terms of the dynamics of the response's evolution to a shock in international food prices. However, the impulse responses from the models using the other three international food price indices suggest that, in general, the duration of the effect over local headline price stemming from an international food price shock is shorter than that implied by the responses to a shock to the FAO Food Index. In the case of Mexico, the total effect is estimated to take four quarters using any of the three other international food price indices, instead of six quarters as implied when using the FAO Food Index. For Chile, the length of the effect is suggested to fall to two quarters by the models using two of the three additional indices, with the third one showing the effect takes only one quarter. The four quarter total effect is supported in the cases of Colombia and Peru by two of the three models using the other indices, while the third model suggests the total effect takes place over three quarters. For the case of Brazil the story is somewhat different, as the additional models actually suggest the total effect takes place over a longer period. All three models suggest the total transmission takes place over two quarters, instead of just one. While these results differ in some aspects from those implied by the model using the FAO Food Index, the latter's results are taken as the base case given the aforementioned desirable properties this index has over its peers. Table 2 summarizes the results obtained for each country for the models using each of the four international food price indices.

Table 2. Highest and total effect timing of local food indices' forecast error impulse response to different international food indices.

Last statistically significant horizon (horizon in which highest effect occurs)	Brazil	Chile	Colombia	Mexico	Peru
FAO food index	1 (1)	4 (3)	4 (3)	6 (5)	4 (4)
Dow Jones/UBS agricultural commodity index	2 (2)	2 (2)	4 (3)	4 (4)	4 (3)
S&P's GSCI agriculture official close index	2 (2)	2 (2)	4 (3)	4 (4)	4 (3)
UBS/Bloomberg constant maturity agriculture commodity index	2 (2)	1 (1)	3 (3)	4 (3)	3 (3)

Source: Author's calculations.

Forecast error impulse responses of local headline prices to the other three international food price indices also suggest changes in the timing of the maximum effect. For Brazil, the other three indices place the maximum effect two quarters after the shock. In Colombia's case, responses to shocks in all international food indicators, except the UBS/ Bloomberg index, place the maximum effect three quarters after the shock. For Peru, a shock to any of the other three indices would lead to the maximum reaction of the local consumer price index taking place three quarters later. For Mexico, a shock to the FAO Food Index seems to overestimate the timing for the maximum effect, as shocks to two of the three additional indices suggest this takes place one quarter earlier than what that index's shock implies, while the third index signals the maximum effect comes two quarters earlier. For Chile, the maximum effect takes place two quarters after a shock to either the DJ/UBS Index or the S&P Index, while a shock to the UBS/Bloomberg Index results in the maximum effect taking place only one quarter after the shock, as the response is not statistically significant beyond the second horizon, inclusive. These results are also summarized in Table 2.

While looking at regular impulse response functions gives an indication about the timing of the shock's transmission and about when the shock is most strongly reflected in local price indices, we also looked at the accumulated responses to find how much of the shock is actually transmitted to local prices, while controlling for the central bank's reaction. As mentioned earlier, since the variables included in the VAR systems are the natural logarithms of the levels of the original variables, accumulated impulse response functions can be interpreted as the elasticity or long-run effect of local headline prices to changes in international food prices (Lütkepohl and Reimers, 1992). The elasticities calculated using the base models including the FAO Food Index and the other three international food price indices are presented in Table 3. Here, the accumulated response at the highest horizon whose two-standard-error confidence interval did not include zero (making it significant) is taken as the elasticity or long-run effect, and reflects the final percentage of the original shock that has transmitted to the local consumer price index.

Table 3. Estimated elasticities of local consumer prices to a shock in international food prices.

Elasticity of headline prices to international food price indices	Brazil	Chile	Colombia	Mexico	Peru
FAO food index	0,12	0,81	0,27	0,46	0,37
Dow Jones/UBS agricultural commodity index	0,12	0,19	0,17	0,16	0,19
S&P's GSCI agriculture official close index	0,11	0,18	0,17	0,16	0,15
UBS/Bloomberg constant maturity agriculture commodity index	0,12	0,03	0,15	0,29	0,17

Source: Author's calculations.

In general, all countries' inflationary processes present a positive elasticity to international food prices, and it can be seen that a full transmission to local prices is not the norm. This is exemplified by the fact that, while being positive, no elasticity is greater than one, meaning that a one percent increase in international food prices leads to a long-run increase of less than one percent in local headline prices. If we focus on the results obtained when using the FAO Food Index, Brazil presents the lowest value for the elasticity of its headline prices to changes in that Index, with just twelve percent of the shock ultimately passing through to local prices. These same results imply that Chile's transmission is the greatest, with nearly eighty-one percent of the shock being transmitted in the long run. Estimates for this elasticity in Mexico, Peru, and Colombia stand in between, with forty-six, thirty-seven, and twenty-seven percent of the shock, respectively, passing through to their local inflationary process.

