WORKING PAPER Nº IDB-WP-1649

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A Heterogeneous VAR Approach

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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

International versus domestic shocks and pass-through to country prices: a heterogeneous VAR approach / Vanessa Alviarez, Peter Pedroni, Andrew Powell, Ingri Quevedo.
p. cm. — (IDB Working Paper Series ; 1649)
Includes bibliographic references.
1. Food prices-Effect of inflation on-Latin America. 2. Food prices-Effect of inflation on-Caribbean Area. 3. Agricultural prices-Effect of inflation on-Latin America. 4. Agricultural prices-Effect of inflation on-Caribbean Area. 5. Inflation (Finance)-Latin America. 6. Inflation (Finance)-Caribbean Area. I. Alviarez, Vanessa. II. Pedroni, Peter. III. Powell, Andrew (Andrew Philip). IV. Quevedo, Ingri. V. Inter-American Development Bank. Department of Research and Chief Economist. IV. Series.
IDB-WP-1649

http://www.iadb.org

Abstract

This study investigates the disconnect between falling agricultural commodity prices and persistent food inflation by applying a Heterogeneous Vector Autoregression (VAR) model to a panel of 203 countries using data from 1961 to 2022. It analyzes the impact of global crops, fertilizer, and oil prices on domestic inflation and explores the asymmetries in the pass-through of global shocks. Results show that fertilizer price shocks significantly influence crop prices, especially maize and soybeans, while production shocks have a weaker effect. Demand-driven price changes exhibit higher pass-through to food inflation compared to supply-driven shocks, with country-specific characteristics shaping these responses. A historical decomposition reveals that global factors played a larger role in inflation during 2021, particularly for emerging economies, while advanced economies were more affected by domestic shocks. These findings highlight the importance of tailored policies to mitigate inflation in the face of global commodity price volatility.

JEL classifications: E30, E31, Q02, Q11
Keywords: Food prices, Commodities, Inflation, Agriculture

Vanessa Alviarez and Ingri Quevedo are at the Research Department of the Inter-American Development Bank (IDB). Peter Pedroni and Andrew Powell are Professors at Williams College and are consultants to the IDB. We wish to thank Christopher Gilbert and Michel Robe for very useful conversations on this topic.

1 Introduction

Food prices have been on the rise in recent years and soared after the Russian invasion of Ukraine, putting significant pressure on overall inflation. Figure 1 plots food prices and overall consumer prices in Latin America and the Caribbean. The graph shows various periods where food prices grew strongly compared to overall CPI including around 2007-2008, 2011-2012 and especially 2021-2022 after the pandemic and the Russian invasion of Ukraine. While median CPI rose about 150% between 2000 and 2022, food CPI rose by over 250% over the same period. Note, however, that there is considerable country heterogeneity in country-level food CPI movements, as indicated by the gray lines in the background of Figure 1. Given the strong price rises in food products there has been considerable concern regarding the ability of lower-income families to purchase basic required goods that are a larger share of their consumption basket relative to richer households. Understanding the movement of food prices is important for many reasons, including policy. Governments need to assess whether to respond to protect the more vulnerable, and if so how, and Central Banks have a strong interest in understanding the movements in food prices to calibrate monetary policy.

Food prices have risen over recent years for many reasons.[1] These include increased demand as the global population has grown and as incomes have improved, including the extraordinary growth in China through the 2000s. Oil price changes also impact food prices, as transport and other energy uses are important inputs for agricultural supply, and given rises in oil prices, there has been increased interest in using agricultural production for biofuels rather than for food. There has also been interest in the implications for the "financialization" of commodities for prices. Climate change has additionally exacerbated extreme weather events including storms, droughts, and extreme temperatures, which may lead to greater supply shocks. The Russian invasion of Ukraine had several impacts on food prices. First, there was a direct effect on supply, as both Ukraine and Russia are significant grain producers.[2] [3] Second, oil prices rose steeply given the potential reduction in the amount of Russian crude on the world market. But the Russian invasion of Ukraine also placed attention on a further set of shocks that hit food prices, namely the disruption of the global market for fertilizers. Russia is the largest exporter of fertilizer in the world, and the war plus the sharp rise in natural gas prices, which then impacted fertilizer production in Europe, had a huge impact on fertilizer prices.[4]

The interactions between fertilizer markets, grain markets and country food prices are complex.[5] Supply shocks to grain markets such as a war or a drought, or some other event in a significant producer country, may have direct impacts on global prices for grains.

[1] See, for example, Gilbert (2010).

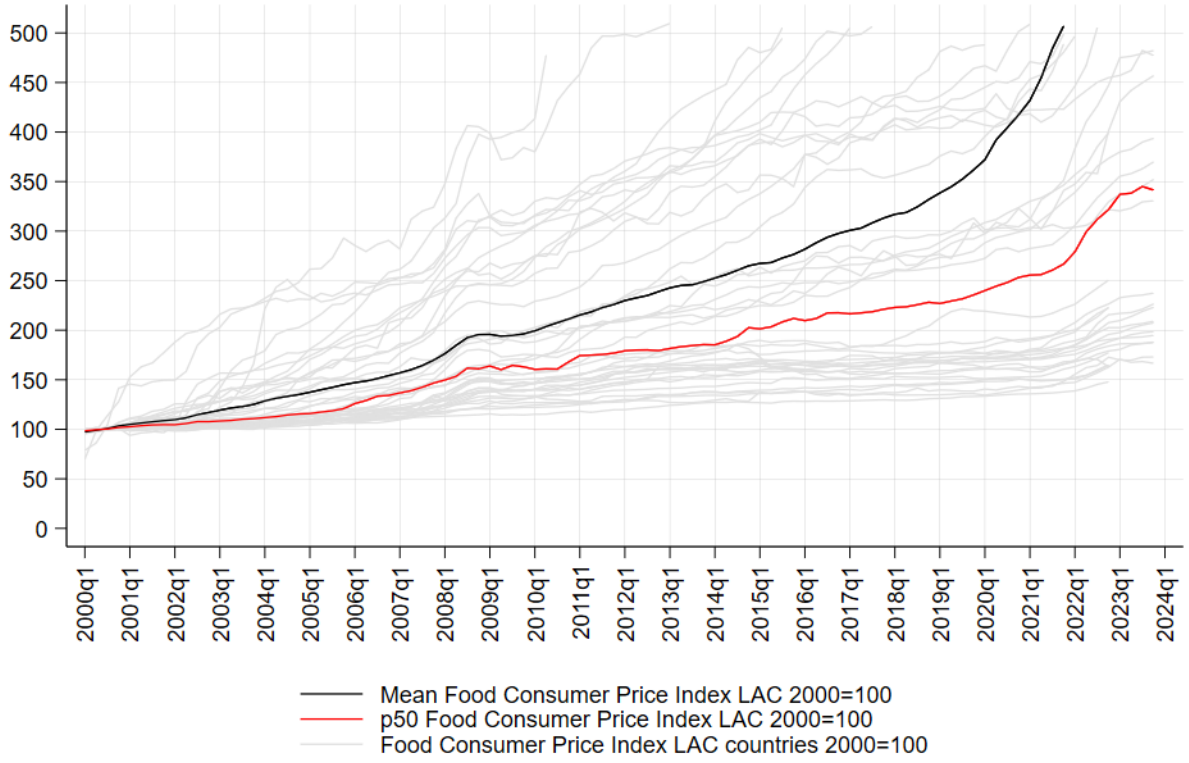
[2] Belarus is also a grain and fertilizer exporter.

[3] Still, while Russian exports for grains fell initially, they rose to a record level in the 2022/2023 season. See Russian grain exports in 2023/24 may slip from record-high 2022/23 - lobby group | Reuters

[4] See Gilbert (2023) for a discussion of the impacts of the war and the Black Sea Grains Initiative on fertilizer and food prices.

[5] See USDA (2022) and IMF (2022a) for a discussion.

Figure 1: Food Prices in Latin America and the Caribbean



Source: Staff's calculations with data from the IMF CPI quaterly data.

