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Output Effects of Global Food Commodity Shocks

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Abstract:

The dramatic fluctuations in global food prices over the past two decades have generated significant concern about their destabilizing macroeconomic effects. While the pass-through effects of international food prices on domestic prices have been widely documented, these estimates have not taken into account reverse causality, omitted variable bias, or differences in sources of international food price fluctuations. We use sign restrictions to identify relevant demand and supply shocks that explain the volatility in global food prices. We quantify their dynamic effects on several components of food exporters' and food importers' domestic output, including household consumption, government consumption, investment, and net exports. Our findings reveal that identifying the sources of the shocks driving global food prices is crucial to evaluating their domestic effects. Expansions in global economic activity that increase global food prices stimulate the domestic output of both food-importing and food-exporting economies; however, disruptions in global food commodity markets that lead to rising real food prices have large contractionary effects for food importers due to deteriorating trade balances and falling household consumption. We also document that the adverse effects of unfavorable global food shocks on household consumption are greater for food-importing countries with relatively high shares of household food expenditures and large food trade deficits.

Keywords: domestic output effects, global demand shocks, Global food prices, oil shocks, sign restrictions, transmission mechanisms

JEL classification: E31, E32, F14, F32

DOI: 10.1515/jgd-2018-0011

1 Introduction

The dramatic rise in world food prices since the early 2000s, particularly reaching record levels from 2006 to 2008, followed by a decline during the financial crisis, and the sharp increase again in 2010–2011 and 2012–2013 has attracted interest among policymakers and academics for understanding the underlying sources of fluctuations in real food prices and their economic consequences.¹ When global food prices increased rapidly over the 2006–2008 period by 40% in real terms – a period commonly referred to as a “global food crisis” – more than 30 countries around the world experienced food riots and protests (Food and Agricultural Organization 2008), and civil conflicts have intensified (Arezki and Brueckner 2014). Many developing countries experienced an increase in food price inflation, trade deficits, and volatile macroeconomic indicators, resulting in a substantial increase in poverty levels.² Low-income countries have been particularly hurt due to the absence of easy substitutes for staple food commodities, the high share of food expenditures in household consumption, and the presence of binding credit constraints. Even advanced countries have been adversely affected. In the United States alone, an unfavorable food commodity market shock is predicted to increase not only real food prices but also consumer prices, leading to a persistent decline in real GDP and consumer expenditures (De Winne and Peersman 2016). The fact that these effects are a multiple of the impact implied by the share of food commodities in the consumer price index indicates the presence of large propagation effects that magnify the macroeconomic consequences.³

Fluctuations in real food prices may have very different effects on economic outcomes depending on their underlying sources (shocks to global demand/supply or shocks to commodity-specific demand/supply). On the one hand, an international food price surge driven by a rise in global economic activity may have expansionary effects on domestic output regardless of whether a country is a net exporter or importer of food commodities. On the other hand, a rise in global food prices stemming from adverse climate events that restrict the supply of food is likely to generate different impacts on domestic output depending on patterns of specialization. Food-exporting economies may experience a positive spending effect to the extent that their net export earnings improve, while the opposite effects may be observed for food-importing economies. The propagation effects of the initial spending effects are also likely to vary depending on the share of food commodities in

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household consumption. Moreover, a rapid rise in global oil prices may partially stimulate global food prices due to higher production costs of food commodities, while both energy and food prices may simultaneously be driven by an expansion of global economic activity (Baumeister and Kilian 2014). While a large body of empirical work on commodity markets has shown that not all oil price shocks are alike and that the effects of such shocks vary depending on their source (Kilian 2009; Kilian, Rebucci, and Spatafora 2009; Lippi and Nobili 2012; Charnavoki and Dolado 2014; Kilian and Murphy 2014), none of the existing studies examined whether the effects of fluctuations in global food prices differ depending on their underlying sources.

Our paper provides one of the most comprehensive analyses to date of the relationship between global food price fluctuations and domestic output changes. We investigate the dynamic effects of global shocks driving international food prices on the domestic components of output for 82 countries from 1980 to 2011. Our findings reveal that identifying the sources of shocks that affect global food prices is crucial to evaluating their domestic effects. Increases in global economic activity that boost global food prices stimulate the domestic output of both food-importing and food-exporting economies; however, disruptions in global food markets that increase real food prices have large contractionary effects for food importers due to deteriorating trade balances and falling household consumption. Our research addresses a number of limitations in existing studies. First, previous studies tended to focus predominantly on the pass-through effects of international food prices on domestic prices (Minot 2011; Ianchovichina, Loening, and Wood 2012; Durevall, Loening, and Birru 2013; Dillon and Barrett 2015) without taking into account reverse causality, omitted variable bias, or differentiating among sources of international food price fluctuations.⁴ Given that omitted variables such as fluctuations in global economic activity or changes in real oil prices might affect both international and domestic food prices, establishing a causal relationship has been difficult. Second, previous studies focused on selected food-importing developing or advanced countries. To the extent that individual countries may have different structural characteristics, the external validity of existing studies has been limited.

Our aim here is to address these limitations. Using a sign-identified structural VAR (SVAR) model framework, we analyze the effects (at business cycle frequencies) of different global shocks driving real food prices on components of domestic output for a large set of developing and advanced countries. In particular, we identify the global shocks driving international food prices using four sets of macroeconomic variables: global economic activity, world real oil price index, world real food price index, and global inflation.⁵ Our identification scheme utilizes sign restrictions to identify four main global shocks during the sample period: (i) a global demand shock (GD), (ii) a global oil market-specific shock (GO), (iii) a global food market-specific shock (GF), and (iv) a global noncommodity supply shock (GS).

Global expansions and contractions of economic activity driven by a shift in global demand could be viewed as examples of positive and negative GD shocks. Negative (unfavorable) GO shocks that are related to rising world oil prices capture geopolitical events that decrease global crude oil supply or increase oil market – specific demand due to anticipated future shortages or speculative trading. Examples of negative (unfavorable) GF shocks that are associated with rising world food prices include climate shocks that may cause heat waves and droughts, resulting in a decrease in the food supply, or an increase in food market – specific demand due to biofuel production or expansion of middle-income populations in emerging markets. Finally, examples of positive (favorable) GS shocks include improvements in productivity that decrease average price level and whose origins may range from innovations in information technology to technological upgrading in developing countries.

We document the spending effects of global shocks driving international food prices, examining the channels through which these shocks have an impact on different components of domestic output. Using rich data from the Penn World Tables (PWT) 8.1, we analyze the dynamic effects on total output as well as its components, including household consumption, government consumption, investment, and the trade balance in real terms for 82 countries, including both advanced and developing economies. To assess the channels through which global shocks are transmitted, we focus on heterogeneity among food importers. In particular, we examine whether the household consumption response to negative GF shocks is higher in countries where food expenditures represent a larger share of the household consumption basket and in countries that depend on imported food commodities for their consumption.

Our findings can be summarized as follows. First, we find that international food prices are driven by a combination of global shocks rather than by a single shock. In particular, our results show that GD, GO, and GF shocks account for most of the variation in international food prices. Second, our findings reveal that international food price fluctuations have very different impacts on domestic output depending on their source. A positive GD shock that increases global activity and international food prices has an expansionary impact on the domestic output of both food importers and food exporters. By contrast, a negative GF shock driving a surge in global food prices leads to a contraction in real domestic output among food importers. This contraction is mainly explained by a decline in household consumption, a similar but less precisely estimated decline in government consumption, and a deterioration in the trade balance. Food-exporting economies respond to

a negative GF shock with an increase in investment and an improvement in the trade balance, resulting in an expansion of domestic output.

Third, an examination of the heterogeneous effects of GF shocks on food importers indicates that the negative effects on household consumption are higher among countries where food expenditures represent a relatively high share of the household budget. In addition, we document that these effects are larger for countries that import a large share of their domestic food supply from abroad. Finally, we find that approximately 7–9% of the share of the variation in output is explained by the combination of GF and GO shocks. Hence, the share of variation in domestic output explained by these shocks is modest. Our results are robust to using alternative measures of global energy prices and global economic activity.

