GLOBAL RELATIONS FORUM YOUNG ACADEMICS PROGRAM
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ANALYZING GLOBAL COMMODITY PRICES AND THEIR PASS-THROUGH INTO TURKISH INFLATION MEASURES

DR. KEREM TUZCUOĞLU

Columbia University, Ph.D. in Economics

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This paper entitled "*Analyzing Global Commodity Prices and Their Pass-Through into Turkish Inflation Measures*" is authored by Dr. Kerem Tuzcuoğlu as part of the *GRF Young Academics Program Policy Paper Series*. GRF thanks him for his contribution and commitment to this effort.

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GRF is grateful to all members who participated in the evaluation commission for their invaluable insights and informed guidance, as well as for the time and effort they dedicated to the program.

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About the Author

Dr. Kerem Tuzcuoğlu was born in 1985 in Istanbul. He attended Cağaloğlu Anadolu Lisesi, after which he studied at the Mathematics Department at Boğaziçi University. He has received M.A. degrees in economics from both Koç University and The Ohio State University. He obtained his Ph.D. in Economics from Columbia University in 2017.

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Tuzcuoğlu's research is focused on theoretical and applied econometrics with the applications on macroeconomics and finance. His Ph.D. thesis contains research on factor models, nonlinear dynamic models, credit ratings, the behavior of rating agencies, and the effects of global energy and food price fluctuations on various classes of countries. Currently, he focuses on Bayesian Threshold VAR model to assess the nonlinear dynamics of the Canadian economy variables in certain macro-financial risk scenarios.

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Analyzing Global Commodity Prices and Their Pass-Through into Turkish Inflation Measures

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Abstract

The aim of this paper is to magnify the pass-through effects of global commodity price shocks on different Turkish inflation measures, especially core and headline inflation. Based on the working paper Erten and Tuzcuoğlu (2016), I first develop a structural vector autoregressive model for the global economy and identify structural oil and food price shocks using sign restrictions. Then, I analyze the effects of these underlying sources of energy and food prices on Turkish inflation indicators. One important result is that there are significant pass-through effects of global commodity price shocks into Turkish core inflation, as opposed to the general belief that core inflation is unaffected by commodity price shocks. The propagation is more delayed after an energy price shock compared to a food price shock. Finally, I provide a qualitative narrative to explain this pass-through by focusing on the differences between advanced and emerging countries.

The results and the methodology of this paper can be beneficial to policy institutions (such as Central banks and food- and energy-related institutions) and financial institutions (such as credit, research, and strategic planning departments of banks and investment agencies). Basically, any institution that uses Turkish inflation measures and global commodity prices as integral parts of their analysis might find the results here valuable.

1. Introduction

Many central banks are inflation-targeters and most of them use the headline inflation as their primary target. They also focus on and follow closely the core inflation, which is by definition the headline inflation excluding energy and food prices. Hence, the core inflation measure excludes items that tend to go up and down in price dramatically or often, like food and energy items. Moreover, these two commodity price fluctuations are assumed to be temporary, in that these prices revert back in a short period of time. Therefore, many central bankers see core inflation as an unbiased predictor of headline inflation and believe that core inflation provides a better forecast of headline inflation than headline itself.

For this reason, many central banks use core inflation as an "operational guide" in coming to their monetary policy decisions.[1] Focusing on core inflation might help a central bank refrain from responding too strongly to the transitory movements in inflation due to food and energy price fluctuations. As a result, the policymakers emphasize core inflation to adjust the monetary policy, because what central bankers are truly concerned with is the underlying rate of inflation going forward; core inflation can be a useful proxy for that rate.

There is a crucial hidden assumption here: the core inflation measure is not affected by global commodity price shocks since it excludes those prices. However, in this paper, I will show that this assumption fails to hold for Turkey. The core – as well as the headline – inflation in Turkey is significantly affected by global commodity shocks. By providing a qualitative narrative, I will argue why this assumption might hold in advanced countries, while it may not in emerging and developing ones. The results of this paper suggest, inter alia, that policymakers should be careful when using the core inflation in their analysis. They should pay attention to the effects of global commodity price shocks, not only on headline inflation, but also on the core inflation. In many inflation-targeting economies, there was a widespread overshooting of inflation targets before the recent crises and a widespread undershooting after the crises. One of the reasons might be the fact that a surge of food and oil commodities inflation in 2007-2008 led to overshooting, which was followed by undershooting of the targets once commodity prices declined.[2] These pronounced price fluctuations can be seen in Figure 1, where logarithm of real oil and real food prices are plotted.[3] Global oil and food inflation was around 40% in real terms in 2008. These global price changes might have important effects on domestic prices, by generating large and permanent pass-through effects on domestic inflation. Hence, they pose significant challenges for domestic monetary policy.