Note: Latin American and the Caribbean countries included in this graph are Aruba, Anguilla, Argentina, Antigua and Barbuda, the Bahamas, Belize, Bolivia (Plurinational State of), Brazil, Barbados, Chile, Colombia, Costa Rica, Curaçao, the Cayman Islands, Dominica, the Dominican Republic, Ecuador, Guadeloupe, Grenada, Guatemala, French Guiana, Guyana, Honduras, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Mexico, Montserrat, Martinique, Nicaragua, Panama, Peru, Puerto Rico, Paraguay, El Salvador, Suriname, Trinidad and Tobago, Uruguay, Saint Vincent and the Grenadines, and the British Virgin Islands.

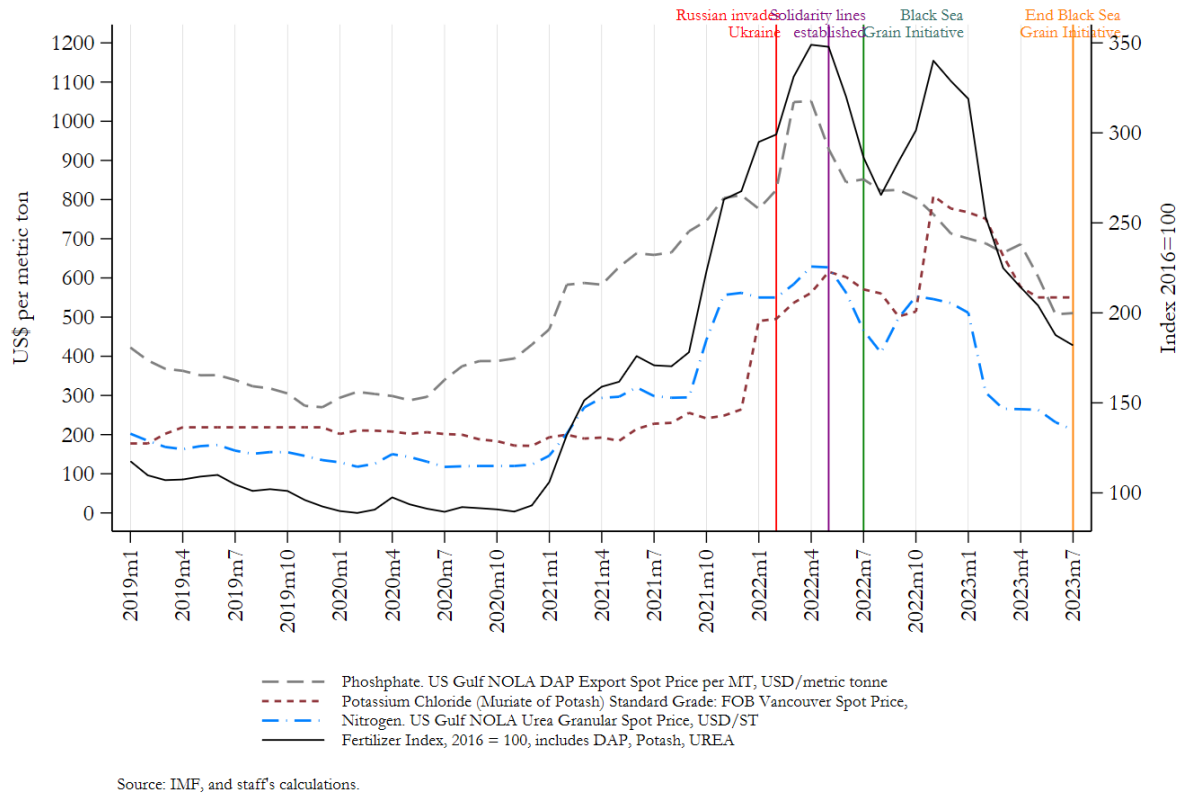
Demand shocks may also impact grain markets directly.[6] But grains and other crops also require fertilizers. Fertilizer use varies across crops and across countries.[7] There are 3 main fertilizer nutrients, namely nitrogen, potassium and phosphorus. Different crops in different countries require different amounts of these nutrients, and there are different

[6]See Kilian (2009) for a discussion of how to separate demand from supply shocks in the case of oil prices.

[7]In larger countries this also varies across regions, as fertilizer use depends on soil type and other environmental factors.

technologies for their application. Moreover, some countries are more intensive in the use of fertilizers than others. Fertilizer prices have varied considerably over recent years. Figure 2 displays the prices of the three main nutrients alongside the composite fertilizer price index. It is important to note that fertilizer prices were already trending upwards prior to the Russian invasion of Ukraine, partially driven by heightened oil prices in the last quarter of 2021—an essential intermediate input in fertilizer production. The invasion significantly exacerbated this trend. However, subsequent initiatives to facilitate trade from the region, such as the Black Sea Grain Initiative, have somewhat mitigated the price surge Gilbert (2023).

Figure 2: Fertilizer Prices



Source: Staff calculations with data from the World Bank Commodity Prices Dataset "Pink Sheet."

Note: Prices deflated using the Manufacturing Unit Index.

Shocks to fertilizer prices may provoke different responses. In general, farmers have limited scope to reduce fertilizer use per hectare of the crop planted, as this depends strongly on soil and the technology of application, which is hard to change quickly.[8] If farmers can

[8]See the discussion in USDA (2022) that discusses farmers' limited degrees of freedom given a strong

pass on the additional cost of a fertilizer price increase, then that might provoke a rise in grain prices. Farmers may also decide to produce less, provoking further price increases, although flexibility is low once the crop is planted. While farmers have limited scope for reducing the amount of each nutrient per hectare, there may also be substitution between crops, as one crop may be much more intensive in the use of one type of fertilizer and less intensive in the use of another. A price shock in one type of fertilizer may then provoke a switch to crops less intensive in that product. Still, such switches may not happen immediately. After planting farmers' choicesare largely locked in, and such switches are thus likely to occur for the following season and if soil and other environmental conditions permit. By the same token, shocks to crop prices may also provoke changes in fertilizer prices. An increase in the demand for one product may induce a greater area to be planted and hence a higher fertilizer demand, although if the change in demand induces a switch from one crop to another, then that would induce a switch in demand from the quantities of nutrients relevant for the original crop to those relevant to the one that is now in higher demand. The various sources of shocks and their potential impacts and feedback effects call for an analysis through Vector Autoregression (VAR) techniques. One approach is to consider the market for fertilizers and crops, a global one, and we start with that approach. In particular, we estimate VARs that include global crop prices, global fertilizer prices and global production. However, we also wanted to analyze responses at the country level. Having established how global fertilizer price shocks may impact global grains markets, we first look at how food CPI at the country level reacts to changes in global grain prices. Such impacts may be heterogeneous across countries. We therefore adopt a heterogeneous VAR approach which can allow for different country characteristics to influence the pass-through from global prices of grains to the value of a country's consumer food basket. Having established that a) fertilizer prices impact global grain markets and b) global grains prices impact country level food CPI, we turn to the more complex question of how global fertilizer price shocks may impact country-level agricultural production. In particular we are interested in how global fertilizer prices may induce different responses across countries, depending on the crops that they produce, and the different intensity of their fertilizer use for those crops, depending largely on soil and fertilizer application methods. This paper is organized as follows. Section 2 discusses the characteristics of the data utilized in our analysis. Section 3 delves into the dynamics of the global market for grains and fertilizers. In Section 4, we examine the pass-through effects of global grain prices on country-level Consumer Price Indices (CPI). Section 5 explores the interrelationships between fertilizer prices, grain prices, and country-level production. Section 6 analyzes the asymmetrical responses to international demand and supply shocks. The paper concludes with Section 7.

rise in fertilizer prices.

2 Data Description

Our study includes data from 203 countries, focusing on three key crops—wheat, maize, and soybeans—and three primary fertilizer nutrients—Phosphorus, Nitrogen, and Potassium. The global benchmark prices for these commodities are sourced from the World Bank. At the national level, we examine crop production and the Food Consumer Price Index (CPI) from the UN's Food and Agriculture Organization (FAO), spanning from 1992 to 2022. Price data are adjusted for inflation using the Manufacturing Export Unit Value Index from the World Bank and transformed into log changes for the analysis.

To enhance the temporal resolution of our data, we expanded the frequency to quarterly intervals by allocating production data to the corresponding harvesting quarter. This approach follows the methodology described by De Winne and Peersman (2016), which utilizes country-specific harvest calendars to accurately distribute annual production figures across the relevant quarters.