1.1 Related Literature

Our study contributes to several related strands of literature. First, a growing theoretical literature examines the macroeconomic effects of global food prices with a focus on the characteristics of developing country markets. Catao and Chang (2015) examine how monetary policy should respond to large fluctuations in world food prices using an open economy model in which imported food has a greater weight in domestic consumption than abroad and international risk sharing can be imperfect. Anand, Prasad, and Zhang (2015) focus on what measure of inflation a developing country central bank should target if a large proportion of households are credit constrained and the share of food expenditures in total consumption expenditures is high. Both of these studies find that deviations from complete financial markets require central banks to use alternative inflation targets such as headline inflation (as opposed to core inflation) in order to improve welfare outcomes. Gregorio (2012) provides a theoretical discussion of how commodity price shocks matter for optimal monetary policy and finds some reduced-form evidence of pervasive second-round effects of commodity prices on core inflation in emerging market economies.⁶ Our study contributes to this literature by empirically examining the macroeconomic effects of shocks to global food commodity markets in a large set of countries, which allows us to compare how these effects differ based on export specialization, the degree of dependence on imported food, and the weight of food expenditures in consumer basket.

A related body of empirical work analyzes the macroeconomic effects of commodity price shocks with a focus on the identification of oil price shocks and their effects in developed economies. The spending effects of oil price shocks have been documented for the United States (Kilian 2009), the euro area economies (Peersman and Robays 2009), and developed countries (Baumeister, Peersman, and Robays 2010). Similarly, focusing on the US economy, other recent studies have examined the discretionary income effect of oil price shocks on consumer expenditures and real domestic income (Edelstein and Kilian 2009; Baumeister and Kilian 2016; Baumeister, Kilian, and Zhou 2018). Moreover, Kilian, Rebucci, and Spatafora (2009) analyzed how external balance effects of different oil shocks vary for oil-exporting and oil-importing economies, and Charnavoki and Dolado (2014) provided evidence for the spending, external balance, and Dutch disease effects for a typical commodity exporter, Canada.⁷ Our paper is closely related to Charnavoki and Dolado (2014) in its identification of global commodity shocks and to Kilian, Rebucci, and Spatafora (2009) in its analysis of the transmission effects of global shocks to commodity-exporting and commodity-importing economies.⁸ A recent paper has analyzed the macroeconomic effects of global food commodity shocks in the United States, finding large and persistent effects of these shocks, which suggests that indirect effects appear to be important even in a context with a relatively small share of food expenditures in the consumption basket (approximately 17%) and lower credit constraints in comparison to most developing countries (De Winne and Peersman 2016). Using unfavorable harvest shocks, a related paper has documented that these shocks have negative effects on economic activity (De Winne and Peersman 2018).

Furthermore, there is mixed evidence on whether oil prices have a systematic impact on certain food commodity prices. While some studies find that oil price innovations affect food prices, most notably for corn prices (Avalos 2014), others find no evidence of a tight link between oil and food prices (Baumeister and Kilian 2014; Baumeister, Ellwanger, and Kilian 2017).⁹ We contribute to this literature by analyzing whether there are systematic spending and external balance effects in response to global shocks driving real food prices and the extent to which these effects differ between food-exporting and food-importing economies.

Lastly, a related strand of literature focuses on the effects of terms-of-trade shocks on developing countries by assuming that such shocks are exogenous to small economies. While earlier studies generally find that terms-of-trade shocks explain a large share of the variation in output (approximately 30%) (Mendoza 1995; Kose 2002), recent studies find that these shocks account for a much smaller share (approximately 10%) (Lubik and Teo 2005; Aguirre 2011; Schmitt-Grohe and Uribe 2015).¹⁰ Our empirical methodology has the advantage of capturing two sources of exogenous terms-of-trade shocks originating from oil and food markets, allowing us to shed more light on how much of the variation in output is explained by these more exogenous components of terms-of-

trade shocks. Our findings are parallel to the recent literature in that the food and oil market-specific shocks explain approximately 7–9% of the variation in domestic output.

The remainder of the paper is organized as follows. Section 2 presents the empirical methodology, including descriptions of the data, the estimation strategy, and the identification schemes for global shocks. Section 3 presents the empirical results. In particular, we report the dynamic responses of global and domestic economies to GF, GO, and GD shocks, focusing on the channels through which they are transmitted to food-importing and food-exporting economies. Section 4 provides a robustness analysis of our results and extends it to provide a comparison to GO shocks, and Section 5 concludes.

2 Empirical Methodology

2.1 Data

Our dataset is composed of two sets of variables. First, we use quarterly data from 1977:II to 2014:II for the international variables in the global SVAR model. Appendix A provides a list of variables, including their descriptions, sources, and transformation codes. The non-stationary variables are stationarized by appropriate transformations (e.g. using growth rates or first differences). Following Charnavoki and Dolado (2014), the international variables include data for the world economy (if available) as well as for the large regional blocks (OECD, European Union, G7) and the United States.¹¹ Real economic activity is measured by the common factor of time series for real GDP, industrial production, volume of exports and imports, and the global real activity index constructed by Kilian (2009) by using the same series as in Charnavoki and Dolado (2014).¹² Real oil prices are measured by the real price of crude oil calculated as the nominal crude oil price index provided by the IMF (a simple average of the Dated Brent, West Texas Intermediate, and Dubai Fateh prices) deflated by the Manufacturing Unit Value (MUV) index provided by the World Bank.¹³ The real price of food is measured by a global food price index reported by the World Bank Global Economic Monitor (GEM) and deflated by the MUV index.¹⁴ The weights in the (nominal) global food price index are based on 2002–2004 developing countries' export values, and the category with largest weights is grains, including rice, wheat, maize, barley, and soybeans.¹⁵ Thus, our measure for the real price of food largely reflects the weighted average of staple food commodity prices. Given that staple food commodities have the largest export shares, they are also the most integrated global food markets.¹⁶ Finally, following Charnavoki and Dolado (2014), global inflation is measured by the common factor of time series including implicit price deflators of GDP, consumer, and producer prices.¹⁷

Second, we use annual data from 1980 to 2011 on domestic output measures to assess the impacts of global shocks on food-importing and food-exporting economies. The data source is the PWT 8.1. Following standard country selection procedures from the empirical growth literature (Mankiw, Romer, and Weil 1992; Hausmann, Pritchett, and Rodrik 2005), we eliminate from our sample (i) all countries with populations of less than 1 million, (ii) all countries with fewer than 30 data points in the PWT, (iii) all countries with low-quality data (classified as poor data quality category "D" in the PWT 6.1), and (iv) all countries with designated outlier values in the PWT. These country selection criteria produce a sample of 82 countries.

We use annual data because international data on national accounts are available only at an annual frequency for most countries. Following Kilian, Rebucci, and Spatafora (2009), we construct measures of annualized global shocks by averaging quarterly structural innovations for each year. Next, we use a distributed lag model to estimate the effects of these global shocks on individual countries' domestic output measures. The data series we use from the PWT 8.1 are real GDP, real domestic absorption, real household consumption, real government consumption, real investment at constant 2005 national prices (in million 2005 US\$) and trade balance as a share of GDP (as a percentage).¹⁸

As Figure A1 illustrates, there are large cross-country differences in net exports of oil and net exports of food (as shares of GDP), with little overlap between them. To account for these differences in specialization, our analysis focuses on two country classifications. First, we classify countries based on their food trade account: food importers or food exporters. A country is classified as a food importer (exporter) if its average net food exports are negative (positive) over the 1980–2011 period. We calculate the net food exports of each country using FAOSTAT data as the difference between the export value of food and animal products and the import value of food and animal products. Among food exporters, we exclude countries that are net exporters of tropical cash crops and net importers of grains because our index for global food prices is predominantly composed of grains and oils rather than tropical cash crops. Second, we classify countries based on their oil trade account: oil importers or oil exporters. A country is classified as an oil importer (exporter) if its average net fuel exports are negative (positive) over the 1980–2011 period. Appendix A includes a list of the countries included in each classification.

2.2 Empirical Model

In this section, we present the empirical strategy employed at the global level and the domestic level. First, we introduce the SVAR model with the sign-restrictions at the global level, which allows for the identification of the main shocks driving global food prices. Second, we present the distributed lag panel data model, which we use at the country level to analyze the transmission of global shocks to domestic output measures. Estimated global shocks enter into the domestic panel data regression as exogenous regressors.