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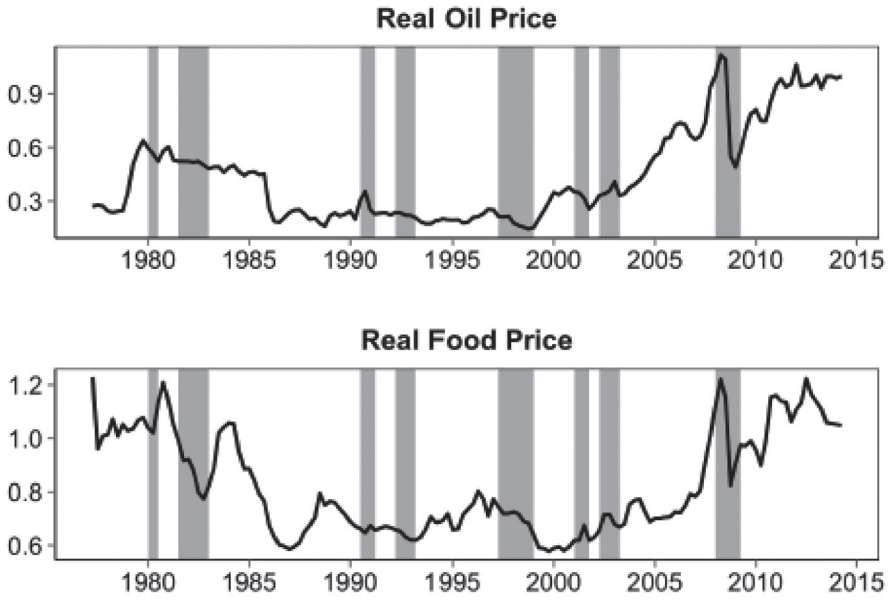
[1] For instance, the Bank of Canada announced that it can "look through" temporary changes in total CPI and focus on the underlying trend of inflation by monitoring the core inflation. "Inflation." Bank of Canada. http://www.bankofcanada.ca/core-functions/monetary-policy/inflation/.

[2] Examples for these countries contain Sweden, Norway, Canada, Australia, New Zealand, Turkey, Serbia, Chile, Colombia, Guatemala, Peru, Thailand, the Philippines, Indonesia, and Ghana. For instance, in Turkey the inflation targets for the years 2007–2010 were 4%, 4%, 7.5%, 6.5%, whereas the realizations of the inflation were 8.4%, 10.1%, 6.5% and 6.4%.

[3] Real prices are obtained by dividing original prices by the US CPI (in constant 2010 US Dollars).

Figure 1: Real Commodity Prices



Note: Dark gray shaded areas represent major global recessions. (Data source: World Bank)

There is a large literature focusing on pass-through effects. A big part of the literature takes the global prices as exogenous. A small but growing literature takes a different approach by examining the sources underlying commodity price shocks, including global demand, supply, and commodity-specific shocks, and shows that the reaction of domestic macroeconomic variables depends on the underlying sources of shocks. The first group in the literature misses a very important point: identification of the pure price shocks. Analyzing the effects of commodity prices on the domestic variables is not the right approach per se. In order to conduct a more accurate monetary policy, a central bank needs to know the underlying reasons of the fluctuations in commodity prices. For instance, food prices might go up due to a drought or an increase in global demand or an increase in oil prices. In each scenario, the reaction of a central bank would be different since the origin of the shock is different. Hence, without knowing the real source of the fluctuations, monetary policy cannot be effective. Therefore, using commodity prices as exogenous variables in the pass-through analysis could be misleading.

This research paper will belong to the latter group in the literature mentioned above. That is, I will decompose global commodity prices and identify the fluctuations due to global demand, supply, and commodity-specific shocks. There are a few prominent research papers in this category, such as Kilian (2009) and Charnavoki and Dolado (2014). However, none of the existing papers analyze global food prices separately. For instance, Kilian (2009) analyzes only global oil prices, whereas Charnavoki and Dolado (2014) focuses on global commodity prices as a single variable. My analysis in this paper will be mostly based on the working paper Erten and Tuzcuoğlu (2016), which is the first paper to disentangle global oil and food price shocks. I will use their strategy at the global level, but I will focus only on Turkey at the domestic level. Hence, this paper can be considered a policy paper in the sense that I will measure the magnitude and the duration of the pass-through effects of global commodity price shocks on Turkish inflation. Thereby, any policy institution can make use of these results or the estimation strategy in their analyses that include global commodities and Turkish inflation.

The rest of the paper is organized as follows. Section 2 provides descriptions of the global and domestic data sets and their limitations. Section 3 discusses the identification strategy for global shocks as well as the domestic analysis. Empirical results on pass-through analyses are also reported in this section. Section 4 contains qualitative reasoning for some of the results. Section 5 concludes.

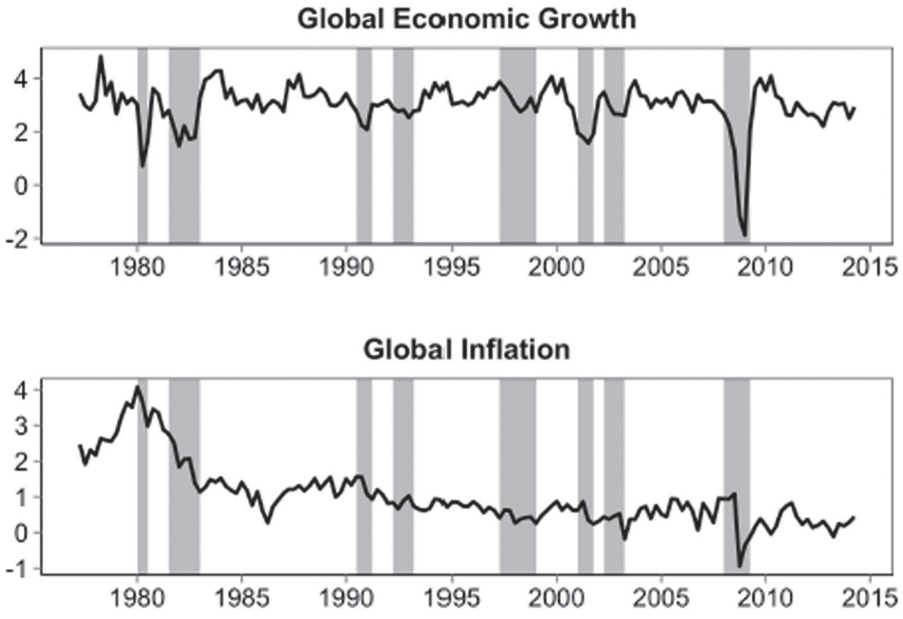
2. Data

In this section, I describe the global and Turkish data sets, their sources, and the transformations I applied to the data before using economic techniques later on.