The elasticities calculated using the other three indices confirm a positive effect, though they once again suggest the pass through to local inflationary processes are smaller in magnitude than the FAO Food Index suggests. The Dow/Jones Index and the S&P Index continue placing Chile as the country with a higher transmission, with the models placing the transmission at nineteen and eighteen percent, respectively. For the Dow/Jones Index, Peru matches the nineteen percent elasticity. For Brazil however, all of the indices continue placing its elasticity around the order of eleven or twelve percent, which continues ranking Brazil as having the lowest pass through to local prices among sample countries. The latter is true except in the case of the model using the UBS/Bloomberg Index, in which Chile is shown to have an elasticity of just three percent. It is worth pointing out that this last result is linked to the fact that the accumulated forecast error impulse response is not significant for Chile beyond the second horizon, inclusive, when the UBS/Bloomberg Index is used, making Chile's elasticity considerably shorter in this case. All in all, we use the result stemming from these three models to confirm the positive effect a shock to international prices has over local inflationary processes, though our base results continue to be drawn from the model using the FAO Food Index.

In this subsection we presented the results from our base models, and found evidence that a shock in international food prices does have a positive effect over local headline inflation processes. We have quantified the total pass though of an international food price shock to local consumer prices as depicted in Figure 1 in the form of long-run elasticities, and we have characterized the timing of such a shock for each individual economy. Our results suggest that, for the countries

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in the sample, the highest pass through of the shock to local headline takes place in Chile, and the lowest occurs in Brazil. Furthermore, the total effect takes the longest to pass through in Mexico, and takes the least in Brazil. Overall, these results suggest that headline prices ultimately present a statistically significant rise when each particular economy is faced with an exogenous international food price shock, which indicates that there is a role for monetary policy reactions to these shocks.

IV. A closer assessment of local food and non-food prices' response to international food price shocks

A. An augmented model for analyzing local food and core prices

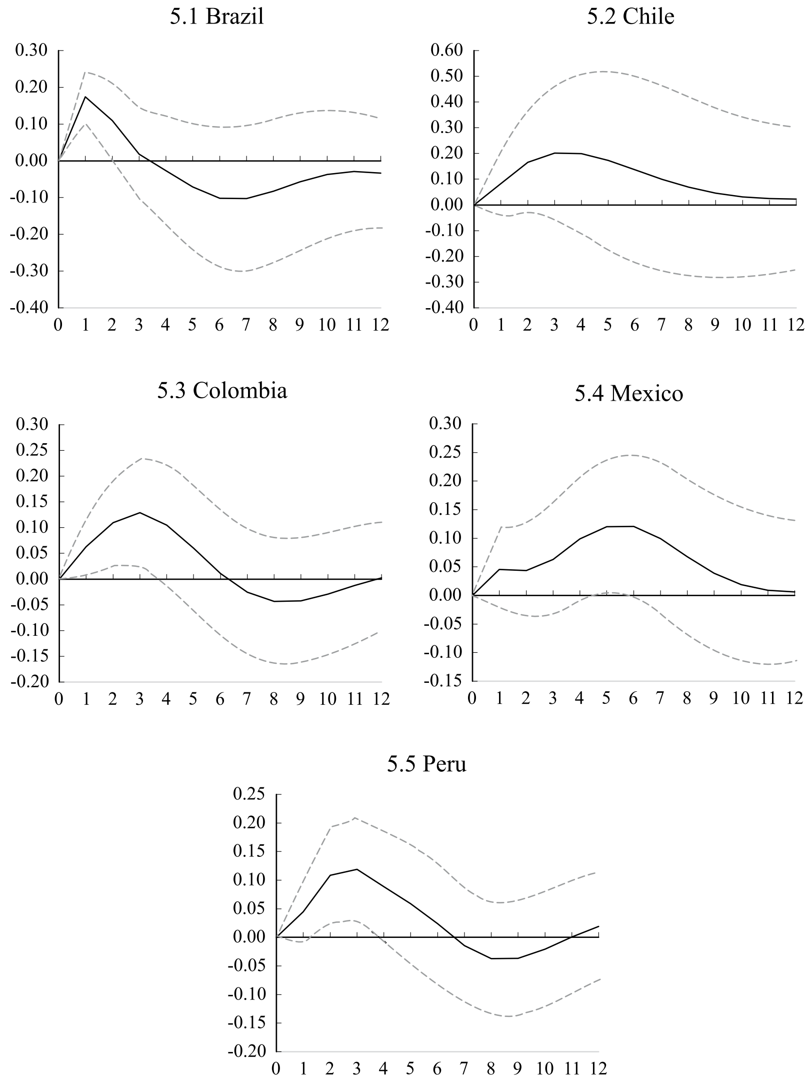
In addition to our base models, we estimated a second set of VAR models in which we seek to better identify the transmission from international food prices to both local food and core price indicators. For these models we removed the CPI variable from our base estimations and replaced it with the natural logarithm of the food price index and the core price index mentioned in the previous section. Both the food and core indicators were included in the model simultaneously. Hence, these augmented models are specified as in Equation (1), with the exception that $\boldsymbol{y}_t$ now contains six instead of five variables. Specifically, $\mathbf{y_t} = \left(food_t^* \quad gdp_t \quad food_t \quad core_t \quad i_t \quad e_t\right)'$ where $food_t^*$, gdp_t, i_t, e_t represent variables as in the base models for each country, $food_t$ is the natural logarithm of the food price indicator for the country, and $core_t$ is the country's corresponding core price indicator. While the food and core indicators for a particular country do not necessarily contain all goods and services in that country's CPI, they do contain enough information to account for a considerable portion of the total CPI basket. As a result, we once again found presence of cointegration relations in each system's variables, allowing us to estimate unrestricted VARS with the variables in levels.