2.2.1 Global SVAR Model and Identification of Structural Shocks

At the global level, we use an SVAR(8) model of a (4×1) vector Y_t consisting of global economic activity, the growth rate of the real oil price, the growth rate of the real food price, and changes in global inflation. The structural model, for $t = 1, \dots, T$, can be written as

$$B_o Y_t = B_1 Y_{t-1} + \dots + B_8 Y_{t-8} + \varepsilon_t, \quad (1)$$

where $\varepsilon_t = (\varepsilon_{D,t}, \varepsilon_{O,t}, \varepsilon_{F,t}, \varepsilon_{S,t})' \sim (0, I_4)$ denotes the structural shocks with the identity covariance matrix I_4 , and $\{B_o, \dots, B_8\}$ are the structural coefficient matrices. The structural parameters and shocks cannot be estimated directly. However, if we multiply both sides of Equation (1) by B_o^{-1} , we obtain the reduced-form VAR model:

$$Y_t = A_1 Y_{t-1} + \dots + A_8 Y_{t-8} + e_t, \quad (2)$$

where $e_t \sim (0, \Sigma)$ denotes the reduced-form errors and $\{A_1, \dots, A_8\}$ are the reduced-form coefficient matrices to be estimated. We estimate the model by Bayesian techniques.

The relation between the structural and reduced-form errors is $e_t = B_o^{-1} \varepsilon_t$, which implies that $\Sigma = B_o^{-1} B_o^{-1'}$. The Bayesian techniques provide posterior draws for $\{A_1, \dots, A_8\}$ and Σ ; however, they are not sufficient to recover any draws for the structural parameters, particularly B_o^{-1} , without further restrictions on the model. One of the popular ways to identify B_o^{-1} is to use sign restrictions.¹⁹ This method relies on the signs of the relationships between variables and shocks (Canova and Nicolo 2002; Uhlig 2005). Sign-restricted identification is based on the fact that there are infinitely many ways to factorize Σ into $\Sigma = B_o^{-1} B_o^{-1'}$, but not all factorizations will comply with the sign restrictions imposed on B_o^{-1} . Note that given an orthonormal matrix Ξ , i.e. $\Xi \Xi' = I_4$, one can write $\Sigma = B_o^{-1} B_o^{-1'} = B_o^{-1} \Xi \Xi' B_o^{-1'} = (B_o^{-1} \Xi) (B_o^{-1} \Xi)' = \tilde{B}_o^{-1} \tilde{B}_o^{-1'}$. Hence, the idea of the identification lies in drawing Ξ such that $\tilde{B}_o^{-1}$ satisfies the desired sign restrictions.

We focus on the identification of the four global structural shocks: (i) an unanticipated change in global demand (a GD shock), $\varepsilon_{D,t}$, (ii) an unanticipated change in the global price of oil (a GO shock), $\varepsilon_{O,t}$, (iii) an unanticipated change in the global price of food (a GF shock), $\varepsilon_{F,t}$, and (iv) a shock to global supply that is not related to commodity markets (a GS shock), $\varepsilon_{S,t}$. The second and third shocks capture unexpected changes in the real prices of oil and food that are orthogonal to the other two innovations. These shocks can result from unanticipated changes in the supplies of oil and food commodities, as well as from demand changes that are specific to these markets, such as changes in precautionary demand for oil or food commodities.

Sign Restrictions: Our identifying assumption is that contemporaneous responses of global variables to changes in a global structural shock have the signs presented in Table 1. A positive (favorable) GD shock results in increased global activity, a rise in real oil and food prices, and higher inflation. A negative (unfavorable) GO shock implies a rise in real oil prices, a fall in real economic activity, an increase in inflation. However, we leave the response of real food prices to a negative GO shock unrestricted since the net effect of two opposing forces is ambiguous: when oil prices increase, this may result in an increase in food prices if oil is an input for food production without close substitutes (i.e. the cost channel), while the fall in economic activity and rise in inflation resulting from higher oil prices may lead to a decline in real food prices (i.e. the demand channel). A negative (unfavorable) GF shock results in rising real food prices, higher inflation, decreasing real activity, and a resulting decline in real oil prices. Finally, a positive (favorable) GS shock reflects a positive productivity shock, which is associated with a decline in inflation, an increase in real activity, and increases in real energy and real food prices due to falling inflation.

Table 1: Sign restrictions on impulse response functions.

	GD Shock, $\varepsilon_{D,t}$	GO Shock, $\varepsilon_{O,t}$	GF Shock, $\varepsilon_{F,t}$	GS Shock, $\varepsilon_{S,t}$
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Global economic activity	+	−	−	+
Real energy price	+	+	−	+
Real food price	+		+	+
Global inflation	+	+	+	−

The table reports the sign restrictions imposed on the impulse response functions in the SVAR model.

We follow the Bayesian algorithm of Arias, Rubio-Ramírez, and Waggoner (2018) for both estimation and sign-identification of the parameters.²⁰ We employ commonly-used conjugate priors (Normal-Wishart) for the VAR estimation.²¹ We sample the posterior distribution of the parameters by 2000 draws that comply with the sign restrictions. Denoting the set of the posterior draws of $\tilde{B}_o^{-1}$ by $\{\tilde{B}_o^{-1}(s)\}_{s=1}^{2000}$, we can compute $\varepsilon_t(s) = \tilde{B}_o(s)e_t(s)$, where $\varepsilon_t(s)$ is the s^{th} posterior draw for the $((T - 8) \times 4)$ dimensional structural global shocks. Impulse-response functions (IRF) and forecast error variance decompositions (FEVD) are computed based on the posterior draws of $\{A_1(s), \dots, A_8(s), \tilde{B}_o^{-1}(s)\}_{s=1}^{2000}$.²² Hence, all of the structural analysis at the global level as well as the structural shocks used at the domestic level are based on these 2000 posterior draws.

2.2.2 Domestic Panel Model

In this step of the empirical analysis, we examine the effects of the (structural) global shocks on domestic output as well as its components (trade balance, domestic absorption, household consumption, government consumption, and investment) for different groups of countries, assuming that the global shocks are predetermined with respect to the domestic economic conditions in a given country.

However, note that there is a frequency mismatch between the global shocks and country-level variables. The global shocks are measured at the quarterly frequency whereas domestic variables for most of the countries are available at the annual frequency. To match the frequencies, we follow a common procedure in the literature (Kilian 2009; Kilian, Rebucci, and Spatafora 2009), and compute annual versions of the quarterly global shocks by taking annual averages.²³ Based on the posterior draws of the quarterly structural shocks, we construct the annual shocks $\{\tilde{\zeta}_t(s)\}_{s=1}^{2000}$ by

$$\tilde{\zeta}_t(s) = \frac{1}{4} \sum_{j=1}^4 \varepsilon_{tj}(s),$$

where $\varepsilon_{tj}(s)$ denotes the s^{th} posterior draw of the global shock in the j^{th} quarter of the t^{th} year. Note that $\tilde{\zeta}_t(s)$ contains all four global shocks $\tilde{\zeta}_t(s) = (\tilde{\zeta}_{D,t}(s), \tilde{\zeta}_{O,t}(s), \tilde{\zeta}_{F,t}(s), \tilde{\zeta}_{S,t}(s))'$.

Let N denote the total number of countries in a given country category and $\tilde{T}$ denote the total number of years of the sample.²⁴ For country i and year t , let X_{it} denote the stationarized version of one of the six macroeconomic variables mentioned above.²⁵ We estimate the domestic model separately for each of these six variables as the dependent variable. Our main model for the domestic analysis is a fixed effects panel data model with distributed lags of the annualized global shocks as the explanatory covariates. For a given posterior draw s , we have

$$X_{it} = \beta_0 \tilde{\zeta}_{F,t}(s) + \beta_1 \tilde{\zeta}_{F,t-1}(s) + \beta_2 \tilde{\zeta}_{F,t-2}(s) + \beta_3 \tilde{\zeta}_{F,t-3}(s) + \alpha_i + u_{it}, \quad (3)$$

where α_i is the country-specific fixed effects and u_{it} is the idiosyncratic shock. We run this panel data model separately for each posterior draw s to obtain a collection of estimated dynamic multipliers $\{\hat{\beta}(s)\}_{s=1}^{2000}$, where $\hat{\beta}(s) = \{\hat{\beta}_0(s), \hat{\beta}_1(s), \hat{\beta}_2(s), \hat{\beta}_3(s)\}$, which indicate the transmission of a GF shock to an individual economy's output measure X_{it} over 4 years. Finally, we compute the median dynamic responses individually at each horizon year by $\tilde{\beta}_j$ as the median of $\{\hat{\beta}_j(s)\}_{s=1}^{2000}$ for $j = 0, \dots, 3$. For our main domestic results, we plot the median estimates $\tilde{\beta}_j$ as well as the 68% equal-tailed probability bands of $\{\hat{\beta}_j(s)\}_{s=1}^{2000}$ at each horizon year $j = 0, \dots, 3$. The interpretation of these dynamic responses are as follows: At the median response, a 1-unit increase in the current GF shock, $\tilde{\zeta}_{F,t}$, which increases global real food prices approximately by 2.3%, will generate $\tilde{\beta}_0\%$ increase in X_{it} ; $\tilde{\beta}_1\%$ increase in $X_{i,t+1}$; $\tilde{\beta}_2\%$ increase in $X_{i,t+2}$; and $\tilde{\beta}_3\%$ increase in $X_{i,t+3}$.