For a broader view, we employ the global cereals price index from the IMF and the global fertilizer price index from the World Bank, alongside annual gross production data for a comprehensive set of cereals, as defined by the FAO. This dataset encompasses production metrics from 1992 to 2022.

Additional variables include Crop Quality Metrics (assessing fat, caloric, and protein content), Trade Openness Indicator (exports and imports as a percentage of GDP), Exporter Identification Index (categorizing countries based on their export volume), and Arable Land data (total hectares, averaged over 2010-2020), all sourced from the World Bank. Economic indicators such as GDP per capita at PPP and total population for 2023 are also included to enrich our analysis.

This combination of agricultural, economic, and demographic data allows for a comprehensive analysis of the factors influencing agricultural markets over the past three decades.

3 The Global Market for Grains and Fertilizer Prices

In this section we present the results of VARs estimated with global crop prices, global crop production and global fertilizers. Here we present the results using a standard Cholesky decomposition where we order the variables with the three fertilizer nutrient prices as the first three variables, followed by global production and then followed by global prices. This implies that (global) fertilizer prices may impact contemporaneous (global) crop production quantities and prices, but that global production can only impact fertilizer prices with a lag and global prices can only impact fertilizer prices and global production quantities with a lag. After the contemporaneous effect in the first period there are no further restrictions. While this identification does present a set of restrictions, given the fact that farmers tend to be locked in after crops are planted, there is

a natural interpretation in the real world. In future work we plan to use other restrictions, adopting Structural VAR techniques, to identify the VAR and allowing us to differentiate between what might be thought of as supply shocks in crop markets versus demand shocks in crop markets. Still, the results from the standard Cholesky identification scheme are interesting and serve to illustrate the importance of fertilizer prices in these markets.

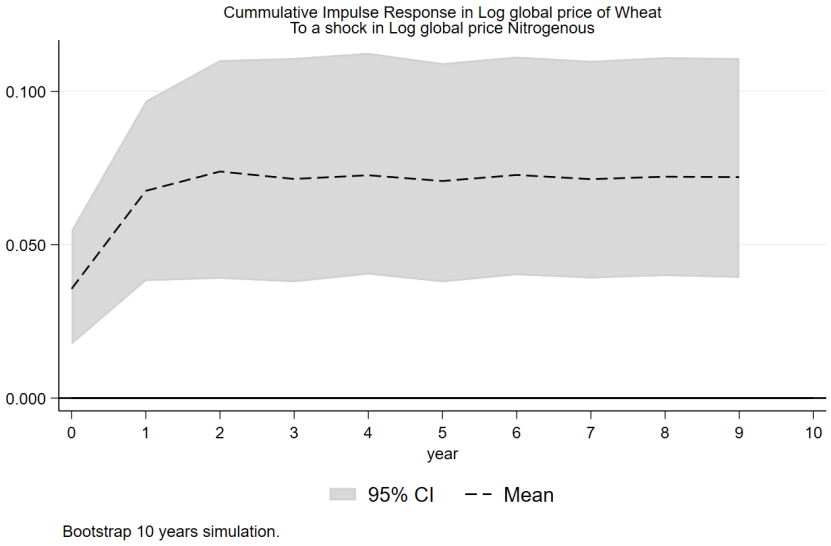
We focus on three crops, namely wheat, maize and soybeans. Global production and price data come from the UN's Food and Agriculture Organization (FAO), and the three fertilizer nutrients, namely phosphorus, nitrogen and potassium, and their inferred prices come from the World Bank. The data run for 30 years from 1992 to 2022. The price data are all deflated by manufacturing export units values, and all the data employed in the VAR are in the form of log changes.[9] This then allows the coefficients to be interpreted as elasticities and taking first differences eliminates the econometric problem of potential non-stationarity in price levels. [10]

To give an example of the results Figure 3 plots the impact of a one percent positive shock in nitrogen fertilizer prices to maize prices. As can be seen, the impact of the shock is positive and significant and implies that a 10% rise in nitrogen prices would lead to more than a 3% change in maize prices initially and rising to almost a 6% change after three years. Somewhat similar results are found for the impact of Phosphorous prices shocks on maize prices (see Figure 4). The impact of a Potassium fertilizer price shock to Maize prices is also initially positive (i.e., to increase prices), but this dies out and becomes insignificant after two or three years; see Figure 5. These results reflect the relevant importance of nitrogen and phosphorous fertilizers for maize production.

[9]The manufacturing unit value series is the IMF's MUV series for manufactured exports from a set of advanced and higher income developing countries.

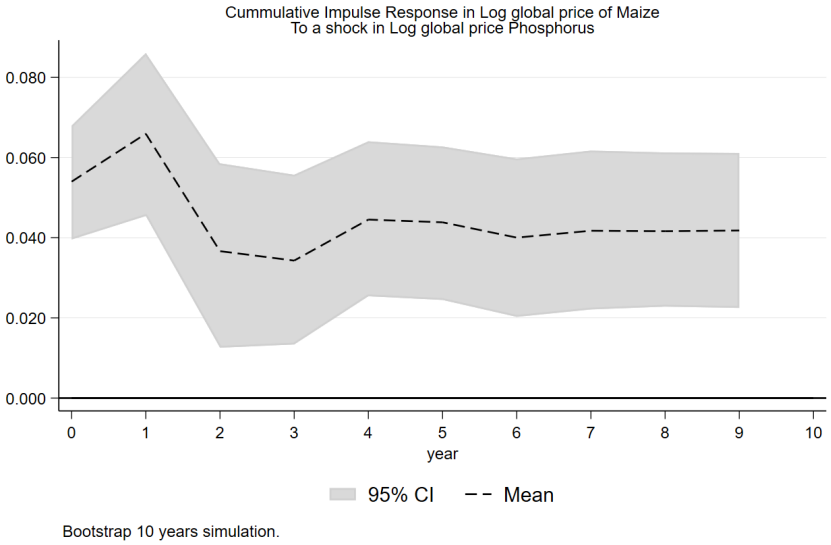
[10]Strictly speaking, it eliminates this problem if prices are I(1).

Figure 3: Impact of a Shock to Nitrogen Fertilizer Prices to Maize Prices



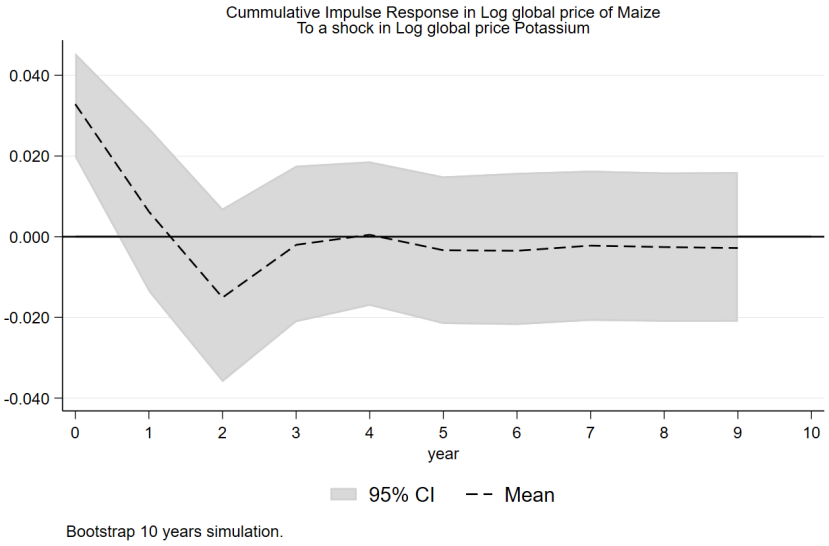
Note: Bootstrap 10 years simulation.

Figure 4: Impact of a Shock to Phosphorous Fertilizer Prices to Maize Prices



Note: Bootstrap 10 years simulation.