2.1 Global Data

We use quarterly data from 1978Q2 to 2014Q2 which consists of series representing the global variables of interest: global economic activity, real oil price, real food price, and global inflation. Since it is hard to find to a good measure for global economic activity, we extract the first principle component of seven series representing real GDP, industrial production, and volume of exports and imports of the world economy, the large regional groups (OECD, European Union, and G7), and the United States (the data are downloaded from the FRED database).

Figure 2: Global Economic Growth and Global Inflation (Estimated as first principal components)



Note: Dark gray shaded areas represent major global recessions. These two series are the first principal components of activity measures and inflation measures, respectively, as explained in details in the text above.

The fact that there are not enough emerging countries in the global data set might be a concern. The main reason for not having emerging countries' activity series in our data set is data limitations: either the data of emerging countries is short or the data is not of high quality (several irregularities and structural breaks in the data hinder high-quality factor extraction). Moreover, the inclusion of volume

of world exports and imports allows us to capture real activity related to faster-growing emerging market economies. Hence, we believe that emerging economies are indirectly represented in our data set. The same approach with a similar data set was taken in several papers in the literature (see for instance Charnavoki and Dolado (2014)). Finally, as can be seen in Figure 2, the extracted factor successfully captures the key global business cycles, including the recessionary episodes in the early 1980s, the European exchange rate mechanism crisis of the early 1990s, the East Asian crisis of 1997-1998, the collapse of the dot-com boom and 9/11 attacks in the early 2000s, and the great moderation period until the Great Recession of 2007-2009.

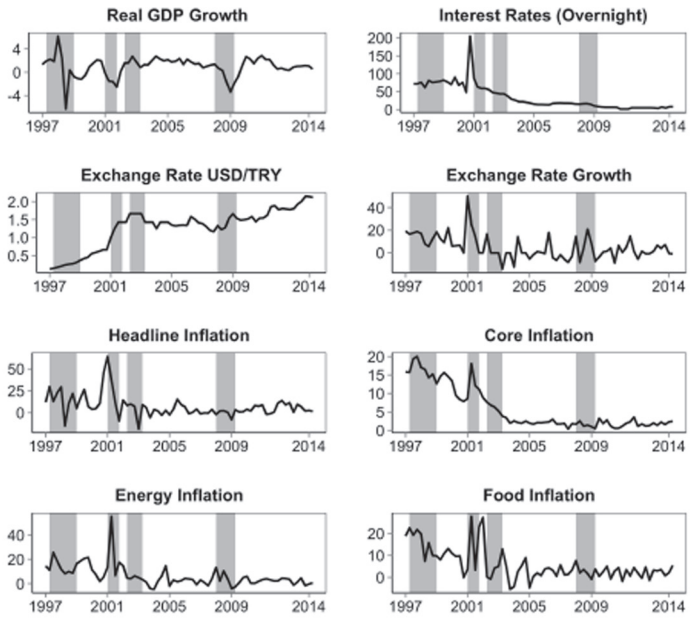
The real price of energy is the simple average of Dated Brent, West Texas Intermediate, and the Dubai Fateh deflated by the US consumer price index. The real price of food is defined as the global price of food measured by the Global Economic Monitor of the World Bank and deflated by the US consumer price index (in constant 2010 US dollars). The real oil prices reflect major developments in the global energy market, and the real food prices capture major supply shortages in food production. The reason for using real prices instead of nominal prices is to eliminate the effect of the inflation in oil and food prices. Real price captures the relative price of a good compared to other goods and services. Hence, using real prices is a much better way for understanding the price changes in oil and food relative to other goods and services.

For global inflation, we use the same approach as for global activity. Global inflation is extracted as a first principal component from a data set containing GDP deflators, CPIs, and PPIs of the OECD, European Union, G7, and the United States (the data set is obtained from FRED). The global inflation factor reflects the inflationary of the early 1980s, the relatively low levels of inflation in the 1990s due in part to positive productivity shocks, followed by rising inflation in the late 2000s as the global commodity prices began to trend upward, and the subsequent deflation of the 2010s as the commodity prices began to decline.

2.2 Turkish Data

The domestic data set, which is plotted in Figure 3, contains data between 1997Q1 - 2014Q2 for the variables real GDP growth, nominal exchange rate, interest (overnight borrowing) rate, headline (CPI) inflation, core inflation, energy inflation, and food inflation. There are several points worth paying attention to in the Turkish data. We see a big (and delayed) impact of the Asian Crisis at the beginning of the data set, where real GDP went down around 5%. In that crisis, we also see sharp fluctuations in inflation and exchange rate. Yet, the 2001 crisis had overall a much bigger impact on the Turkish economy. The Turkish Lira depreciated around 40%, inflation went up to 80%, and interest rates skyrocketed to a quarterly average of 200% (there were days where a 6000% interest rate was observed). After 2001, there have been several changes in the structure of the economy. First of all, the Central Bank of the Republic of Turkey announced a (more) flexible exchange rate regime, and started inflation targeting. Second, the so-called Derviş Economy Plan was implemented to change the banking system and stabilize the economy. Finally, interest rate and inflation measures decreased to reasonable numbers only after 2003.