The equation (3) will also be estimated separately with GD and GO shocks, $\tilde{\zeta}_{D,t}$ and $\tilde{\zeta}_{O,t}$, as explanatory variables to examine the effects of the global demand and oil shocks on individual countries. Since the structural shocks are orthogonal to each other, it would not create any bias in the estimates to regress (3) only with one structural shock (and its lags) at a time.²⁶

3 Estimation Results

In this section, we present the empirical results from our global SVAR and domestic fixed effects panel models. First, we provide an overview of the time series of the four global variables and show their dynamic responses to global shocks, relying on the sign identification schemes described in the previous section. Second, using detailed data on the output measures of individual countries, we present the dynamic effects of global shocks on domestic output and its components in real terms.

Table 2 displays the forecast error variance decomposition (FEVD) at the 10-quarter horizon based on the sign-restricted identification scheme. The table shows that, in total, 96% and 95% of the variation in real prices of oil and food, respectively, are explained by GD, GO, and GF shocks. Since GS shocks explain a very small percentage of the variation in commodity prices, for brevity, we focus on the transmission of the other three shocks to individual economies.

Table 2: Forecast Error Variance Decomposition.

	GD Shock, $\varepsilon_{D,t}$	GO Shock, $\varepsilon_{E,t}$	GF Shock, $\varepsilon_{F,t}$	GS Shock, $\varepsilon_{S,t}$
Global activity	0.75	0.13	0.09	0.03
Real energy price	0.12	0.78	0.06	0.04
Real food price	0.12	0.12	0.71	0.05
Global inflation	0.08	0.19	0.09	0.62

The table reports the median forecast error variance decomposition obtained by the SVAR using the sign-restricted identification scheme shown in Table 1.

3.1 Global Shocks

Figure 1 provides plots of the global variables for real activity, the real price of oil, the real price of food, and inflation. The global economic activity index captures the key global business cycles from 1977:II to 2014:II, including the recessionary episodes of the early 1980s and 1990s, the East Asian financial crisis of 1997–1998, and the period from the Great Moderation to the Global Recession of 2007–2009. Real oil prices reflect major developments in the global oil market: the uncertainty following the Iranian revolution of 1978–1979, the Iraq war of the early 2000s, the rising industrialization in emerging markets that boosted demand in the 2000s, and the collapse of prices during the Global Recession. Real food prices capture major supply shortages in food production, including the droughts in the Midwestern US and Russia of the early 1980s and mid-1990s, the Australian droughts of the late 2000s, the Russian droughts and subsequent ban on grain exports of 2012, as well as rising demand for food commodities in the run-up to the Global Recession, and its collapse during the Global Recession of 2007–2009. Finally, the global inflation index reflects the relatively low levels of inflation of the 1990s partly due to the positive productivity shocks, the rising inflation of the late 2000s as global commodity prices began to trend upward, and the subsequent deflation of the 2010s as commodity prices began to decline.

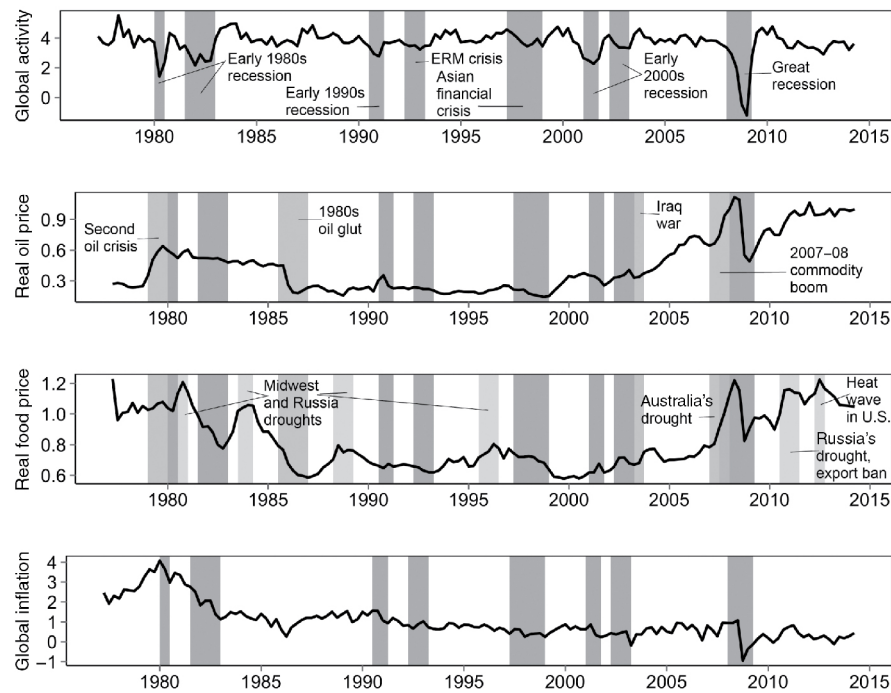


Figure 1: Evolution of Global Variables in the SVAR Model.

Note: Dark gray shaded areas represent major global recessions, medium gray shaded areas represent major events in global oil markets, and light gray shaded areas illustrate major events in global food markets, particularly periods of major crop shortages due to drought.

Figure 2 presents the median and 68% equally-tailed credible sets of IRFs of the global variables to one-standard-deviation shocks in the four global innovations, imposing the benchmark sign restrictions.²⁷ The initial response of a global variable to its own shock corresponds to the estimated standard deviation of that variable. Since the variables in the SVAR model are in growth rates, the effects of global shocks diminish quickly. A positive GD shock gives rise to a substantial increase in global economic activity, a rise in real oil and food prices, and an increase in global inflation, with the largest effect taking place within the first two quarters. A negative (unfavorable) GO shock pushes up the real price of oil and global inflation, reduces global economic activity, without any significant impact on real food prices (however, the median effect is positive). A negative (unfavorable) GF shock leads to higher real food prices, temporary increases in global inflation, a reduction in real economic activity, and a decline in real oil prices. Note that a one-standard-deviation GF shock and GO shock have similar effects on global economic activity on impact; however, the effect of GF shock dies out quickly while that of GO shock endures around 5–6 quarters. Finally, a positive GS shock increases real activity, reduces inflation, and increases the real prices of oil and food.

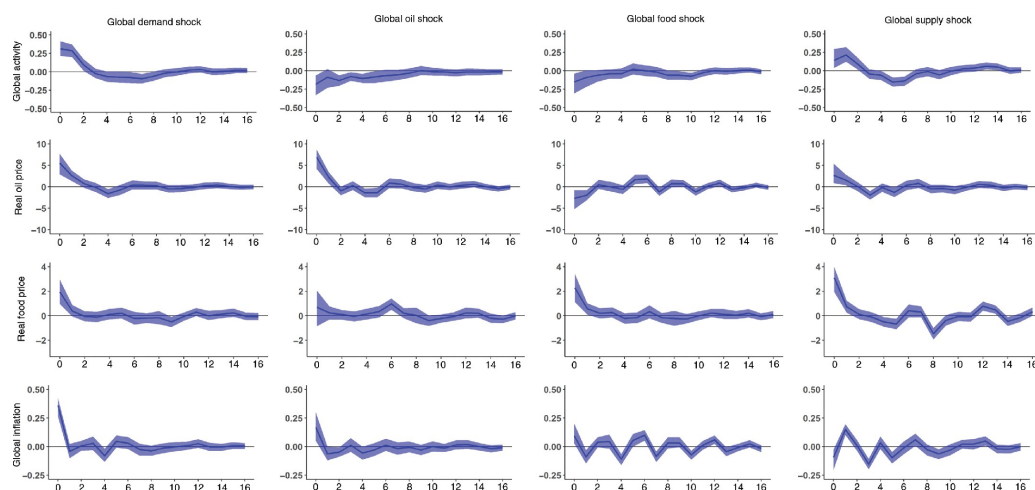


Figure 2: Impulse Responses of International Variables to Global Shocks.

Note: Identification by sign restrictions is represented by the purple shaded area covering equally-tailed 68% credible set, with the solid line representing the median.