We used these models to asses the direct effect of an international food price shock to local food and core prices. Given that both the food and core indices are included together, these models allow us to make an approximation of how the total effect over headline prices stemming from fluctuations in international food prices is divided among these two CPI subcategories. Once again, we used forecast error impulse responses as in our base models to look at the dynamics of each local food and core price index's response to a shock in the international price index. We also calculated elasticities for both indicators in the same way as for total headline inflation in our base models.

In the previous section we showed how our base models suggest that a shock to international food prices leads to rising local headline prices. However, as shown in Figure 1, the ultimate rise in headline prices can come either through an increase in local food prices, either directly as a result of higher imported food prices or through local food market interactions, or through a direct effect over core prices as a result of rising inflation expectations. In this subsection we present the results of our augmented models, all of which use the FAO Food Index as the international food price indicator, and replace total headline prices with food and core price indicators simultaneously, in order to better understand the whole pass through process to local headline prices.

We found that local food inflation processes do have a positive reaction to world food price shocks, as would be expected. Figure 5 plots the forecast error impulse responses of local food indicators to a one unit shock in the FAO Food Index. With the exception of Chile, all impulse responses depicted show that the initial positive reaction is statistically significant at some horizon, judging by the two-standard-error confidence intervals. Regarding the timing of the transmission from international to local food prices, Brazil presents the shortest transmission period, with the full effect taking place in two quarters. The full effect from the shock to the FAO Food Index takes the longest to pass through to Mexico's local food inflation, taking five quarters to do so. Results for both Colombia and Peru suggest the full effect takes place over a three quarter period. As mentioned, Chile's impulse response is not significant at any horizon, so a quantification of the full effect's timing is not possible. As mentioned above, this transmission can be explained by a combination of a rise in the local food price index directly as a result of rising imported prices tracked by the index, along with local consumers and producers shifting their supply and demand preferences.

Figure 5. Local food price indices' forecast error impulse response to a one unit shock to the FAO food index (horizons in quarters).



Source: Author's calculations.

More important for the conclusions that are sought to be drawn in this paper is the fact that local core price indices are also found to present a positive response to a shock in the FAO Food Index. Figure 6 plots the forecast error impulse responses of local core indices to a one unit shock in the FAO Food Index. Just like in the case of local food prices, all core indicators have a positive reaction to an international food price shock, with the reaction being statistically significant. As mentioned earlier, this reaction can be explained by a rise in overall inflation expectations increasing when an external shock takes place, thus shifting core price setting strategies. As core price represent the CPI subcategory of goods and service prices that are usually demand driven and are thus more prone to be affected by monetary policy, this positive reaction further supports the conclusion drawn from our base models that a reaction from local central banks when the economy is faced with an international food price shocks is warranted to mitigate eventual inflationary pressures.

Core price indices' reaction to an international oil shock appears to take longer than that of local food indicators. This is understandable, as the immediate effect that takes place in the case of food indices via rising imported food prices is not present in the case of core prices, which depend on shifting inflation expectations. Our results suggest that in the cases of Colombia and Peru, the full effect over core prices takes four quarters to be entirely observed. In the case of Chile, the impulse response is significant in this case, and suggests the full effect over core prices is also observed by the fourth quarter after the shock. For Mexico, the full effect takes six quarters, which is the same as the full effect's timing of this country's food price indicator's reaction. Brazil's case is particular, as the full effect of the shock over core prices takes just one quarter, which is quicker than the timing of the shock to its food price indicator.

The augmented models also allowed us to calculate elasticities in the same way as we did for each country's headline price index. In general, as foreshadowed by the impulse response functions shown in Figures 4 and 5, all elasticities or long-run effects over both food and core price indicators are positive. In addition, we found that, for every country, the elasticity of food prices to a shock in the FAO Food Index is greater that the elasticity for core prices.