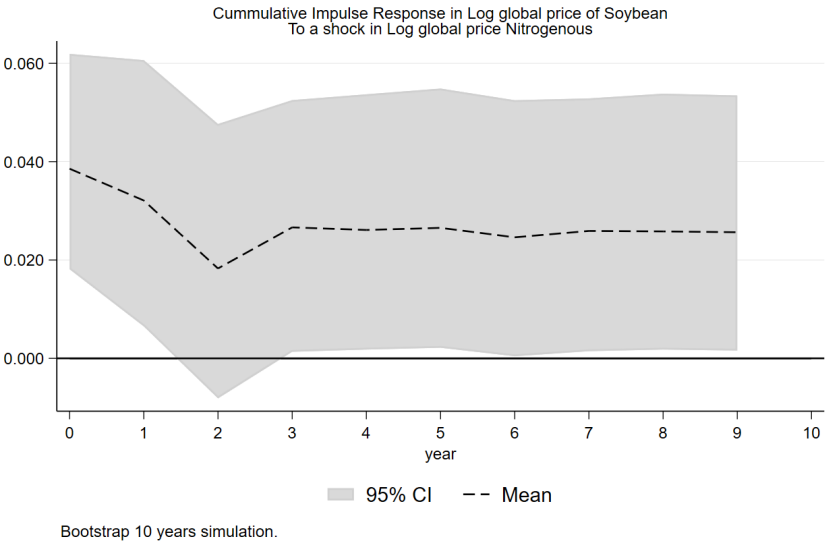
Figure 5: Impact of a Shock to Potassium Fertilizer Prices to Maize Prices



Note: Bootstrap 10 years simulation.

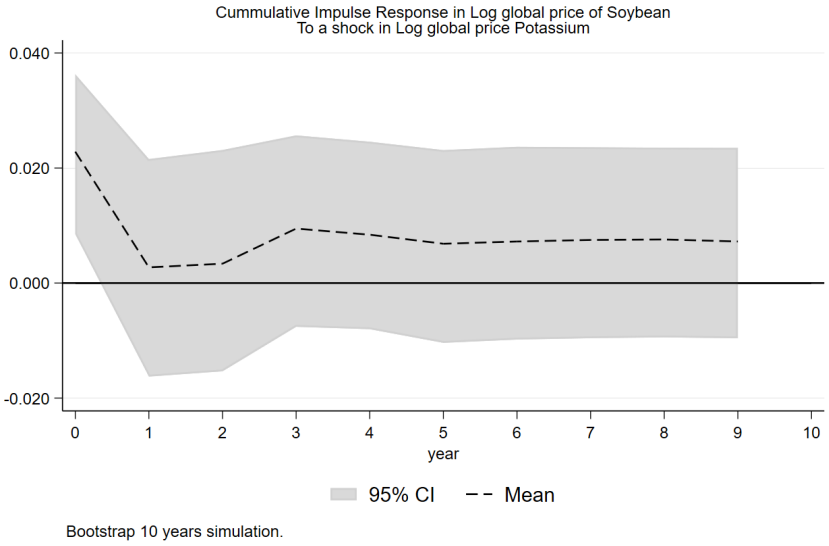
We also find positive impacts of nitrogen and phosphorous fertilizer prices on soybean prices but no significant reaction in soybeans to potassium fertilizer prices.

Figure 6: Impact of a Shock to Nitrogen Fertilizer Prices to Soybean Prices



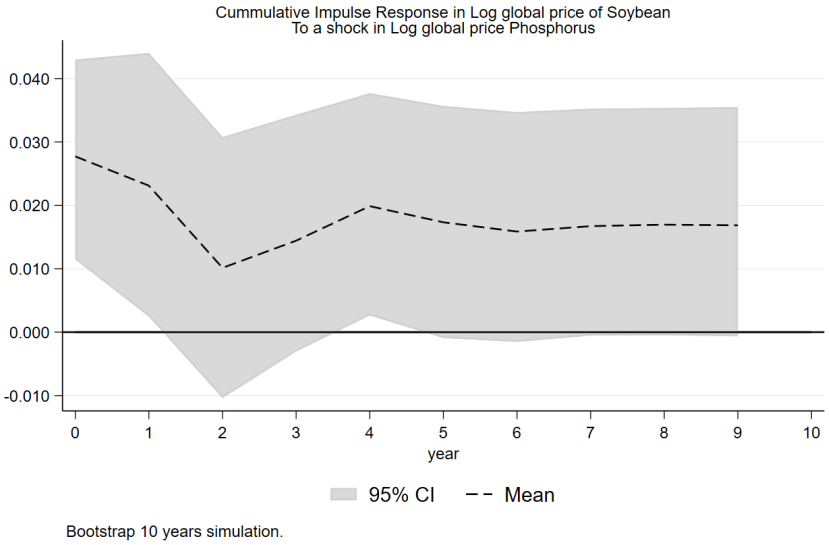
Note: Bootstrap 10 years simulation.

Figure 7: Impact of a Shock to Phosphorous Fertilizer Prices to Soybean Prices



Note: Bootstrap 10 years simulation.

Figure 8: Impact of a Shock to Potassium Fertilizer Prices to Soybean Prices

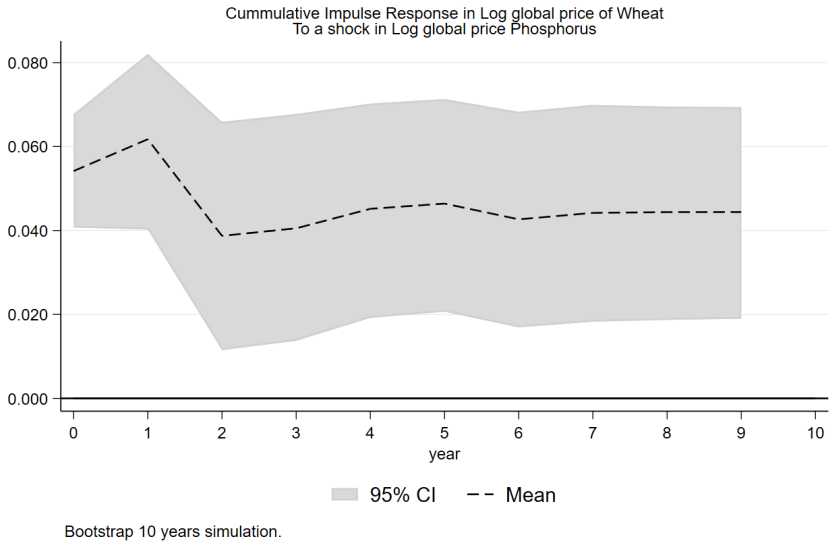


Note: Bootstrap 10 years simulation.

The impacts of fertilizer price shocks on crop production in general are weaker than the impacts of fertilizer price shocks on crop prices. For example, a shock to phosphorus

fertilizer prices has a significant negative impact on Wheat production, but this dissipates quickly over time.

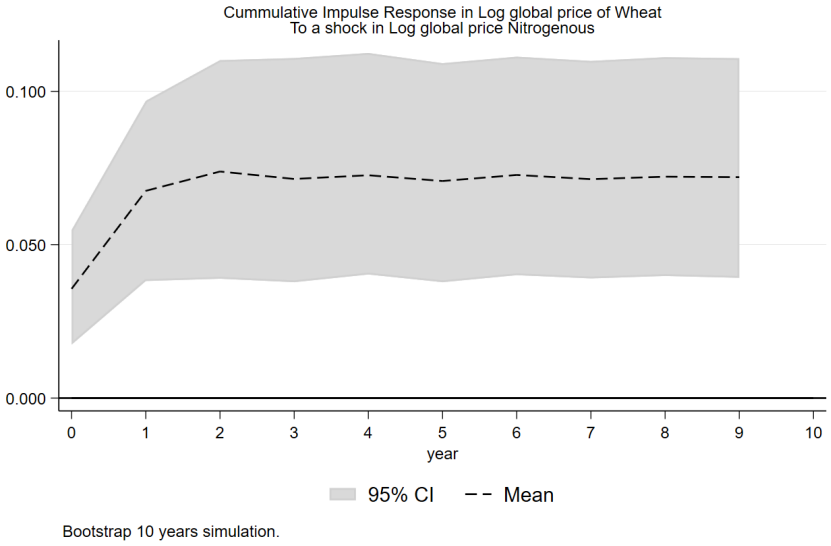
Figure 9: Impact of Phosphorous Price Shock on Wheat Production



Note: Bootstrap 10 years simulation.