Prior to analyzing the effects of global food shocks on domestic output, it is important to illustrate the type of events in the global food commodity markets that are captured by the global food shocks. Figure 3 plots the annualized global food shocks, i.e. the median $\tilde{\zeta}_{F,t}$, that are obtained from the sign-restricted SVAR model. For every global food shock that lies outside of its one-standard-deviation cutoff points, Figure 3 illustrates the major disruptions in global food commodity markets using FAO reports on the State of Food and Agriculture going back to the 1980s.²⁸ It can be seen that the global food shocks primarily correspond to the major supply disruptions in the production of food commodities, including unfavorable weather conditions such as droughts and monsoons that lead to a fall in global food production as well as favorable weather conditions that result in an excess production of food commodities.

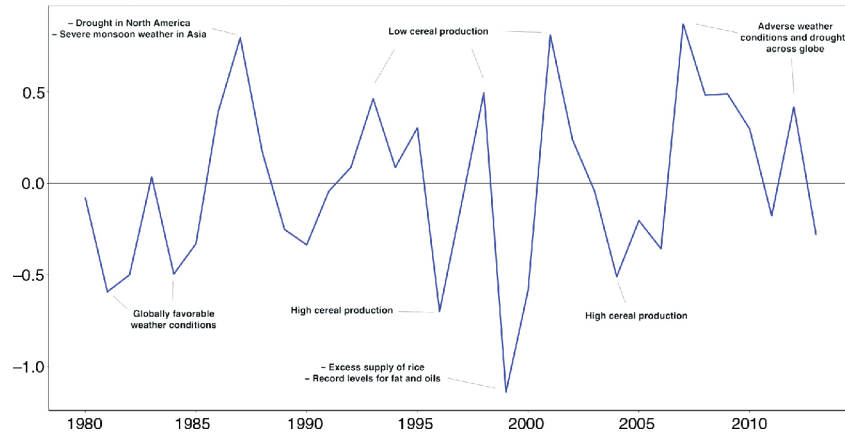


Figure 3: Annual Averages of the Global Food Shock.

Note: The figure displays the median of the annual averages of the global food shocks obtained by the sign-restricted SVAR model whose IRFs are shown in Figure 2. The global food shocks that are outside of one standard deviation correspond to the major global food supply shocks shown in the figure.

3.2 Transmission of Global Food Shocks to Domestic Output

In this section we analyze the results of the fixed effects panel data model given in (3). We focus particularly on two groups of countries – net food importers and net food exporters – and measure their domestic responses to global food shocks and global demand shocks.

Panel A in Figure 4 displays the IRFs of domestic output and its components to a GF shock that increases global real food prices by one standard deviation (2.27%) on impact. In the same figure, Panel B illustrates the IRFs to a GD shock that increases global economic activity by one standard deviation (0.32%) on impact. As explained in Section 2.2.2, the plotted IRFs contain the median estimates $\hat{\beta}_j$ (indicated by dark solid lines) as well as the 68% equal-tailed probability bands of $\{\hat{\beta}_j(s)\}_{s=1}^{2000}$ (indicated by dashed lines) at each horizon year $j = 0, \dots, 3$.²⁹ For food-importing economies, Panel A shows that a negative (unfavorable) GF shock that results in a one-standard-deviation increase in global food prices (2.27%) generates an on-impact decline of 0.36% in domestic output in real terms, which is largely driven by a significant decline in trade balance (0.61%). We find that this negative trade shock generates a significant fall in domestic absorption in the first year after the shock, which is due to a strong and steady decline in household consumption (0.47%) and a comparable but less precisely estimated decline in government consumption (0.30%). Overall, the negative output effects of the GF shock persist for about 2 years.³⁰

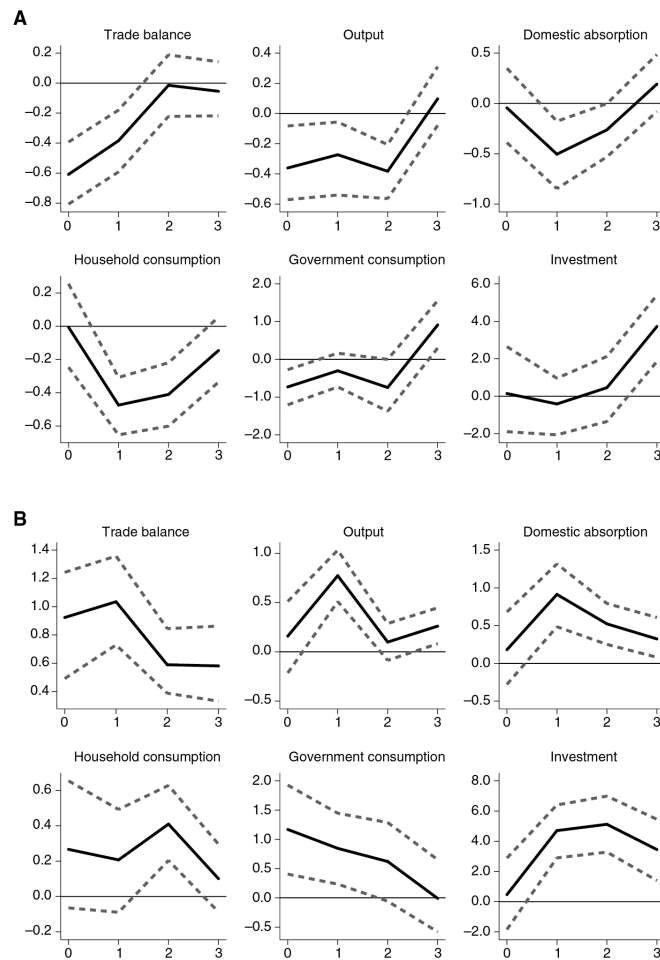


Figure 4: Response of Food Importers to Global Shocks.

Note: The figure displays the median impulse responses (solid line) together with equally-tailed 68% credible interval (dashed lines) to a global food shock in Panel (A) and a global demand shock in Panel (B) by food importers. All variables are measured at constant 2005 national prices (in million 2005 US\$). The trade balance is presented as a share of GDP, and all other variables are presented as growth rates.

We find opposite and shorter-lived effects of a GF shock on domestic output among food-exporting economies. Panel A in Figure 5 indicates that a negative (unfavorable) GF shock that increases food prices results in an improvement in trade balance in the first 2 years after the shock occurs. The higher net export revenues from higher food prices stimulates investment in food exporting countries. In addition, government expenditures increase on impact, reflecting the increase in government revenue from windfall revenues in the export sector. These spending effects result in an imprecisely estimated and small increase in domestic absorption and real output. Overall, the contrast with food importers is interesting in that among countries that import food, the higher food prices generated by a negative GF shock result in the contraction of household expenditures. When combined with a trade deficit, the result is a contraction in domestic output. Hence, while the primary channels of transmission for food-importing countries are the consumption and trade channels, for food-exporting countries, the key channels are the trade and investment channels.³¹

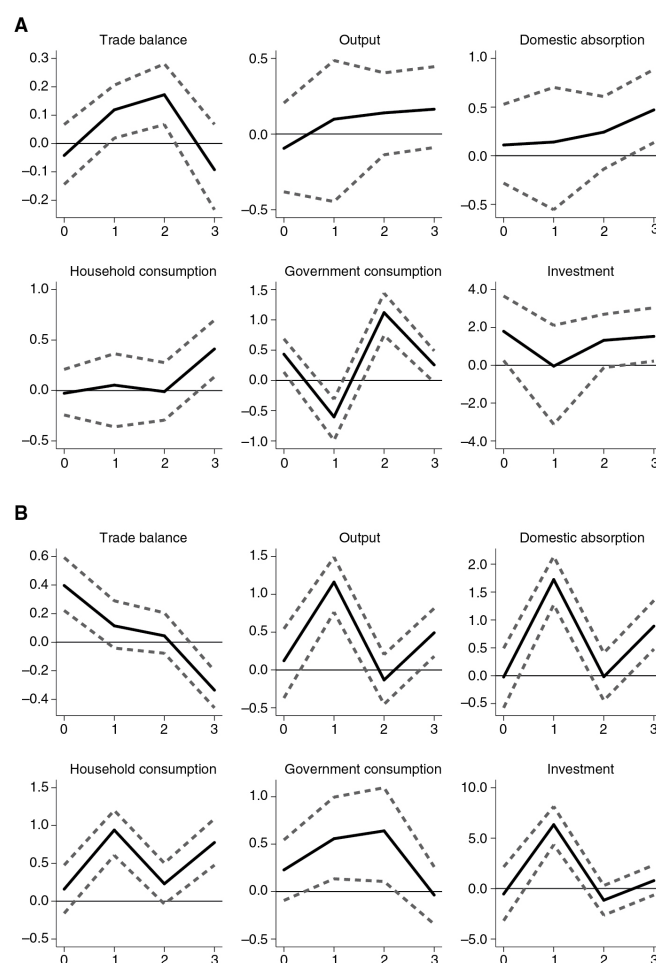


Figure 5: Response of Food Exporters to Global Shocks.