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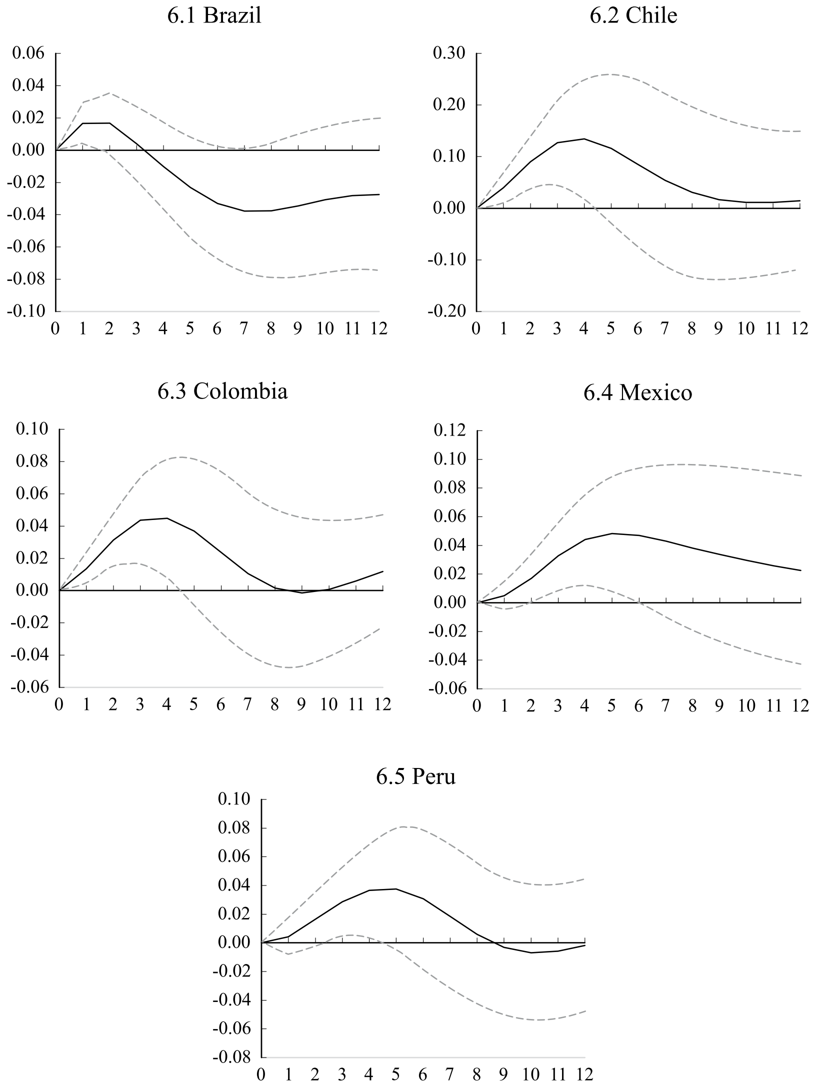
Figure 6. Local core price indices' forecast error impulse response to a one unit shock to the FAO food index (horizons in quarters).



Source: Author's calculations.

Our results suggest that the elasticity for headline prices appears to be a linear combination of the elasticities for food and core prices. This can be seen in Table 4, which plots the elasticities of food and core indicators to a shock in the FAO Food Index, along with the corresponding elasticity of headline prices as estimated in our base models. It can be seen that, in every country specific case, the elasticity of headline prices falls between that of the food and core indicator used, except in the case of Chile, for which an estimate of the elasticity of its food prices to international food price shocks cannot be calculated, given that its particular food indicator's impulse response is not statistically significant at any horizon. It should be pointed out once again that indicators for Colombia represent the only case in which the food and core indicators are complimentary and together make up the total CPI. In this case, a linear combination assigning the elasticity of food prices a weight of 28.21%, which is the weight of the food component in the total CPI basket, and of 71.79% (its compliment) to the core indicator's elasticity yields a result of 0.271, which is very similar to the 0.267 elasticity estimated using our base headline model. This example supports our claim that the elasticity for headline prices using our base models is a linear combination of the elasticities for food and core price indicators.

Table 4. Estimated elasticities of local consumer prices to a shock in international food prices.

Elasticity	Brazil	Chile	Colombia	Mexico	Peru
Elasticity of headline prices to international food prices	0,119	0,811	0,267	0,463	0,372
Elasticity of local food prices to international food prices	0,301	N/A[a]	0,467	0,592	0,443
Elasticity of local core prices to international food prices	0,033	0,592	0,194	0,309	0,124

[a] The accumulated impulse response of Chilean food prices to a one unit shock to the FAO food index was not statistically significant at any horizon.

Source: Author's calculations.

The results presented in this section confirm that international food price pass through to local headline prices occurs as a result of transmission through both core and food prices simultaneously, with the effect through the latter being quicker and more pronounced than through the former. Furthermore, while we had already concluded that monetary reactions to international food price shocks should not be discarded given the likely subsequent rise in headline prices, the fact that a direct transmission via inflation expectations to core prices is present reinforces this conclusion.