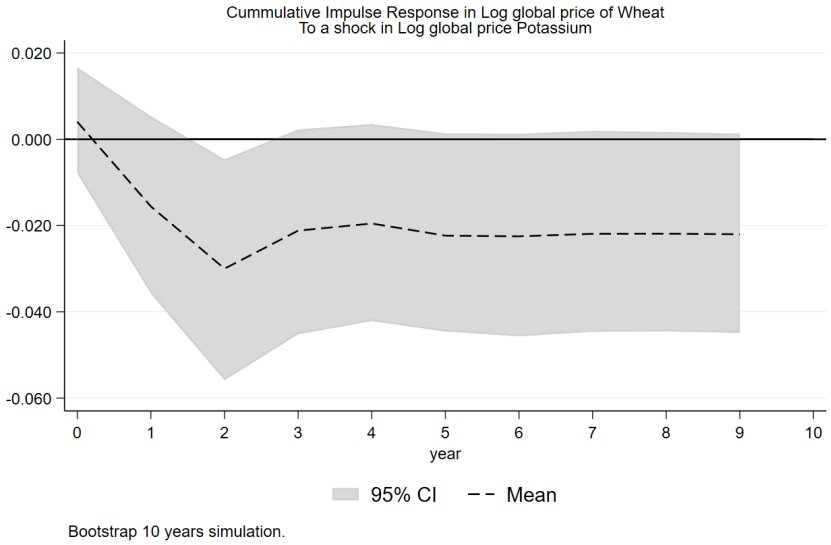
A similar reaction is found for maize and soybean production as a response to a shock to nitrogen fertilizer prices (Figure 10 and Figure 11). The remaining fertilizer shocks had little or no significant impact on crop production.

Figure 10: Impact of Nitrogeneous Price Shock on Wheat Production



Note: Bootstrap 10 years simulation.

Figure 11: Impact of Potassium Price Shock on Soybean Production



Note: Bootstrap 10 years simulation.

The fact that fertilizer price shocks appear to have greater impacts on crop prices than on crop production is an interesting result. It may imply that, in general, farmers are able

to mark up prices given a rise in this important input price. However, these results on global production may hide heterogeneous impacts at the country level. While global production may be reasonably stable in the face of fertilizer shocks there may be negative impacts on some countries (that are intensive in the use of the fertilizer type suffering a positive price shock) and other countries (less intensive in the use of that type of fertilizer increase production to take advantage of the rise in crop prices. We come back to this point below.

4 Global Crop Prices and Country Food CPI

Having established that shocks to fertilizer prices impact global crop prices, the next question we address is how those global crop prices impact country food CPI. There have been various studies focusing on this question but none to our knowledge that use the heterogeneous VAR approach that we adopt here.[11] Some studies conduct panel regressions to obtain a pass-through coefficient and then ask the question, what country factors does that coefficient depend on? The downside with this approach is that, in a dynamic panel context, including interaction effects will likely result in biased estimates. The two-stage heterogenous VAR approach, by contras, yields consistent estimates.

The first stage of this approach is to run country-level VARs where there is one local variable (namely the country food CPI) and three global variables (namely the three global crop prices). We choose a lag length of five years with annual data running for approximately 30 years from 1992 to 2022. [12]

[11] See, for example, IMF (2022b) for a discussion of the impact of food prices on country CPI. See Mishra et al. (2014) for a discussion of heterogenous effects in the panel and VARs with a different application.

[12] As we are running individual VARs for each country, the data are unbalanced.

Figure 12: Impact of Grain Price Shocks on Country Food CPI

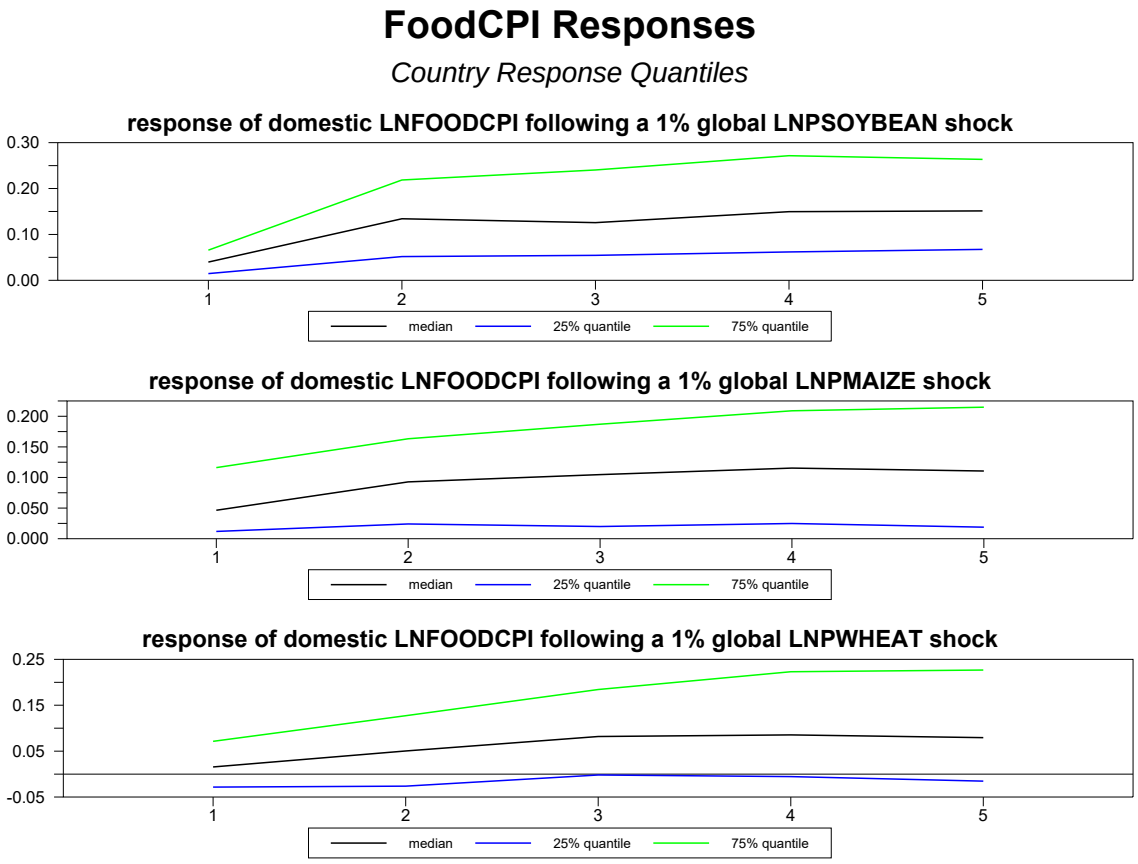
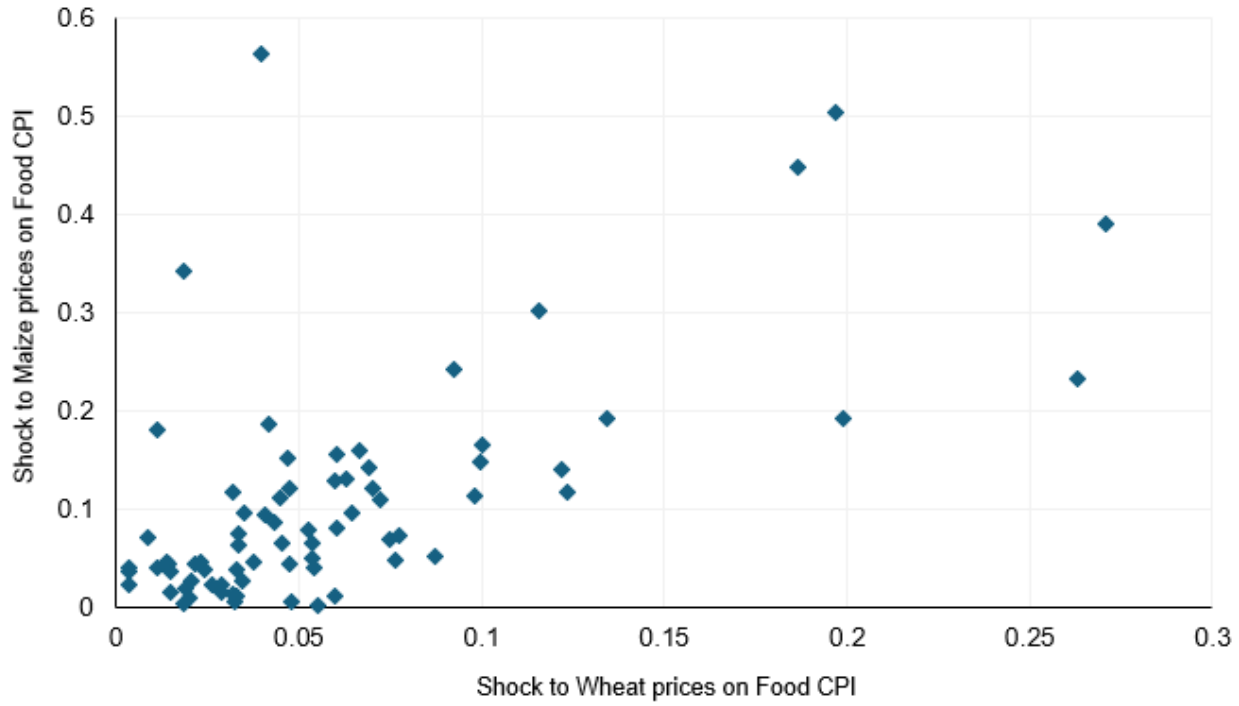