Figure 3: Turkish Data



Note: Dark gray shaded areas represent major global recessions.

There are several issues related to the Turkish data that threaten the soundness of an econometric analysis. Policy changes in inflation, interest rates, and exchange rates are not easy to account for if one wants to include data before 2001. Non-stationarities and extreme spikes are present in the data, all of which threaten to skew the results. However, using merely stationary episodes of the data, which corresponds to the more restricted interval 2003-2014, results in very few observations for time series analysis. Moreover, there has been a relatively recent change in the policy rate. Since 2010, the one-week repo rate has been used as the policy rate instead of the overnight borrowing rate by the Central Bank of the Republic of Turkey.

In the face of all these challenges, I have decided to use the whole data set (1997Q1-2014Q2) and detrend the data by removing a deterministic trend. The idea behind using a deterministic trend is that there is a common decline in inflation in most of the countries around the world, especially in emerging ones. Hence, if we assume that Turkey follows this declining inflation trend, then we can remove this extra global force on Turkish inflation, and obtain a stationary inflation variable. Instead of over-differencing, which would cause loss of important information, I believe this approach yields better results, under the assumption of global decline in inflation. Regarding the policy rate, I will use the overnight borrowing rate instead of the one-week repo rate even though the most recent policy rate is the latter. If I only used the repo rate then I would have ended up using just four years of data. If I used overnight borrowing rate data until 2010 and then switched to repo rate, it would create an abrupt change in the policy data. The results will be unquestionably affected by this artificial policy rate. Hence, using only overnight borrowing rate throughout the data span seems to be the best choice for now. In any case, the correlation between overnight borrowing rate and repo rate is 84% after repo was introduced in 2010.

Below are the mean and the standard deviations of each inflation measure for the time period 2003-2014.[4] Headline and energy inflation have a larger variation than other inflation measures. Core inflation, however, varies notably less than any other variable. This fact is one of the reasons why central banks prefer using core inflation as a guide to forecast headline inflation.

Table 1: Descriptive statistics for inflation variables (2003-2014)

	Headline Infl	Core Infl	Energy Infl	Food Infl
mean	3.24	1.90	2.35	2.18
standard dev	4.95	0.75	3.95	2.97

3. Empirical Methodology and Results

In this section, I introduce the global model, which is borrowed from Erten and Tuzcuoğlu (2016), where global-level commodity shocks are identified. Then, I measure the magnitude and the duration of the pass-through of these global commodity shocks on Turkish inflation measures.

3.1 The Global Model and Identification of Structural Shocks

Vector autoregressive (VAR) models are frequently used in the empirical literature to extract unobserved shocks to the economy. The biggest advantage of VAR models is that one can take into account the reverse causality between the variables of interest. By adding enough lags in the model, one can avoid the need to control for other variables. However, to be able interpret the underlying shocks, one needs to impose extra assumptions on the relationships between the variables in the model. These identifying restrictions make the model a Structural VAR model (SVAR). For the identification of structural shocks, Erten and Tuzcuoğlu (2016) uses Sign Restrictions, which is a relatively new technique in SVAR models. It does not rely on "timing" of the variables as in Recursive Identification (also called Cholesky Decomposition). The Sign restriction approach uses only knowledge from economic theory, such as whether the relationship between variables is positive or negative.

The global model is a VAR model with 8 lags and with endogenous variables of global economic growth factor, first difference of the natural logarithm of real oil price, first difference of the natural logarithm of real food price, and global inflation factor. Global variables are denoted as $Y_t^g = [Act_t^g, Oil_t^g, Food_t^g, Inf_t^g]$, which follows a VAR(8) process. Hence, the model can be expressed as $Y_t^g = A_1 Y_{t-1}^g + \cdots + A_8 Y_{t-8}^g + B\varepsilon_t^g$, where the matrices $\{A_i\}_{i=1}^8$ capture the dynamics of the model, and the errors $\varepsilon_t^g = [\varepsilon_{D,t}^g, \varepsilon_{E,t}^g, \varepsilon_{F,t}^g, \varepsilon_{S,t}^g]$ are the structural global shocks we are interested in, i.e., global demand, energy, food and supply shocks. The matrix B is called the *structural* matrix. It is the most important coefficient in the model since it captures the effects of each structural shock on the global variables. However, there is no way to obtain *B* without making extra assumptions about the structure of it; hence, sign restrictions help us. The identification of the structural shocks ε_t^g comes from the restrictions imposed on the *B* matrix. The following identification strategy is implemented for global analysis.

[4] Since the variables are stationary only after 2003, I use the 2003-2014 period for simple descriptive statistics. Still, the 1997-2014 period will be used for more complicated analysis.