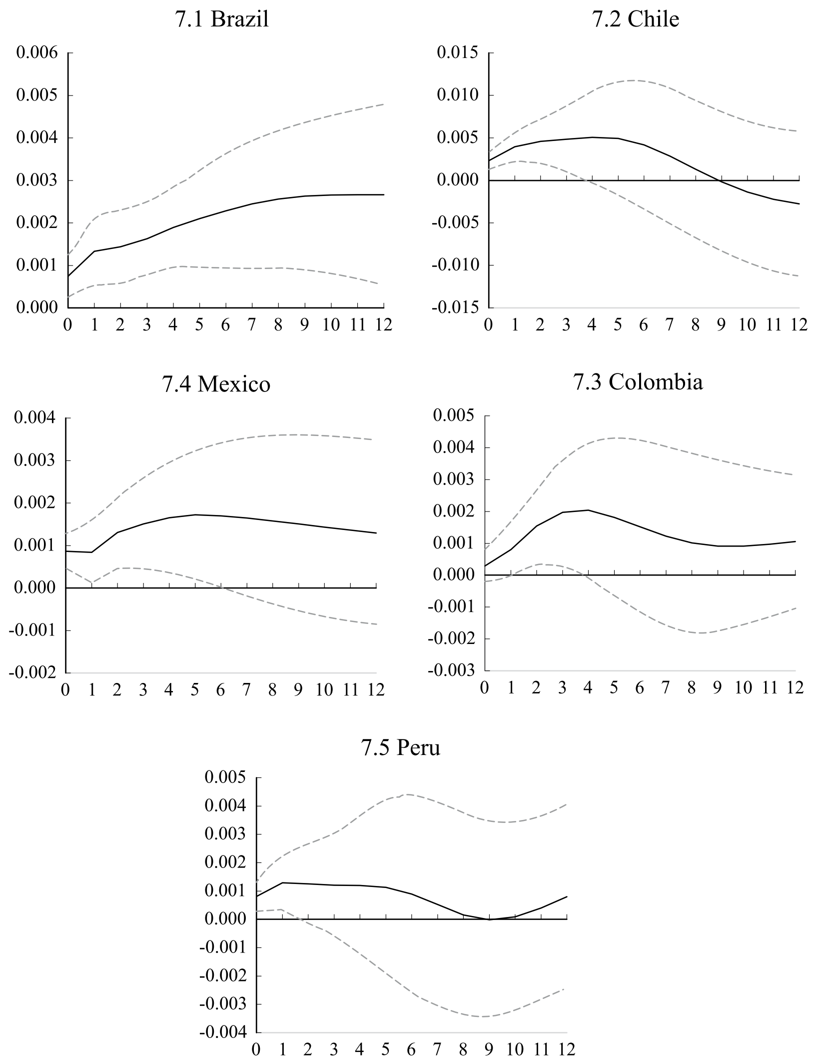
B. An approximation to second round effects

Having established that there is in fact a response of local inflation to shocks in international food prices through effects in both food and core price indicators we also used our augmented models to look at the effects on core prices stemming from the rise in local food prices. Hence, we used these models to assess the possibility of second round effects over core prices stemming from an international food price shock. As any conclusion drawn here stems from the assessment of local core prices' response to a shock in local food prices, we acknowledge that exogenous shocks to local food prices can come from many sources, one of which is the international shock. Therefore, our results allow us to make an inference about the possibility of second round effects taking place, but do not allow us to identify exactly what part of a reaction in core prices is actually caused by the original international food price shock. Thus, we use here the orthogonal impulse responses of core prices to a one standard deviation shock to local food prices in each country since local variables are endogenous to the system. Figure 7 plots these impulse responses for each country.

Core price responses to shocks in food prices were positive and statistically significant in all countries, as shown in Figure 7. A positive result indicates that inflationary pressures over core prices take place as a result of increases in local food indicators, which can be explained as a result of rising inflation expectations following Van Duyne (1982). These results can be considered as a proxy for second round effects given that we have already seen that an international food price shock leads to a rise in local food prices. It should be pointed out that some of the effect seen here has probably already been accounted for in local core price indicators' response to a shock in the FAO Food Index, which was also estimated using this same augmented model.

Orthogonal impulse responses allow us to draw some conclusions regarding the timing of the proxy for second round effects. Peru presents the shortest duration in its core prices' response, lasting only two quarters, with the maximum effect taking place in that second quarter. In the cases of Chile and Colombia, the total effect over core prices occurs over four quarters, with the highest effect coming in the fourth quarter as well. In Mexico, core prices take somewhat longer to show a full effect stemming from a rise in food prices, doing so in

Figure 7. Second round effects: orthogonal impulse responses of core prices to a one standard deviation shock to local food prices (horizons in quarters).



Source: Author's calculations.

five quarters, with the maximum effect taking place in that last quarter as well. Brazil presents the longest possible second round effect, with the full response taking over three years[8].