Note: The figure displays the median impulse responses (solid line) together with equally-tailed 68% credible interval (dashed lines) to a global food shock in Panel (A) and a global demand shock in Panel (B) by food exporters. All variables are measured at constant 2005 national prices (in million 2005 US\$). The trade balance is presented as a share of GDP, and all other variables are presented as growth rates.

In contrast, Panel B of Figure 4 and Figure 5 show that a positive GD shock has an expansionary impact on the domestic output of both food-importing and food-exporting economies. Both groups experience increases in their trade balances in response to higher global economic activity and international trade. This has large positive impacts on domestic output and domestic absorption, which are largely driven by a strong increase in investment and consumption expenditures. The positive effect on domestic output in response to a positive GD shock peaks in 1 year; it declines thereafter, although it remains mostly positive throughout.

3.3 Heterogeneous Effects

We would expect the effects of a negative GF shock on household consumption to be larger in food-importing countries whose typical consumers spend relatively high shares of their household budgets on food commodities. Figure 6 plots the response of food importers' household consumption to GF shocks by the share of food expenditures in total household expenditures. In particular, we present the IRFs by grouping countries according to their share of food in household expenditures: (A) low food share, including countries with food shares ranging from 0 to 12% of household expenditures, (B) medium food share, including countries with food shares ranging from 12 to 24% of household expenditures, and (C) high food share, including countries with food shares ranging from 24 to 40% of household expenditures. The findings show that the response to GF shocks become more negative as the food shares in household expenditures increase, with the largest response observed for the group of food importing economies with high food shares. We conclude that the share of average household budget spent on food commodities is an important mechanism through which GF shocks affect household consumption and thereby aggregate demand.

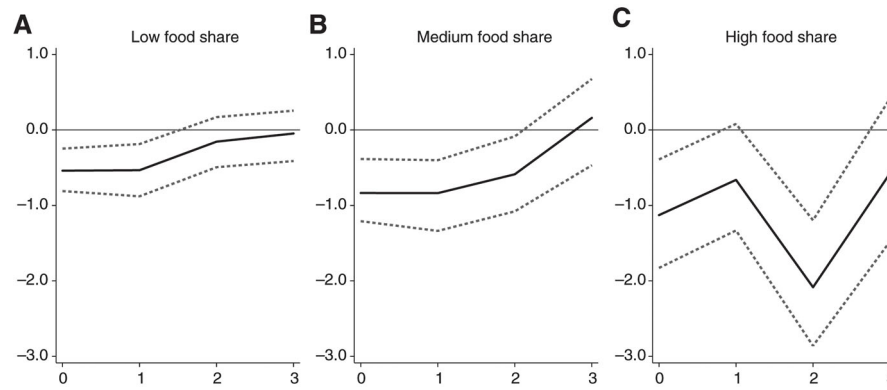


Figure 6: Response of Food Importers' Consumption to Global Food Shocks by Share of Food in Household Expenditures. *Note:* The figure displays the the median impulse responses (solid line) together with equally-tailed 68% credible interval (dashed lines) of household consumption of food importers to a global food shock. We plot the IRFs by grouping countries according to their share of food in household expenditures: (A) low food share (0 to 12% of household expenditures), (B) medium food share (12 to 24% of household expenditures), and (C) high food share (24 to 40% of household expenditures). All variables are measured at constant 2005 national prices (in million 2005 US\$).

Another channel through which the effects of GF shocks are transmitted is the extent to which countries import food from the rest of the world. If a country consumes mostly domestically produced food commodities, an increase in global food prices generated by a GF shock would have no impact on its domestic demand. Figure 7 plots the response of food importers' household consumption to GF shocks by food trade deficits as a share of total food trade: (A) low deficit, including countries with food trade deficits ranging from 0 to 30% of total food trade, (B) medium deficit, including countries with food trade deficits ranging from 30 to 60% of total food trade, and (C) high deficit, including countries with food trade deficits ranging from 60 to 90% of total food trade. Our results show that countries with higher food trade deficits as a share of their total food trade have stronger negative responses to GF shocks, with the most negative responses observed for countries with high food trade deficits. These findings imply that countries that produce a relatively larger proportion of their food commodities (and therefore import less food) are better able to insulate themselves from the adverse effects of GF shocks.

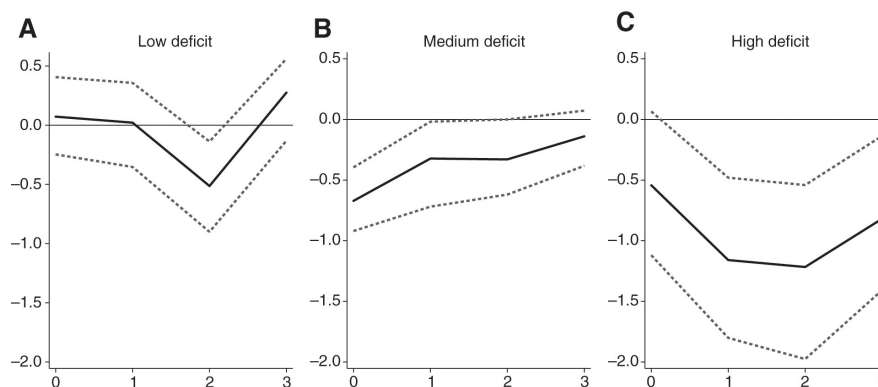


Figure 7: Response of Food Importers' Consumption to Global Food Shocks by Food Trade Deficit.

Note: The figure displays the median impulse responses (solid line) together with equally-tailed 68% credible interval (dashed lines) of household consumption of food importers to a global food shock. We plot the response of food importers' household consumption to GF shocks by food trade deficits as a share of total food trade: (a) low food trade deficit (0 to 30% of total food trade), (b) medium food trade deficit (30 to 60% of total food trade), and (c) high food trade deficit (60 to 90% of total food trade). All variables are measured at constant 2005 national prices (in million 2005 US\$).

3.4 Variance Decomposition of Output and Household Consumption

One common way to assess the importance of a global shock to domestic output fluctuations is to examine the share of the variance of output measures explained by the shock. Table 3 presents the fractions of domestic output and its components explained by global shocks.³² The first three columns report the variation explained by each shock and its three-period lags as in Equation (3). The last column reports the variation explained by the combination of GO shocks and GF shocks and their one-period lags. The latter represent the variation

explained by global commodity shocks, which roughly corresponds to the estimated variation explained by terms-of-trade shocks in the literature.

Table 3: Share of Variance of Domestic Output and its Components Explained by Global Shocks.

	GD Shock (1)	GO Shock (2)	GF Shock (3)	GO and GF Shocks* (4)
(a) Trade balance				
Food exporters	0.04	0.04	0.03	0.04
Food importers	0.14	0.09	0.05	0.06
Oil exporters	0.09	0.10	0.09	0.12
Oil importers	0.04	0.13	0.04	0.14
(b) Output				
Food exporters	0.09	0.08	0.05	0.09
Food importers	0.07	0.04	0.05	0.07
Oil exporters	0.09	0.06	0.06	0.08
Oil importers	0.08	0.05	0.04	0.08
(c) Domestic absorption				
Food exporters	0.08	0.06	0.05	0.07
Food importers	0.06	0.04	0.04	0.04
Oil exporters	0.08	0.06	0.05	0.08
Oil importers	0.07	0.05	0.04	0.06
(d) Household consumption				
Food exporters	0.07	0.05	0.05	0.06
Food importers	0.05	0.04	0.04	0.04
Oil exporters	0.06	0.05	0.04	0.06
Oil importers	0.07	0.04	0.03	0.04
(e) Government consumption				
Food exporters	0.05	0.05	0.03	0.06
Food importers	0.04	0.04	0.03	0.03
Oil exporters	0.04	0.03	0.04	0.04
Oil importers	0.04	0.04	0.04	0.04
(f) Investment				
Food exporters	0.09	0.08	0.04	0.09
Food importers	0.05	0.04	0.04	0.05
Oil exporters	0.07	0.05	0.05	0.06
Oil importers	0.04	0.05	0.04	0.05

The table reports the median of the R^2 values obtained from the estimation of the panel model in Equation (3). GD shock represents global demand shocks, GO shock represents global oil shocks, and GF shock represents global food shocks, each of which is identified using the sign-restricted identification scheme in Table 1. The first three columns report the R^2 values using each global shock and its three period lags as in Equation (3). * denotes the R^2 values using the global oil and food shocks and their one-period lags jointly in the regression. This specification corresponds to the regressions used in the literature on terms-of-trade shocks.