Table 2: Sign restrictions on impulse response functions

	GD Shock, $\varepsilon^g_{D,t}$	GE Shock, $\varepsilon^g_{E,t}$	GF Shock, $\varepsilon^g_{F,t}$	GS Shock, $\varepsilon^g_{S,t}$
Global economic growth	+	-	-	+
Real energy price	+	+	0	+
Real food price	+	+	+	+
Global inflation	+	+	+	-

The interpretation of these sign restrictions is as follows. In the first column of *B*, it is assumed that global demand shocks will have a positive effect on all of the variables. That is, an increase in the global demand will increase the global economic growth and prices. From the second column, one can infer that energy (oil) price shocks will have a negative effect on real economic activity and a positive effect on the prices. The third column implies that shocks to the food prices have a negative effect on real economic activity and a positive effect on inflation, but no effect on real oil price. Finally, the fourth column can be interpreted as showing that a supply (technology/productivity) shock has a positive effect on all real variables but a negative effect on inflation.

Interested readers can see detailed estimation results and impulse response functions in Erten and Tuzcuoğlu (2016). For brevity, I present here only the initial median impulse responses and 10-quarter-ahead forecast error variance decomposition to give an idea of how much each shock can explain each variable. Table 3 reports the estimated contemporaneous median responses of global variables to global shocks. For instance, one unit increase in global demand leads to a 0.45% increase in the global economic activity growth, or in other words a 2.2 ($\cong$ 1/0.44) unit increase in global demand will expand the world economy by 1%. Similarly, a 4 unit increase in global demand increases real food inflation by 1%. These numbers will be useful in understanding the pass-through effects in the domestic analysis.

Table 3: Contemporaneous median responses of global variables to global shocks

	GD Shock, $\varepsilon^g_{D,t}$	GE Shock, $\varepsilon^g_{E,t}$	GF Shock, $\varepsilon^g_{F,t}$	GS Shock, $\varepsilon^g_{S,t}$
Global activity	0.45	-0.09	-0.11	0.25
Real energy price	0.32	0.63	0.00	0.19
Real food price	0.26	0.09	0.55	0.39
Global inflation	0.47	0.29	0.22	-0.18

Table 4 documents the 10-quarter-ahead forecast error variance decomposition. One can observe that each variable is explained mostly by its associated shock, as expected. Oil price shocks are the second most important variable for other quantities, whereas supply shocks have the least explanatory power. For real food prices, global demand and energy shocks have similar importance ($\cong$ 12% of the variation in real food prices). Since global supply shocks have very low explanatory power for variations in other variables, we will not use global supply shocks in the domestic analysis for brevity.

Table 4: Forecast Error Variance Decomposition

	GD Shock, $\varepsilon_{D,t}$	GE 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

3.2 Pass-Through Analysis in Turkish Economy

Ideally, a SVAR model for the Turkish economy where reverse causalities between GDP growth, exchange rate, inflation, and monetary policy are taken into account would be the best model to analyze the effects of global shocks on Turkish macro variables. However, due to the short span of data, multivariate models will not provide reliable results. Instead of a VAR model, I use a single-equation pass-through regression where the dependent variable is different components of inflation and the independent variables are structural shocks, as well as nominal exchange rate and growth rate of real GDP.

Structural shocks coming from the global regression are denominated in dollars. Hence, the effects of these shocks will contain not only the effect of structural shocks but also appreciation/depreciation of the domestic currency against dollars. In order to convert the shocks into Turkish Lira, they need to be multiplied by the nominal exchange rate; i.e., Turkish Lira-denominated structural shocks will be $\varepsilon_t^g X_t$. However, this will generate non-stationarity in the global shocks since the shocks are stationary but the exchange rate is not. In order to avoid non-stationarity in the variables of interest as well as to capture the effects of changes in the value of the domestic currency, the natural logarithm of the exchange rate is added to the regression.[5]

[5] The idea of adding log X_t comes from the following. Assume I multiplied the shock ε_t by the exchange rate X_t to obtain TRY-denominated global shocks, and added it as a regressor after taking the logarithm of it. This is equivalent of adding the logarithm of the shocks and the logarithm of the exchange rate: $\log(\varepsilon_t X_t) = \log \varepsilon_t + \log X_t$. However, since the shocks have some negative values, I cannot take the logarithm of them. Hence, I leave the shocks as they are but add the logarithm of the exchange rate in the regression.

Output gap is an important determinant of inflation. A positive output gap is usually associated with an increase in inflation. However, it is very hard to get a good measure of output gap since it depends on potential economic activity. A frequently used substitute for output gap in econometric analyses is the real GDP growth. Hence, by controlling for the growth of real GDP in the regression, I take the output gap (domestic aggregate demand and supply) into account. Finally, as mentioned in the data description section, I detrend the nonstationary variables, i.e., inflation and exchange rate, by regressing them on a deterministic trend and taking the residuals as the detrended series. Hence, the following is the domestic pass-through regression that I use for analyzing Turkish inflation. For $t = 1, \ldots, 63$,

$$\pi_t = c_o + \sum_{j=0}^{6} \beta_j \hat{\varepsilon}^g_{t-j} + \sum_{j=0}^{6} \delta_j \log X_{t-j} + \sum_{j=0}^{6} \gamma_j G_{t-j} + u_t, \qquad (1)$$

where Turkish inflation, estimated global shocks, the logarithm of the USD/TRY nominal exchange rate, and the Turkish real GDP growth rate are denoted as π_t, $\hat{\varepsilon}^s_t$, log X_t, and G_t, respectively. Note that regression (1) is estimated separately 4×3 = 12 times for each measure of inflation (headline, core, energy, food) and for each global shock (demand, energy, food). The parameters $\{\beta_o, \ldots, \beta_6\}$ capture the 6-quarter-response of Turkish inflation to global shocks. The reason for not going beyond a 1.5-year effect is data limitation. Adding one more lag to the regression will decrease the number of observations by one and increase the number of parameters by three. Hence, the degrees of freedom will deteriorate dramatically. For example, if I used 2.5-year lags I would have ended up using 59 observations to estimate 1+3x11=34 parameters. That is, only 25 observations would have been used to fit the data, which would probably not give reliable results.