In this subsection we showed evidence supporting the possible presence of second round effects over core prices taking place as a result of an international food price shock. These effects can be explained by rising inflation expectations when local food prices increase, thus modifying agents' price setting strategies much in the same way as they would if their inflation expectations increased due to rising international food prices, as seen in subsection A. These findings serve as additional support for our conclusion that an international food price shock does carry policy implications for regional central banks, given that their effect over food prices leads to an additional effect to core prices, which is, once again, the price category which central banks have traditionally been considered to have an effect over through their monetary policies.

V. Conclusions

In this paper we have looked at how international commodity price shocks can be transmitted to local price fluctuations in Brazil, Chile, Colombia, Mexico and Peru, using data spanning over the last decade. Our goal was to identify if such a transmission did in fact occur and how it affected both food and core prices in order to asses if international food prices shocks could potentially have monetary policy implications for inflation targeting central banks, despite the fact that these type of shocks are usually considered to be supply driven, thus rendering central bank actions to mitigate inflation ineffective.

We calculated the magnitude and timing of a transmission from international food prices to local headline prices. We found evidence that international food price shocks do pass through to local price indicators

[8] In addition to looking at second round effects through our augmented models, we estimated bivariate VARS using the seasonally adjusted food and core price indicators for robustness. We used standard lag selection criteria for these VARS, always making sure no signs of serial autocorrelations were present. In that case, orthogonal impulse responses also suggest the presence of second round effects, as rising local food prices positively affect local core prices.

in all the economies in our sample but that, in general, the transmission is not 100% complete. Regarding the time it takes the shock to have its total effect on local headline prices, the quickest transmission occurs in Brazil, taking just one quarter, while the slowest takes place in Mexico, lasting six quarters for the full effect to take place. Moreover, an international food price shock takes four quarters for its full effect to be registered in local headline indicators in Chile, Colombia, and Peru. Regarding the effects' magnitude, we calculated the elasticities or long run effects of headline prices resulting from an international food price shock, while controlling for the central bank's reaction. The highest elasticity, which can be read as the percentage increase in local headline prices as a result of a percentage increase in international food prices (as measured by the FAO Food Index) was found for Chile at 0.81, while the lowest was Brazil's at 0.12. Elasticities for Colombia, Mexico, and Peru were 0.27, 0.46, and 0.37, respectively. These elasticities suggest that the transmission to local headline inflation from a shock in international food prices is not complete.

We also found that the transmission of an international food price shock to local headline inflation can be seen as a combination of the responses of local food and core indicators to that shock. Our results suggest that the effect over food prices is stronger than the effect over core prices, which can be explained by considering that the former is more directly impacted by rising imported food prices and local market interactions, while the latter increases as a result of rising inflation expectations and thus core price setting strategies. These results thus show that the rise in total consumer prices is not solely explained by rising food prices.

Furthermore, we also found evidence that local core prices do react to local food prices, which opens the door for possible second round effects stemming from international food price shocks. This situation can be explained by the fact that a rise in food prices generates an increase in inflation expectations, which in turn has an effect over core price setting strategies. Our estimations show that the shortest proxy for second round effect takes place the quickest in Peru, with a full effect over core prices occurring in the two quarters following the shock to local food prices. Approximation to second round effects in Colombia, Chile, and Mexico all take place within four quarters after the shock to local prices, while the effect lasts over three years in Brazil.

Having these results at hand, an assessment regarding the implications for monetary policy can be made. Inflation targeting central banks are in charge of keeping inflation rates in their economies low and close to a target they have set for this indicator. Our results suggest that a rise in international food prices has an eventual impact on local inflation processes, which should raise a concern for regional central banks when such a situation takes place. If the shock was solely transmitted to local inflation processes through local food price fluctuations, then a possible reaction by the central bank would most likely prove to be ineffective in its goal to suppress sprouting inflationary pressures. However, our results suggest that this is not the case, with the transmission to headline prices also being explained by an associated rise in core prices, both directly as the international food price shock increases inflation expectations, but also through possible second round effects stemming from local food price increases, which also modify expected inflation and core price setting strategies. It is in this respect that our results suggest there is a role for monetary policy actions in response to global food price shocks, since monetary policy has a clearer impact on core prices than it does on food prices. Hence, a rise in international food prices can be seen as an early warning sign of an eventual rise in both food and core prices, thus prompting regional central banks to take preemptive measures in order to mitigate the effect of such a shock over local inflation processes.

This conclusion comes at a time when international food prices are reaching historically high levels. We first identified a rise in international commodity prices up to the beginning of the Great Recession, which was followed by a similar rise in local food and headline price inflation in the Latin American countries in our sample. When the recession began, however, international food prices dropped, which was quickly followed by disinflations in Latin America, making the effect of the earlier price increase short lasting. Now, as the world economy treads the road to recovery, with Latin American countries a few steps ahead of mean global growth, international food prices are once again on the rise, and are expected to keep doing so as large developed nations step out of their slump, adding to demand for these goods in global markets.