Several interesting insights emerge from Table 3. First, the estimates in Panel B show that, on average, these shocks explain 4–9% of the variation in output, depending on the country grouping. Second, GF shocks explain roughly the same portion of the variance in output for food importers and exporters (5%). Among the components of output, GF shocks explain a larger variation of trade balance for food importers than food exporters, whereas they explain a larger variation of household consumption for food exporters than food importers. Hence, these differences cancel out, resulting in a similar variance of output explained by the GF shocks for food importers and exporters. Third, our findings also indicate that GO shocks account for slightly more of the variation in output for oil exporters (6%) than oil importers (5%). This difference is driven by a greater share of the variation in domestic absorption and household consumption explained by GO shocks for oil exporters in comparison to oil importers.

Finally, the combination of GO and GF shocks reported in column (4) of Table 3 indicates that commodity-specific shocks combined explain about 7–9% of the variation in output. These combined shocks also explain 4–8% of the variation in components of domestic demand and 4–14% of the variation in the trade balance. Thus, although commodity-specific shocks explain a more sizable portion of the variation in the trade balance, the effects on domestic aggregate demand and final output are rather modest. This evidence is in line with recent findings documented by Schmitt-Grohe and Uribe (2015) that terms-of-trade shocks explain approximately 10% of the variation in output among developing countries. If we restrict our sample to developing countries, our results for the median do not significantly change, since we include a large number of developing countries in our sample.

4 Robustness and Extensions

In this section, we provide a robustness analysis of our results, and extend our analysis to compare the effects of GF shocks to GO shocks. The latter is important given that most of the prior literature focused on analyzing GO shocks. Our robustness analysis will focus on two main robustness checks: (i) the replacement of the crude oil price index with a composite energy price index, and (ii) the replacement of the global economic activity factor with Kilian's index of global economic activity. We present the results of the domestic IRFs and variance decomposition in Appendix B.

4.1 Robustness Analysis

We examine the sensitivity of the results to the use of alternative measures of global variables by considering two versions of the model. First, we replace the real crude oil price with the real energy price index. The data for the nominal energy price index comes from the World Bank GEM Commodities database, and it is composed of the prices of crude oil, coal, and natural gas weighted by their average export values over the 2002–2004 period. We deflate this nominal energy price index by the MUV index to construct a real energy price index. Not surprisingly, this index is highly correlated (98%) with the real crude oil price index used in our baseline estimates, as crude oil represents the highest export share of the global energy market. Thus, as Figures A2 and A3 show, the estimates for the responses of domestic output components are very similar to those in the baseline results in Figure 4 and Figure 5. The baseline results are generally more conservative compared to the results obtained from the real energy price index.³³

Second, we examine a version of the model that replaces our global economic activity factor with the Kilian (2009) global economic activity index. The latter index is constructed from dry cargo bulk freight rates. Figures A4 and A5 show that with Kilian global economic activity index, the effects of GF shocks on the domestic output of food exporters are slightly more positive than the baseline. Those for food importers are slightly more negative initially, but they recover more quickly after the initial impact.³⁴

4.2 Comparison with Global Oil Shocks

Figures A6 and A7 display the output effects of a negative GO shock and a positive GD shock on oil-importing and oil-exporting economies. First, Panel A in Figure A6 illustrates that a negative GO shock produces a contractionary effect on oil importers with a 1-year lag, which becomes significantly negative in the second year.³⁵ The same shock generates an expansionary effect on oil exporters as seen in Figure A7, which is again significant starting in the second year.

Second, among oil importers, the negative GO shock has a negative and protracted effect on trade balance on impact and lagged negative effects on investment and household consumption that peak in 1–2 years. Government consumption responds positively to a rise in global energy prices resulting from a negative GO shock, which is likely an outcome of the fuel subsidies provided by many governments to reduce the contractionary effects of such shocks. However, this rise in government spending does not prevent the eventual decline in domestic output, which leads to a large negative effect on final domestic demand and domestic output in 2 years. By contrast, oil-exporting economies experience a substantial improvement in their trade balance in response to a positive GO shock. The boost in net export earnings on impact increases household consumption and government spending, and sharply increases investment. Hence, on average, our findings indicate that governments spend windfall revenues from taxes in the export sector instead of implementing countercyclical fiscal policies. Finally, Panel B of Figures A6 and A7 illustrate that a positive GD shock generates similar expansionary effects on the aggregate demand components of oil importers and oil exporters.

Our results on the effects of global shocks on oil importers/exporters are similar to those documented in the literature. Kilian (2009), Peersman and Robays (2009), and Baumeister, Peersman, and Robays (2010) find that the effects on the United States, the euro area economy, and industrialized countries vary substantially depending on the source of oil price fluctuations. Exogenous shocks to the supply of crude oil lead to a permanent fall in economic activity in oil-importing economies, while they generate an expansion in oil exporters. On the other hand, positive GD shocks that also lead to a rise in global oil prices generate output expansion in both oil importers and oil exporters. Finally, these studies find that oil-specific demand shocks lead to a temporary decline in output in both groups of economies. In our framework, negative GO shocks capture the combined effect of oil supply shocks and oil-specific demand shocks in a reduced-form specification. Given that the effects of oil-specific demand shocks tend to be temporary, the negative GO shocks generally reflect oil supply shocks over time.

5 Conclusion

Over the past two decades, the high volatility of global food prices has generated substantial concern about their destabilizing macroeconomic effects. Although previous studies have examined the pass-through effects of international food prices on domestic prices using simple pass-through regressions, these estimates have not taken into account reverse causality, omitted variable bias, or differences in sources of international food price fluctuations. In this paper, we use sign restrictions to identify relevant demand and supply shocks that explain volatility in global food prices. We quantify the dynamic effects of these global shocks on several components of domestic output for food-importing and food-exporting economies. In particular, we quantify the dynamic responses of domestic output, domestic absorption, household consumption, government consumption, investment, and trade balance to global structural shocks that drive real food prices.

Our findings reveal that identifying the sources of shocks driving global food prices is crucial to evaluate their domestic effects. Expansions in global economic activity that increase global food prices stimulate the domestic output of both food-importing and food-exporting economies; however, disruptions in global food commodity markets that lead to rising real food prices have large contractionary effects for food importers due to deteriorating trade balances and falling household consumption. We document opposing and shorter-lived effects for food exporters. Moreover, we find that the adverse effects of global food shocks are heterogeneous: they are larger among food-importing countries with relatively high shares of household food expenditures and high food trade deficits. Finally, we find that the share of the variation in output explained by the combination of GF and GO shocks is modest, which is similar to recent findings in the terms-of-trade literature.

Acknowledgements

This article was one of the chapters of Kerem Tuzcuoglu's Ph.D. thesis, previously called "How Important are Global Food Shocks?" We would like to thank Christiane Baumeister, Lutz Kilian, Serena Ng, Ricardo Reis, Stephanie Schmitt-Grohé, Jón Steinsson, Martín Uribe, as well as seminar participants at Columbia University and the Eastern Economic Association Meetings, for their comments and suggestions. The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada. All errors are, of course, our own.

Notes

1 A large body of work has explored the severity of recent food price hikes, and their economic effects in both developing and developed countries (Food and Agricultural Organization 2008; The World Bank 2009; Dillon and Barrett 2015; Giordani, Rocha, and Ruta 2016).

2 See, for example, Ivanic and Martin (2008), Ivanic, Martin, and Zaman (2012), and Attanasio, Vincenzo Di Maro, and Phillips (2013). Ivanic and Martin (2014) have documented that domestic price insulation policies against global food price fluctuations tend to increase price volatility at home.

3 Section 1.1 provides a detailed discussion of this literature, which has mixed results on the linkages between food and oil price dynamics as well as other macroeconomic outcomes.

4 Several studies report single-equation pass-through effects of international food prices to domestic ones. Durevall, Loening, and Birru (2013) find that international food and goods prices have a long-run impact on domestic prices in Ethiopia. They also find that agricultural supply shocks had a significant impact on domestic food prices in the short run. Similarly, Ianchovichina, Loening, and Wood (2012) estimate the pass-through effects of international food prices to domestic food prices in Middle Eastern and North African countries and find that, on average, a 1-percent increase in world food prices increases domestic food prices by 0.2–0.4%. Minot (2011) finds similar results for 11 Sub-Saharan African countries. Dillon and Barrett (2015) examine the effects of global crude oil and maize prices on local maize prices in East African countries, finding that in 7 of 17 local markets, global oil prices have a larger impact on local maize prices than do global maize prices due to transportation costs. None of these studies takes into account reverse causality from global business cycles to global food prices nor do they differentiate among underlying sources of changes in global food prices.