Figure 12 plots some of the results of this analysis, namely how a shock to the three crop prices (maize, wheat and soybeans) impacts country-level food CPI. The VARs include 99 countries, and the figure shows the median impulse response as well as the 75th quartile and the 25th quartile response across countries. A 10% shock in each of the crops leads to a median response of close to 1%, while countries around the 75th percentile suffer close to a 3% rise in food CPI. The second stage of this analysis is then to regress the individual country-level impulse responses on a set of variables that may explain this heterogeneous response. Figure 13 and Figure 14 illustrate the nature of the heterogenous response. In Figure 13 we provide a cross-plot of the one-year impulse response from a 1% shock in wheat and maize prices, and Figure 14 provides a cross-plot of the one-year impulse response from a 1% shock to maize and soybean prices. It is clear that in both cases there is a strong positive correlation between the impulse responses. In fact, countries that suffer high pass-through from one of these crops to food CPI tend to suffer from high pass-through from shocks to the other crop prices as well. This suggests that there may be a set of deeper structural factors that explain high versus low pass-through from shocks

to global crop prices to country food CPI.

Figure 13: Impact of a Shock to Wheat and Maize Prices on Country Food CPI: One Year Impulse Response (Outliers are excluded)



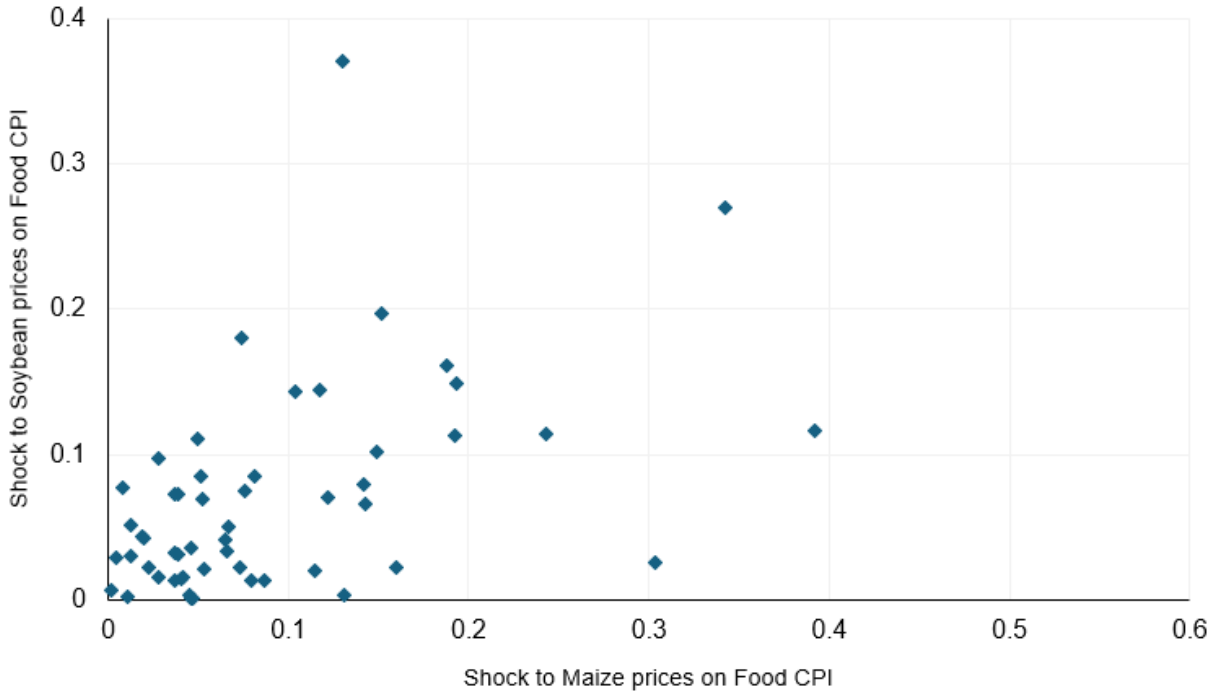
The next step is then to analyze a set of second-stage regressions to uncover what these deeper country characteristics might be. We leave this analysis to a companion paper.

5 Fertilizer Prices and Country Production Responses

As mentioned above, while shocks to fertilizer prices have strong implications for global crop prices, global production of these critical agricultural products appears to be relatively stable in the face of such shocks. However, this does not mean that there are no impacts at the country level. As countries use different fertilizer mixes, given different soil types and fertilizer application methods, a shock to, say, nitrogen fertilizer prices may impact production negatively in one country (which is intensive in the use of that fertilizer type) but, as that shock may also provoke a hike in the price of these crops, a positive production response in countries that use that type of fertilizer less intensively.

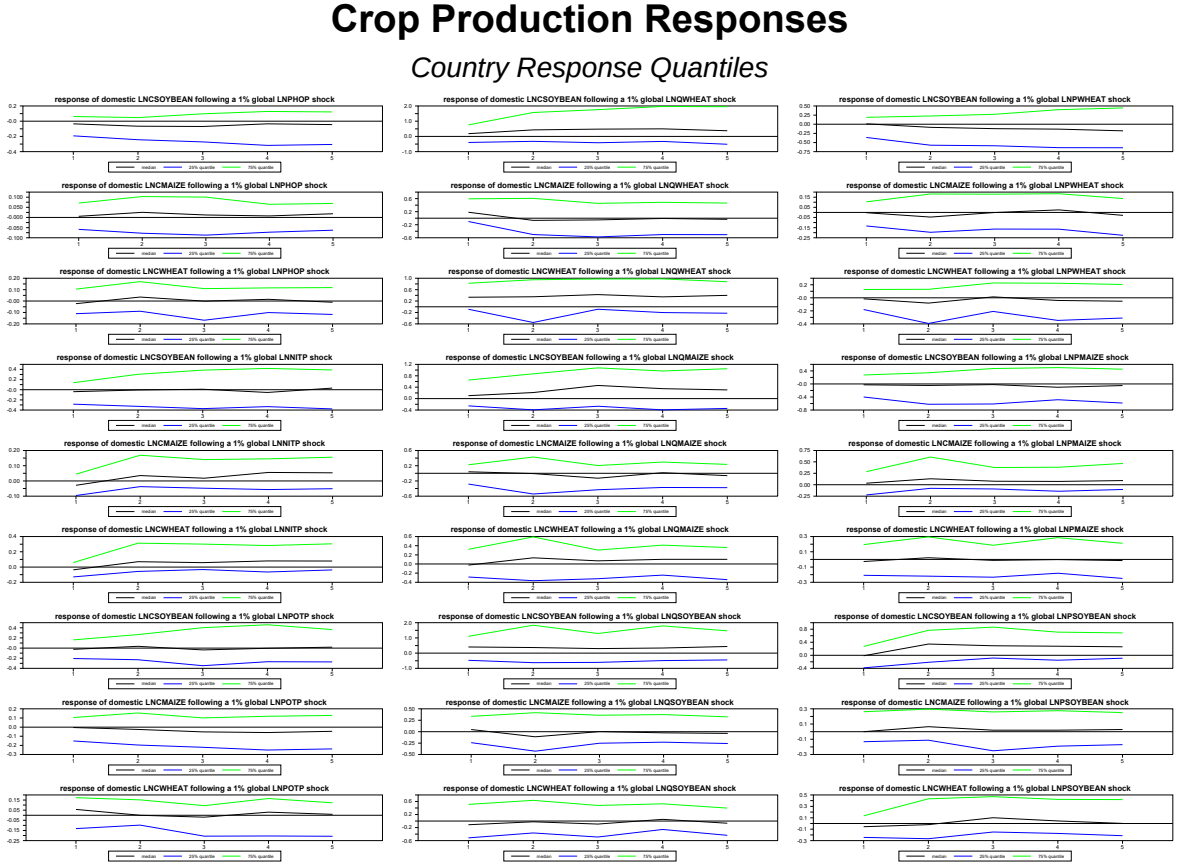
In order to investigate these possibilities, we now turn attention to a more complicated heterogenous VAR which attempts to uncover such effects. We start with a set of VARs which have six variables at the global level (the prices of the three crops: maize, wheat