The Latin American countries included in our sample enjoyed decreasing inflation prints through the decade until 2006, which could be explained, among other things, by a combination of the adoption of inflation targeting regimes and a favorable external commodity price environment. At this point, a rise in international food prices was eventually followed by increases in local headline prices all over the region, at the same time monetary policy rates were increased. Pressures on local prices were eventually mitigated through the Great Recession with monetary policy rates falling simultaneously. Our results, which include data spanning a period before, during, and after the Great Recession, and thus implying that the relationships found in the data held through the decade without being broken by this particular episode, suggest that rising international food prices are a tell-tale sign of a new upcoming round of inflationary pressures as international food price indices continue to increase. Moreover, the results found in this paper also imply that monetary policy responses to such an event should not be discarded as they could potentially aid in controlling future price increases in each particular economy, especially through their effectiveness in keeping core prices in check.

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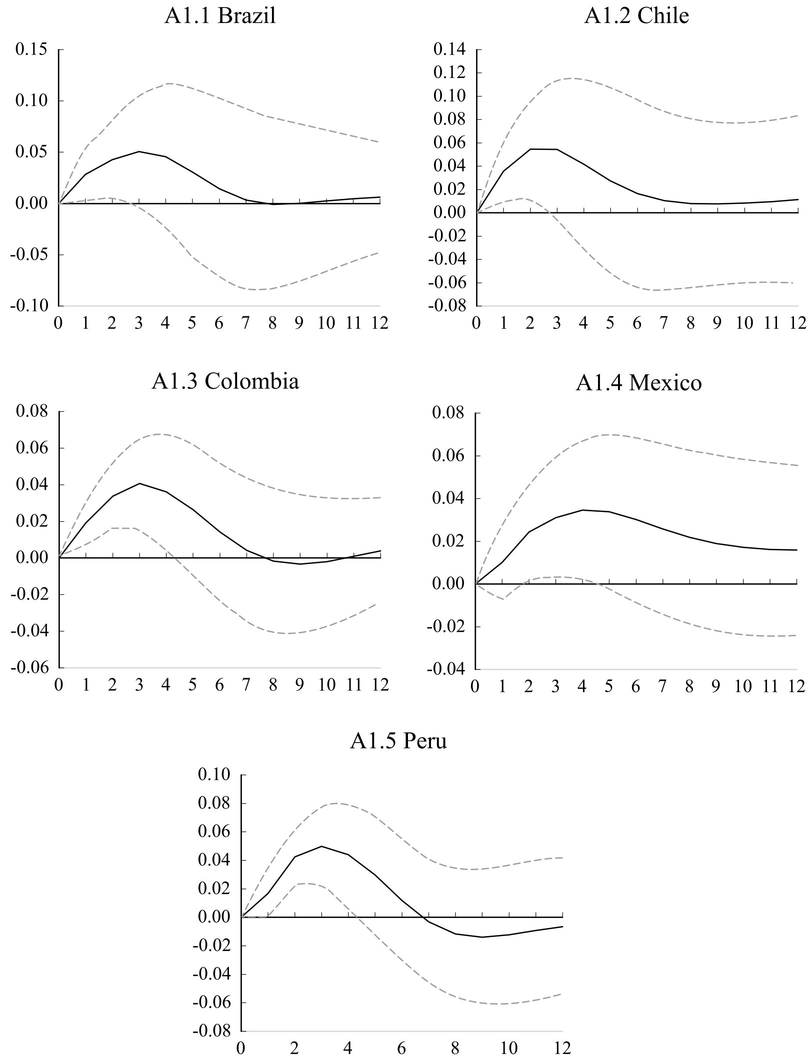
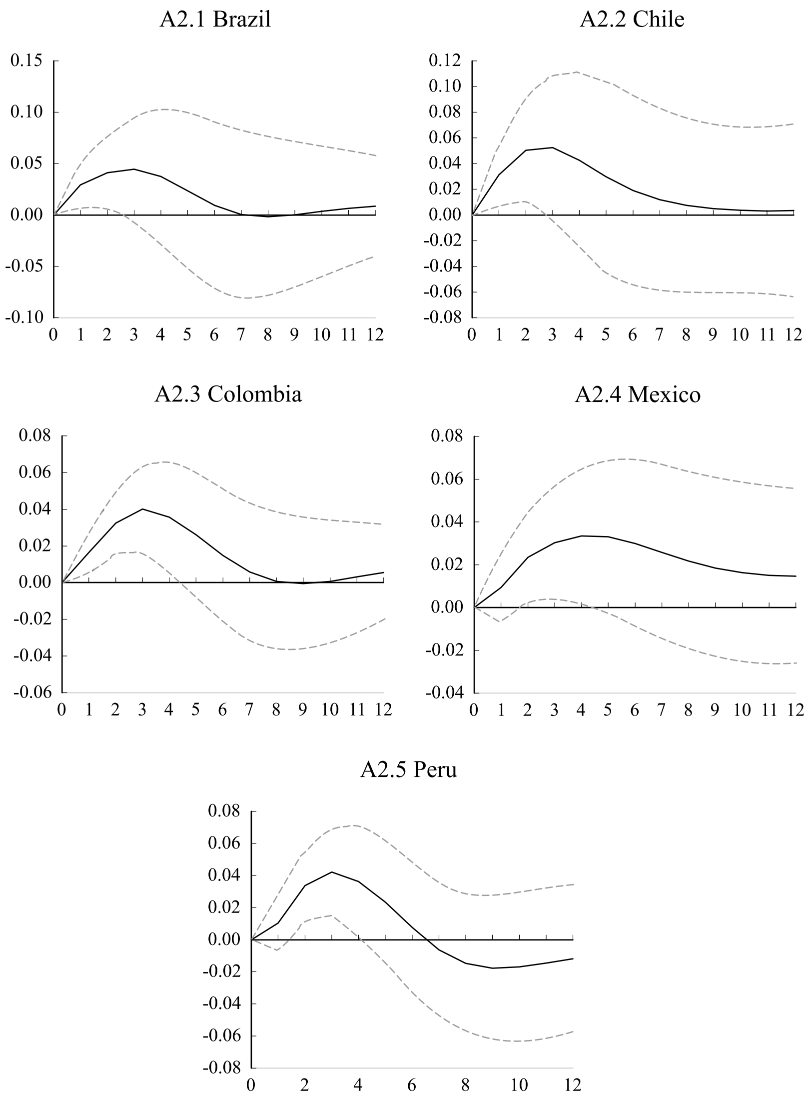
Appendix