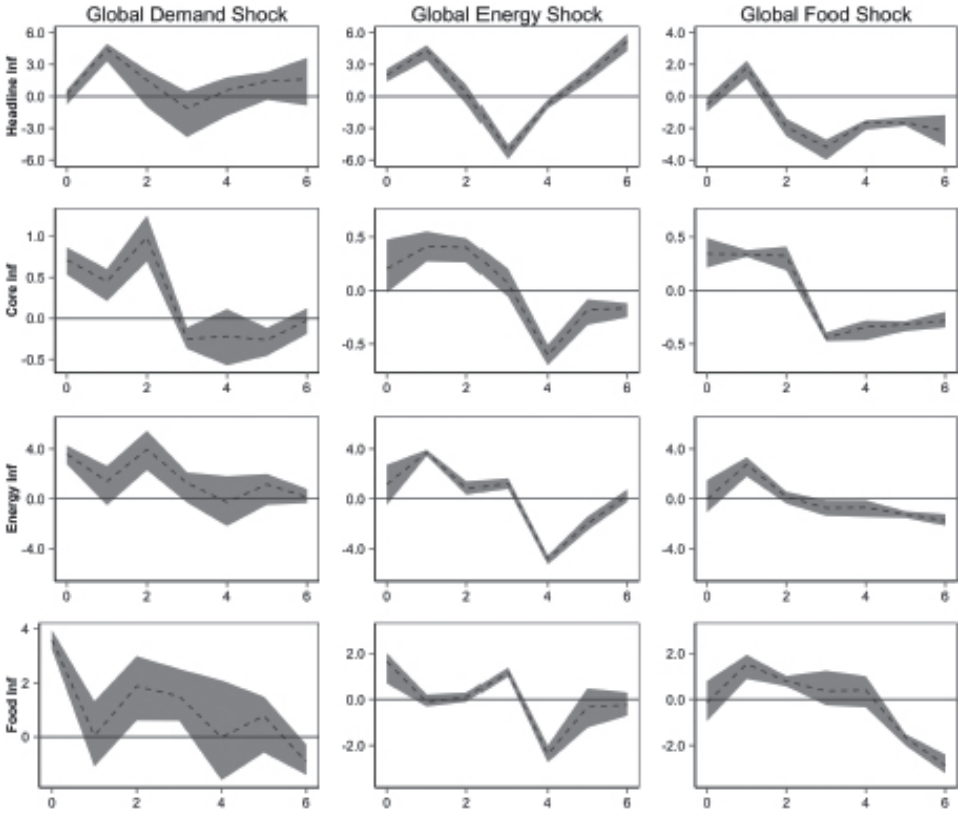
The β parameters determine the magnitude of the pass-through if there is a one unit increase in the current global shock while everything else stays constant. But what does it mean for a global shock to increase by one unit? One could use Table 3 to answer this question. For instance, in a regression with global demand shocks, we can say that a unit increase in global demand, which increases the global economic growth rate by 0.45% at impact, yields a β_0 percentage point increase in Turkish inflation contemporaneously. However, to make it easy for the reader to understand the pass-through effects, I multiplied estimated βs of global demand shocks by 1/0.45. In this case, we can say that a global demand shock that generates a 1% increase in global economic activity will increase Turkish inflation by β_0/0.45 percentage points. Similarly, I arranged the responses such that each global shock generates a 1% increase in their corresponding global variable. All the impulse-response plots are generated in this fashion.

One might be concerned about omitted variable bias in the estimates of equation (1). In fact, potentially, there are biases in the estimates of δ_js and γ_js since the exchange rate and real GDP growth rate are very likely to be correlated with omitted variables. However, as is explained with more details in Kilian (2009, p.1065-1066), the global structural shocks are predetermined with respect to the domestic variables since they are estimated in an orthogonal fashion at the global level. Thus, by the Frisch-Waugh Theorem, the coefficients β_j are estimated without bias.

Another potential pass-through equation can be the regression of π_t on the global variables themselves instead of the global shocks. In this potential regression, the coefficient of, say, the global energy price would reflect the percentage effect of a 1% increase in global energy prices while holding other global variables constant. However, if it is true that the global energy shocks contemporaneously affect the other three global variables, then the coefficient of global energy in this potential regression would capture something different than the coefficient β_j in regression (1). I believe that in this integrated world economy, the β_js, that is, the effects of global shocks, are more interesting than the isolated effects of global prices.