Figure 14: Impact of a Shock to Maize and Soybean Prices on Country Food CPI: One Year Impulse Response (Outliers are excluded)



and soybeans; and the prices of the three fertilizer types: phosphorous, nitrogen and potassium) and three variables at the local (country) level, namely the production of the three crops (maize, wheat and soybeans). In this case, these VARs are estimated across 67 countries for which we have data over a reasonable time span of again around 30 years. Figure 15 illustrates the results by plotting a set of impulse responses obtained.

Figure 15: Impulse Responses from an Analysis of Global Crop and Fertilizer Prices and Country-Level Crop Production



These impulse responses illustrate a number of important features. In the first column of impulse responses are the impacts of a shock to phosphorous fertilizer prices to the country production of soybeans, wheat and maize, followed by the impact of shocks to nitrogen fertilizer prices on the country production of the same three crops. The first three graphs in the second column then show the impact of shocks to potassium fertilizer prices on the production of the same three crops. First, the response of the median country is frequently zero or quite close to zero and in statistical tests insignificant. This accords with the result in the first VAR with the global variables only where global production was relatively stable in the face of fertilizer price shocks. Second, there is considerable heterogeneity in the responses. While in some cases there is a negative reaction in production for the median country to a rise in fertilizer prices (for example, in the case of phosphorus fertilizer prices on soybean production), there is a large degree of heterogeneity in all of the reactions. In the case of a 10% shock in nitrogen fertilizer prices on soybean production, the 25th percentile country reduces production by almost 4%, while

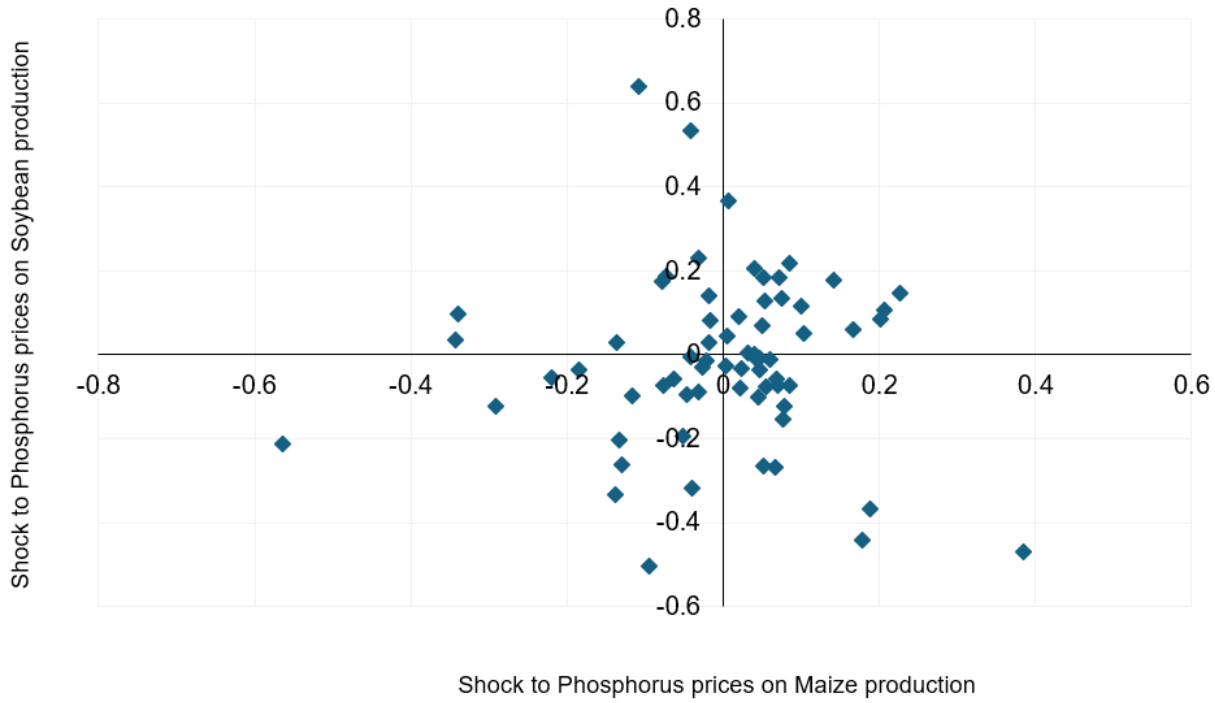
the 75th percentile country increases production by almost 4%.

The other impulse responses illustrate the impacts of global prices on country-level production. Positive price shocks for maize and soybeans provoke increases in maize and soybean production respectively for the median country, while global wheat price shocks have little impact on wheat production for the median case. There are also cross- effects; for example, a positive price shock for maize and for wheat provokes a negative effect on production of soybeans for the median country. But once again there is considerable heterogeneity across countries, as illustrated by the 25th and 75th percentile responses.

As an illustration of this heterogeneity, Figure 16 plots the country-level reactions in terms of the production of wheat and maize in the first period to a positive shock in phosphorous fertilizer prices. There are some countries located in all four quadrants of the graph. This means that some countries react by reducing both the quantity of maize and wheat produced, some reduce the production of wheat and increase the production of maize, and some reduce the production of maize and increase the quantity of wheat produced, while a few countries increase the production of both. Similar heterogeneity was found considering longer impacts and also considering different fertilizer-crop combinations.

These different reactions may depend on, among other characteristics, the particular pattern of fertilizer use for each crop across countries. Perhaps the most interesting aspect is that the various substitutions that are taking place (increases in the production of one crop but a reduction in the production of another) add up to the overall results that global production remains relatively stable in the face of a fertilizer price shock. In turn this suggests that farmers are finding flexibility by switching between the production level of different crops even if fertilizer use by hectare planted of each specific crop does not vary greatly.

Figure 16: Impact of a 1% Rise in Phosphorous Fertilizer Prices on Country Wheat and Maize Production