Figure A1. Local CPI's forecast error impulse response to a one unit shock to the Dow Jones/UBS index (horizons in quarters).



Source: Author's calculations.

Figure A2. Local CPI's forecast error impulse response to a one unit shock to the S&P index (horizons in quarters).



Source: Author's calculations.

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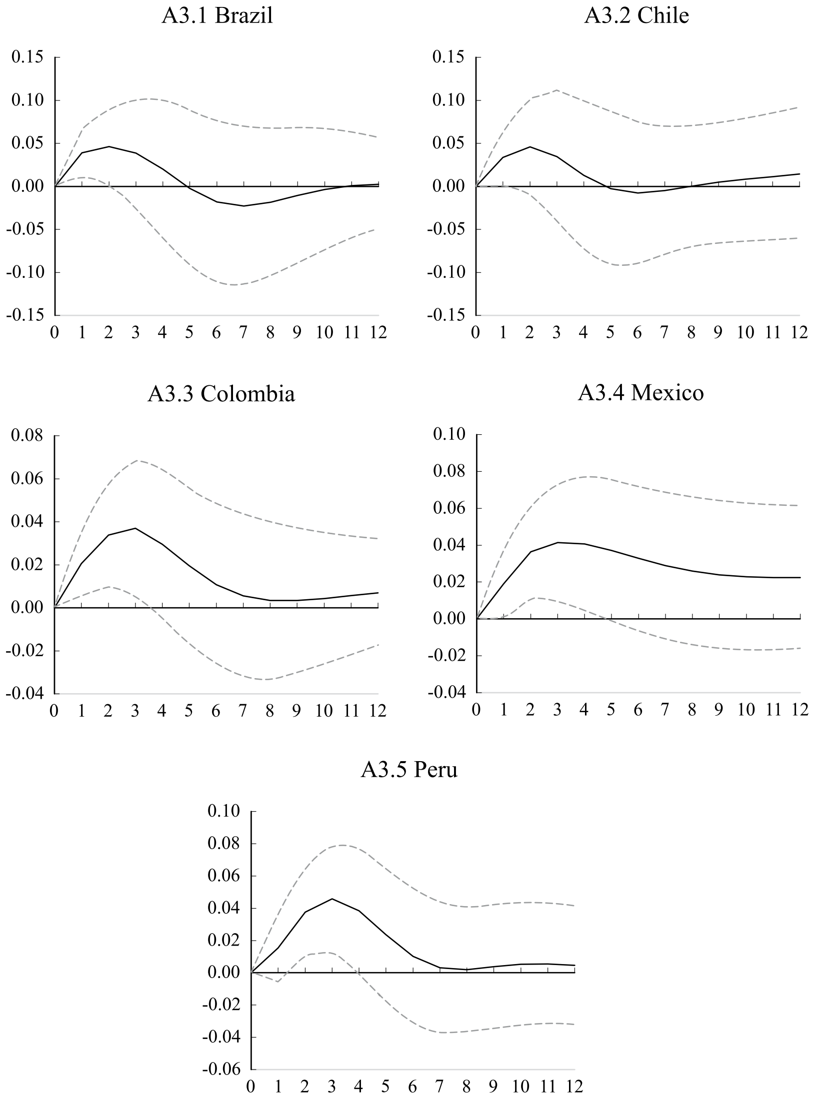
Figure A3. Local CPI's forecast error impulse response to a one unit shock to the UBS/Bloomberg Index (horizons in quarters).



Source: Author's calculations.