Figure 4 plots the responses of Turkish inflation to different global shocks. The gray shading covers the 68% credible set for the responses together with the median response in the dashed black line.[6] There are several important results worth pointing out. First of all, we see that core inflation is affected by global commodity shocks significantly. Both the global energy shock and global food shock generated similar effects on core inflation. A global energy shock that increases real energy prices at the global level by 1%, will increase Turkish core inflation by 0.3 percentage points initially, with a peak increase of 0.5 percentage points after 6 months, and then eventually creating a negative effect. Similarly, a

Figure 4: Responses of Inflation Measures to Global Shocks



[6] A 68% confidence interval is more frequently used than 95% confidence intervals under the cases when previously estimated variables are used in another regression. Here, estimated global shocks in the pass-through regression contain not only the variability in the shocks but also the regression uncertainty that comes from VAR estimation. To account for this extra variation, 68% confidence sets are preferred over 95%.

global food shock that generated a 1% increase in global real food prices has a positive effect initially, but then a negative effect on core prices after a year. Usually, in developing countries we see a delayed effect, or the so-called second-round effect, of the commodity shocks on core inflation. An increase in energy/food prices increases cost of living (this effect is especially significant in developing countries), and thus upward pressure in wages occurs in the following quarters. Hence, we observe inflation in non-commodity prices after a commodity-specific shock. In Turkey, the fact that core inflation reacts by 0.3 or 0.5 percentage points might seem insignificant, but one should note that the average core inflation in the last 10 years is 1.90% with a standard deviation of 0.75 (see Table 1). Hence, these are not negligible effects. This result has important policy implications: using core inflation to predict headline, assuming the fact that core does not contain (temporary) global commodity shocks is not a sound strategy since we observe that global energy and food shocks diffuse into Turkish core inflation significantly. Ignoring this propagation might result in overshooting or undershooting of the inflation target by central banks.

A global demand shock that yields a 1% increase in global activity will generate about a 4 percentage point increase in headline, energy, and food inflation measures with a decaying effect over time. Basically, the initial impact on each inflation component is around one standard deviation. In general, global demand shocks generate larger effects on the Turkish economy than other global shocks. Another observation from Figure 4 is that both commodity shocks generate a decline in prices within a year. I believe the reason is that increases in the commodity prices contract the domestic demand, and that domestic prices are thereby decreased as a result of a decline in domestic economic activity. Given the fact that food and energy constitute a large fraction of the consumption bundle in Turkey, and the fact that it is hard to find substitutes for them, increases in commodity prices result in decreased demand for other goods and services.[7] Hence, there is a delayed negative effect on general prices after commodity price shocks. The last point worth mentioning is the response of commodity inflation to commodity shocks. One can observe that energy inflation reacts around one standard deviation after each global commodity shock. However, food inflation in Turkey reacts much less to global commodity prices. I think the reason is that the global food price index contains basically grain crops (mostly wheat, rice, maize, soybeans, and corn) and animal husbandry products, whereas in Turkey the weights of vegetables and fruits in the index is relatively higher. Thus, the low response of food inflation in Turkey to global food price shocks may be due to the difference in food price index coverages.

[7] In general, emerging countries spend a larger fraction of their income on food and energy than advanced countries. The fraction of income spent on food is 25% in Turkey, whereas it is only 8% in the United States, for instance.

4. How Could Core Inflation Be Affected by Commodity Price Shocks?

In the previous section, the results show that the core in Turkey is affected by energy and food price shocks even though the core inflation measure excludes those prices. To explain this, I will construct a series of qualitative analyses, in narrative form, by comparing advanced and emerging countries.

In particular, global commodity shocks may affect emerging economies more adversely than advanced economies because of the high share of food and energy in household expenditures, the low price elasticity of food as a necessary good, and the presence of financial frictions that reduce the possibilities for consumption smoothing (De Gregorio (2012); Anand et al. (2015); Catao and Chang (2015)). This implies that when international commodity price shocks are large and permanent, the resulting pass-through to domestic commodity prices may result in a reduction in aggregate demand. Under these conditions, monetary authorities in emerging countries should be more careful when using the core inflation as a tool for policy.

Once a country faces a positive global commodity price shock, we expect to see, in general, an increase in domestic commodity prices regardless of the country's trade balance in that commodity. These are called the first-round effects and they affect the headline inflation. Next, I will argue that there could be so-called second-round effects, particularly in the emerging countries, that let the international commodity shocks propagate into core prices. Below are the first- and second-round effects, explained.

First-round effects: Domestic food, energy, and headline inflations react positively to global shocks driving global food and energy prices. We would expect both net commodity importers' and exporters' prices to react positively to global commodity price shocks. This is because net commodity importers buy higher-priced commodities from abroad, which would result in higher domestic prices for those commodities. In addition, the producers in net commodity exporter countries could sell at higher prices abroad, which would induce them to raise domestic prices as their opportunity cost increases; i.e., they could sell the commodity at higher prices in foreign countries otherwise.[8] The first-round effects are expected to be seen in both advanced and emerging countries.

Second-round effects: Domestic core inflation responds positively to the indirect impact of the global commodity shocks on other prices, through cost-push or demand-pull pressures. We expect to find these effects to be large and significant in countries that have a large share of food and energy in consumption baskets and that have financial frictions that prevent their consumers from smoothing out these commodity price shocks, creating large aggregate demand effects. In other words, emerging countries are more likely to face the second-round effects than advanced ones.

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[8] Several countries have imposed export bans precisely to counter domestic price increases because of this reason. Among these are Argentina, which imposed a ban on beef exports in 2006, and Russia, which imposed a ban on grain exports in 2010.

Let's exemplify the second-round effects by comparing two countries whose average households spend 5% and 25% of their disposable income, respectively.[9] Assume that there is a positive global food price shock which increases domestic food prices similarly in both countries. Hence, we will see a similar increase in the headline inflations and no change in the core inflations initially. However, the household with the larger food share is more resource-constrained as a result of the price change. Moreover, if there exist financial frictions that prevent the household from smoothing its consumption by borrowing, then these will lead to wage increase pressure. Once the wages increase, the prices of other goods and services will follow. As a result, the core prices respond indirectly to international food price movements, and more so in emerging countries where households spend relatively more on food.