5 The set of variables in our model differs slightly from those used in previous studies. Following Charnavoki and Dolado (2014), our model includes global inflation but lacks global commodity supply for the same reason: supply data for a range of food commodities are not available. Hence, our model differs from those of Kilian (2009) and Kilian, Rebucci, and Spatafora (2009), which include the global supply of crude oil. However, unlike that of Charnavoki and Dolado (2014), our model includes two separate commodity price indices, one for oil and one for food commodities, instead of a single commodity price index. Thus, our global oil shocks and global food shocks capture unanticipated changes in the supply and demand of these commodities in international markets, which are orthogonal to the changes explained by the other two shocks. However, it is important to note that the shocks in food markets are more likely to originate from the supply side given that natural disasters such as draughts, floods, and earthquakes may have disruptive effects on harvests and affect food prices, whereas demand for food commodities are more tied to households food consumption that varies much less from quarter to quarter.

6 In addition, Bodenstein, Guerrieri, and Kilian (2012) develop a quantitative analysis of how US monetary policy responses should differ depending on the source of the observed oil price fluctuations.

7 The external balance effects of oil shocks have also been analyzed theoretically. See, for example, Bodenstein, Erceg, and Guerrieri (2011) and Backus and Crucini (2000), among others.

8 Another recent paper has documented that commodity demand shocks play a more important role than commodity supply shocks in driving prices over a broad set of commodities and over a long period of time (Jacks and Stuermer 2018).

9 Our paper differs from these studies in a number of respects. First, while previous studies examined the relationship between food and oil prices in a bi-variate VAR model (Baumeister and Kilian 2014; Baumeister, Ellwanger, and Kilian 2017), they have not examined how this relationship may change within a multivariate global VAR model that incorporates global demand shocks and global supply shocks. Second, while existing studies have looked at whether global demand shocks identified in a more restricted model have an effect on global food prices (Baumeister and Kilian 2014), they have not taken into account whether there is reverse causality from global food prices to global economic activity. Since our results show evidence of reverse causality, taking this into account is potentially important in distinguishing between global demand and global food shocks.

10 For oil-exporting countries, Spatafora and Warner (1999) find strong positive effects of terms-of-trade shocks on the components of aggregate demand, consumption, investment and government expenditures. In contrast, Schmitt-Grohe and Uribe (2015) find that terms-of-trade shocks explain only 10% of the variation in output using an SVAR model. Similarly, Aguirre (2011) finds that terms-of-trade shocks generate a smaller impact on macroeconomic aggregates in an SVAR model than in a business cycle model. Lubik and Teo (2005) find that interest rate shocks play a more important role as a source of business cycles compared to terms-of-trade shocks using a small open economy model.

11 Since developing countries have data for quarterly GDP and industrial production beginning in 1990, we do not directly include their activity measures. However, we include quarterly data on world exports and imports to capture the effect of rapidly growing developing countries on global economic activity.

12 For a discussion of alternative measures of global economic activity for different modeling purposes, see (Kilian and Zhou 2018).

13 We use the real price of crude oil rather than a composite index of real energy prices that includes natural gas and coal for two reasons. First, oil is by far the most consumed source of energy worldwide; thus, any energy price index is very highly correlated with oil prices. Second, in the next stage of our analysis, we are interested in the effects of global shocks on the components of output, and the classification of oil exporters and oil importers is less prone to measurement error than a classification that includes a variety of traded energy sources. Appendix Figures A2 and A3 and Table A1 show that our results are robust to the use of a real energy price index that includes the prices of coal, natural gas, and crude oil. The results are also robust to the use of an alternative price deflator, the US CPI index; this analysis is available upon request. We use the MUV index as the deflator since it does not include prices of non-tradable goods, while the US CPI places a large weight on non-tradable goods.

14 The results are again robust to the use of an alternative price deflator, the US CPI, and are available upon request.

15 The World Bank Global Economic Monitor (GEM) database reports that grains and oils have a total weight of 69%, while other food commodities such as meat, sugar, and oranges have a total weight of 31% in the global food price index.

16 Note that there is no data for retail food prices for the large set of countries during the time frame we examine, and hence, it is not possible to examine the effects of global food shocks on domestic retail prices in this analysis.

17 We take the first difference of these inflation series to eliminate the disinflationary trend throughout the world as we construct a global inflation factor.

18 The PWT also provide national income data in PPP terms. However, this might overstate the expansion or contraction of domestic output, which has a large component of non-tradables. In order for our results to be comparable to those of other studies, as well as to avoid overestimating the effects of global shocks, we use data measured in constant 2005 national prices (in million 2005 US\$). Appendix A provides a list of the variables used in the analysis.

19 Another popular method is the Cholesky decomposition (also known as recursive identification). In this decomposition, one needs to assume that B_0^{-1} is lower triangular with unit diagonals such that $\Sigma = B_0^{-1}B_0^{-1'}$. However, in this identification scheme, the ordering of global variables is crucial such that one needs to assume that a variable is not affected on impact by the variables that are placed after itself. Since we do not find this assumption credible, we chose to use sign identification where contemporaneous impacts are allowed.

20 Estimations are carried out by employing MATLAB codes of the BEAR toolbox developed by Dieppe, Legrand, and Van Roye (2016).

21 Using other priors do not change the results.

22 In representing IRFs and FEVD, we use their associated median draws. However, note that these median estimates are subject to the critique of Fry and Pagan (2011), that is, the median of the posterior draws for IRFs and FEVDs do not necessarily coincide with any structural model.

23 Frequency mismatch renders a joint estimation of the global and domestic variables impossible. Since the global shocks are coming from a first step estimation, the domestic regression is subject to a generated regressor problem.

24 Our primary country categories are net food importers ($N = 41$) and net food exporters ($N = 25$). However, we also analyzed net oil importers and net oil exporters as well as different sub-categories of net food importers based on their food trade balance and food expenditure shares.

25 To stationarize the variables, we take the growth rates of output, domestic absorption, household consumption, government consumption, and investment. No transformation is needed on the trade balance variable since it is represented as a share of GDP, thus, already stationary.

26 One thing to note is that these global shocks are coming from a first step estimation, hence there is a generated regressor problem. However, due to the mismatch of the data frequencies between global variables (quarterly) and domestic variables (yearly), a joint estimation is not possible.

27 To obtain similar likelihoods for the occurrence of real oil price shocks and real food price shocks, we choose to use one-standard-deviation effects throughout the analysis. That is, we scale the structural shocks in a way such that a one-unit increase in a global shock corresponds to a one-standard-deviation increase in the associated global variable.

28 The FAO continues to publish these reports: <http://www.fao.org/publications/sofa/the-state-of-food-and-agriculture/en/>. The earliest report was written in 1947. We have used the ones after the 1980s since our domestic output analysis uses data starting from 1980.

29 Impulse responses at longer horizons are potentially of interest given that the adjustments in commodity markets may take a long period of time. However, this is not feasible given the short span of the time series data that are available. Overall, the estimates are robust to the inclusion of 2–3 years of additional lags.

30 The effects of GF shocks on domestic output are comparable to those documented by another recent paper, which finds that a 1% increase in global food prices results in a 0.11% decline in domestic output (De Winne and Peersman 2018). Our estimates show that a one-standard-deviation increase of 2.27% increase in global food prices results in a 0.36% decline in domestic output. This implies that a 1% increase in global food prices generates a 0.16% fall in domestic output.

31 We examine the robustness of these results in Section 4. The results are robust to the use of alternative measures of global economic activity and real energy prices. Other robustness checks are available upon request.

32 We report median R^2 values for the panel model in (3), which is estimated for each of the 2000 posterior draws.

33 Table A1 shows that the variation in output explained by commodity-specific shocks declines slightly to an average of 4–7%.

34 Table A2 indicates that the variation in output explained by commodity-specific shocks declines slightly to an average of 5–7%.

35 The magnitude of the peak effects on output resulting from GO shocks appears to be similar to the magnitude of those resulting from GF shocks.

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Supplementary Material: The online version of this article offers supplementary material (DOI: <https://doi.org/10.1515/jgd-2018-0011>).

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