6 Supply vs Demand Shocks

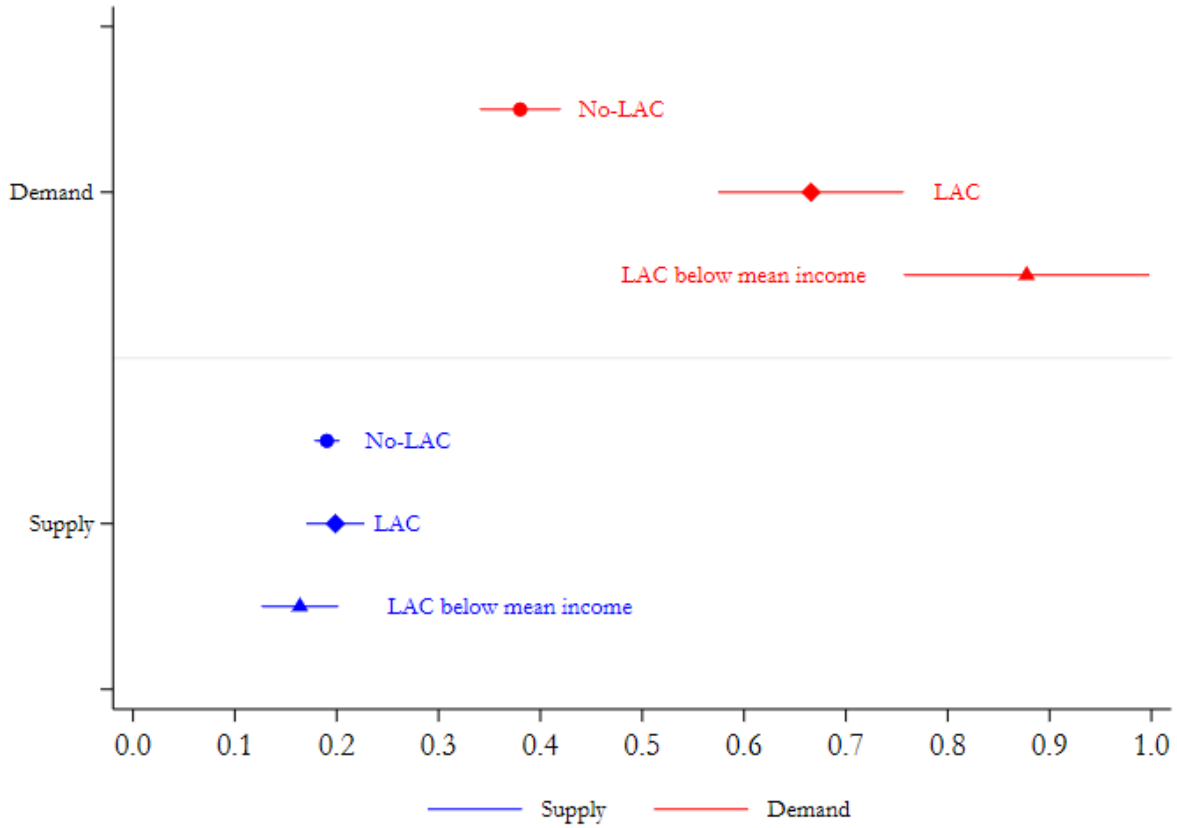
A decomposition of the shocks reveals that the pass-through from global crop prices to food inflation in the typical country is much greater when the change in crop prices is demand-led, compared to the pass-through when supply shocks impact global agricultural prices. Hence, the apparent asymmetry in the transmission may arise from differences in how global crop prices affect country-level food inflation, depending on the underlying cause of the change in crop prices—whether due to supply or demand shocks—and the composition of these shocks.

The pass-through also varies considerably by country. Previous analyzes have acknowledged this heterogeneity, attempting to explore it by introducing country characteristics. The typical approach is to let the overall impact of a change in crop prices on food prices depend on a relevant interaction, such as the country's degree of openness or income level. However, traditional techniques like panel regression (across countries and over time), or the increasingly popular local projections technique, generally yield biased results when including these interaction terms. In contrast, the methodology employed here involves running country-level structural vector autoregressions, extracting the pass-through for each country from the impulse responses, providing unbiased esti-

mates.

The figure below illustrates the pass-through from a 1% increase in maize prices depending on whether the increase in the crop prices was due to a shock in demand or supply for Non-LAC or LAC, as well as for countries in LAC with income per capita below the regional average.[13] [14]

Figure 17: Average Pass-through to Food CPI of a 1% Shock in Maize Prices and Production



Note: The supply coefficient show the average response of Food CPI to a production shock. The demand coefficients show the average response to a price shock.

[13] Maize is the world's most multi-purpose crop, and it leads global cereal in terms of production (>1.2 million metric tons a year), area coverage (>197 million hectares) and utilization (food, feed, and industrial input) (Erenstein et al. (2022)).

Moreover, maize is the main crop produced in the region, and LAC is the second region in the world with the largest mconsumption for food, and with the largest food to feed ratio.

[14] The sample contains 99 countries: 16 countries from Latin America and the Caribbean, 20 countries from Europe, 6 countries from Oceania, and 20 countries from Africa, United States and Canada. These countries account for 53% of global GDP in 2022.

Figure 17 shows that, for all three country groups, the impact of a change in maize prices is smaller if that change is driven by supply shocks. In contrast, when the changes in crop prices result from demand shocks the pass-through is significantly greater, and there is also greater variation across countries. If the most recent decline is largely a result of supply catching up, it may take longer, and the overall impact on food prices may be relatively weak. The figure indicates that LAC countries experience a notably higher pass-through when changes in crop prices are driven by demand (65%, compared to 38% for non-LAC countries). Remarkably, within the region, countries with per capita income below the average exhibit almost complete pass-through to food inflation when maize prices increase due to demand shocks. This underscores the vulnerability of low-income countries, where food constitutes a substantial portion of their consumption basket, ranging between one-third and forty-five percent of total expenditure. On the other hand, supply-driven fluctuations in the price of maize result in a more restrained response in food inflation, with a pass-through of 20% to food CPI for a 1% shock in the price of maize for low-income or all LAC countries. Therefore, if a significant portion of the decline in maize prices can be attributed to supply shocks, we would anticipate a reduction in food inflation, though to a lesser extent. For the region, this implies lower gains from the reduction in crop prices than the losses suffered from the increase in crop prices in the post-pandemic years.

7 Conclusion

This study has considered the results of three separate VAR exercises to explore the links between fertilizer prices, global crop prices, global and country-level crop production, and country-level food CPI.

A first conclusion is that fertilizer prices are a significant driver of global crop prices. Indeed, the impacts on global crop prices appear to be stronger than the impacts on global production. A 10% increase in phosphorus or nitrogen fertilizer prices provokes roughly a 6% increase in global maize or soybean prices, while global production levels remain fairly stable.

In a second VAR analysis we investigated the impact of global crop prices on country-level food CPI. The conclusion, in line with the literature in this area, is that the prices of global crops such as maize, wheat and soybeans are significant drivers of country food CPI for the median country but that there is a wide dispersion regarding the pass-through. A 10% rise in maize or soybean prices leads to a rise in food CPI of about 1%-2% for the median country with a smaller impact for wheat prices, but for the 75th percentile country the impacts are over 2% for wheat and maize and almost 3% for soybeans. Individual country responses display a positive correlation implying that countries that suffer high pass-through from one crop price likely suffer high pass-through from all crop prices. Second-stage regressions can be employed to capture the drivers of the different levels of pass through.

In a third exercise, we considered how global fertilizer prices and global crop prices impact country level production. While in some crop-fertilizer combinations the median country reduces production in the face of a positive fertilizer price shock, in general median country production is relatively stable in the face of both fertilizer and crop price shocks. However, there is considerable variation across countries and heterogeneity in the impulse response coefficients. In some fertilizer–crop combinations, many countries reduce production, but there are also cases where production actually rises. There is then evidence of considerable substitution between crops in the face of fertilizer shocks. The conclusion is that farmers are finding flexibility to respond to fertilizer shocks by switching between the production of different crops even if specific fertilizer use is largely fixed per hectare of a particular crop planted.

Moreover, our study highlights a distinct asymmetry in the impact of supply versus demand shocks on food inflation, particularly from crops like maize. Countries in Latin America and the Caribbean, especially those with lower-than-average incomes, exhibit nearly complete pass-through effects, exacerbating food inflation. This finding is critical for policymakers in those countries, suggesting a need for strategies to mitigate such vulnerabilities.

The results of this analysis lead to some interesting conclusions and hints for future research. Fertilizer prices may be a significant driver of food prices, and yet to date there appears to be less research on fertilizer markets than other drivers of food prices. The heterogeneity of fertilizer use for the same crops across countries implies countries may react very differently to fertilizer price shocks. While fertilizer price shocks have strong consequences for crop prices, global crop production appears relatively stable, presumably as the different country reactions tend to cancel out in aggregate. Further research is required to understand if this result is simply due to the sample under analysis or whether there are structural features which would tend to lead to this outcome and which we could then expect to persist given future shocks. Our ongoing research agenda will expand to address these aspects, aiming to uncover the mechanisms behind these asymmetric responses and the role of structural factors, such as fiscal deficit, monetary regime, money supply, debt levels, trade openness, etc., and the contribution of each component to domestic inflation.

This paper contributes to a deeper understanding of global agricultural economics and emphasizes the importance of integrating both macroeconomic indicators and micro-level agricultural data in policy formulation. The insights gained lay a foundation for future empirical and theoretical research that can further refine our understanding of these critical economic relationships.

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