A similar example can be given for the energy share in a household's budget or on the cost-push side regarding the energy dependency of the production. Regarding the latter, an increase in global energy prices will be translated into prices of goods due to the increase in production cost. Thus, core prices will be affected, with a lag, by global energy price fluctuations even though energy prices are not included in the measurement of core inflation.

In emerging and underdeveloped countries, the share of food expenditure in the household budget can increase up to 50%. Since food has a low price elasticity as a necessary good, the larger its share is in the household budget, the larger the effects of food price changes become. Therefore as is documented in Pedersen (2011), food shocks have larger effects in emerging and underdeveloped countries compared to energy shocks.

5. Conclusion

To the best of my knowledge, this policy paper is the first in the literature to analyze the pass-through effects of underlying (structural) global commodity shocks into the Turkish economy. Being able to identify global level uncorrelated structural shocks – as opposed to using global level prices – as exogenous variables allows us to conduct a more reliable pass-through analysis. The results document the duration and the magnitude of the pass-through of international commodity price fluctuations into Turkish headline and core inflation measures. These findings can be useful to policy institutions as well as financial institutions that use commodity prices and Turkish inflation in their analysis.

One interesting result shown in the paper is that Turkish core inflation is affected by the fluctuations in the global commodity shocks, even though by definition core inflation excludes food and energy prices. This result is important since it calls for more attention when using core inflation in an analysis. For instance, at many central banks, core inflation is used as a guide to predict the headline inflation, which is the target inflation. The prevalent assumption in using the core as a guide is that the core inflation is less volatile than the headline since it excludes temporary

[9] These two countries can be seen as the US and Turkey. According to the ICP by the World Bank, in 2011, the food share in household budget in the US and in Turkey are 5% and 25%, respectively.

and mean-reverting commodity price shocks, which implies that the core provides a better forecast for the headline than headline itself. However, this assumption would fall apart if core inflation is also affected by commodity price shocks. The result of this wrong assumption would be a possibly delayed overshooting or undershooting of the target inflation. On the financing side, the pass-through results can be of assistance to strategic planning or credit analysis at financial institutions. Having an estimate for the magnitude of the pass-through into inflation measures after realizing a commodity price shock could be valuable for assessing the risks of a business.

To explain potential reasons for the propagation of commodity shocks into the core inflation, I compare advanced and developing countries in a qualitative analysis. I believe the main reasons for the propagation into the core lie in the share of food and energy in household budget and the financial frictions present in a country. A household in a typical advanced country spends less than 10% of its disposable income on food; however, this share can go up to 40%–50% in developing countries. Similar numbers are valid for the share of energy in a household budget. Therefore, an increase in commodity prices has a much bigger effect on the household in developing countries than in advanced ones. This brings about an upward pressure in wages and other prices, which are the core prices by definition.

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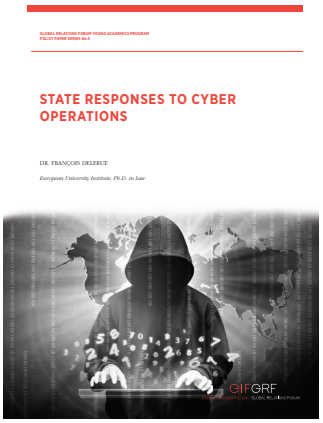

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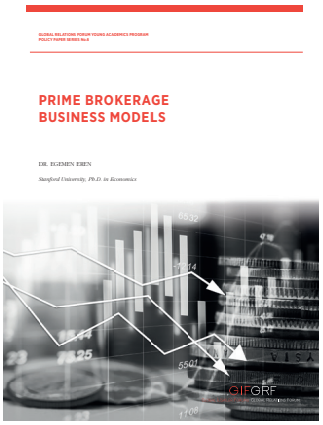

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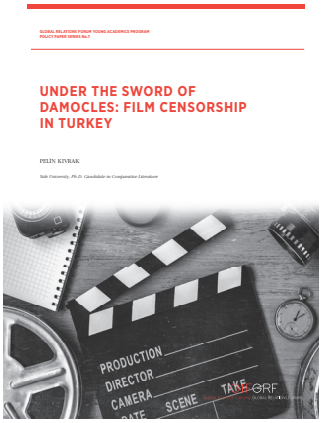

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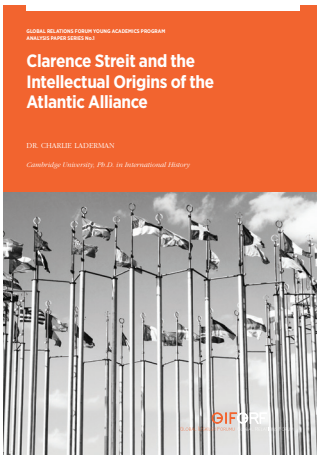

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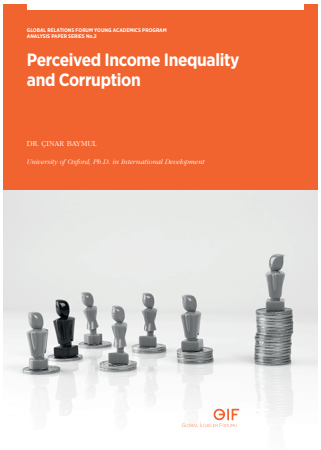

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