Persistence of Commodity Shocks

John Baffes, Ph.D.
Senior Agriculture Economist, Prospects Group, World Bank; and Member of both the J.P. Morgan Center for Commodities' Research Council at the University of Colorado Denver Business School and the *GCARD*'s Editorial Advisory Board

Alain Kabundi, Ph.D.
Senior Economist, Prospects Group, World Bank

Almost two-thirds of emerging market and developing economies (EMDEs) and three-quarters of low-income countries rely heavily on commodity extraction and export. This can put their economies at the mercy of global commodity markets, which are prone to shocks. The most recent example is the impact of the COVID-19 pandemic. To the extent such shocks are transitory, commodity-exporting EMDEs can buffer their impact on local economies; to the extent these shocks are permanent, policymakers in these countries need to facilitate a smooth adjustment to a new economic reality. Based on an analysis of 27 commodities during 1970-2019, this paper finds that transitory and permanent shocks contributed almost equally to commodity price variations, although with wide heterogeneity. Permanent shocks accounted for two-thirds of the variability in annual agricultural commodity prices but less than half of the variability in base metals prices. For energy prices, permanent shocks have trended upward, for agricultural prices, downwards, and for metals prices, flat. The volatility triggered in April-October 2020 by the COVID-19 pandemic appears to constitute a series of largely transitory shocks for oil prices.

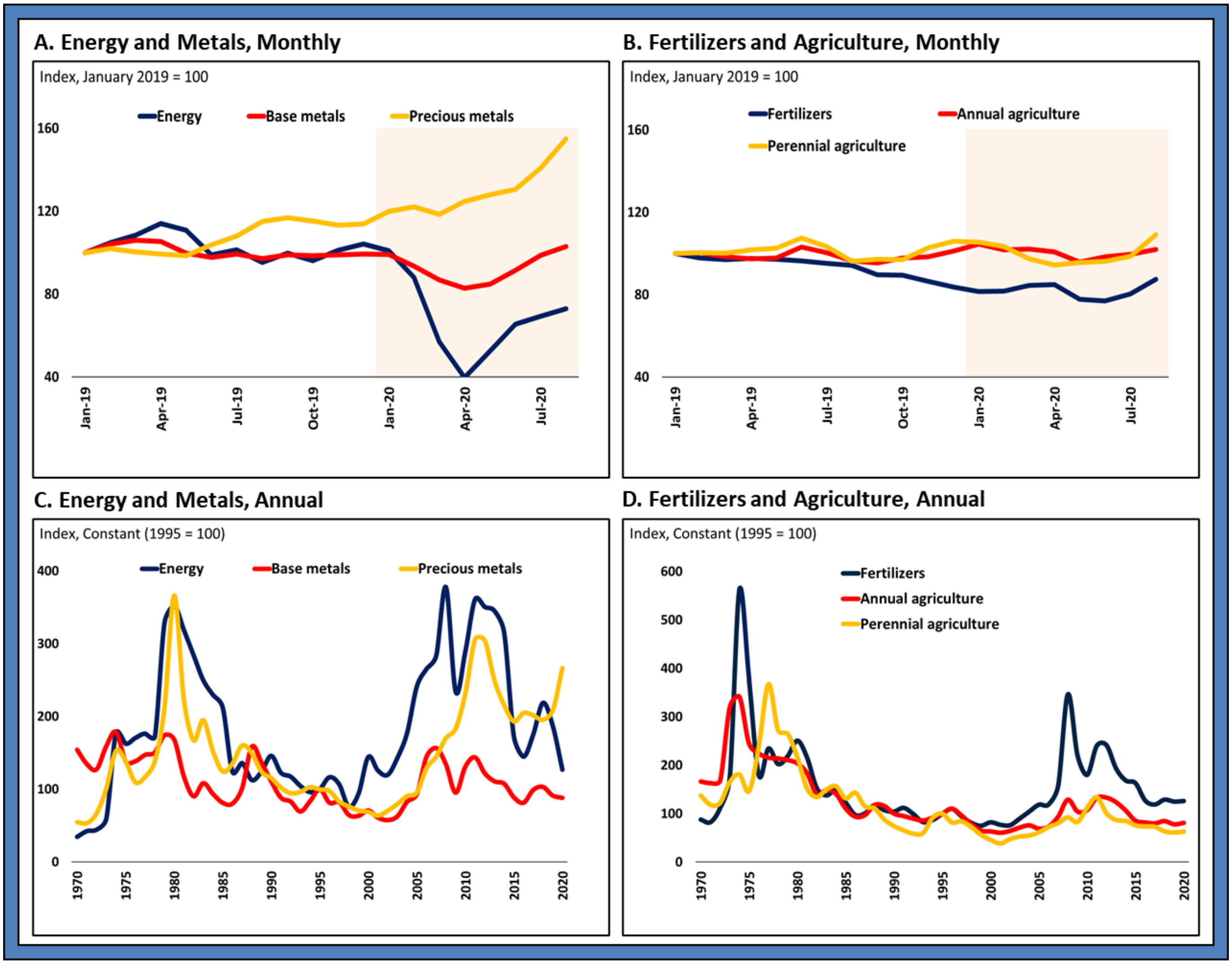
Introduction

The COVID-19 pandemic delivered an enormous shock to the global economy and led to the deepest global recession since the Second World War, by far surpassing the recession in 2009 that was triggered by the global financial crisis (World Bank, 2020a). The pandemic impacted commodity markets as well, but its effect on prices has been heterogenous (World Bank, 2020b). Between January and April 2020 energy prices dropped nearly 60 percent while metals and food prices declined by 15 and 10 percent, respectively (Figure 1). Metal prices recovered in response to supply shocks and a quicker-than-expected pickup in China's industrial activity, and food prices stabilized as concerns about restrictive policy measures faded. However, the impact of the demand shock on the oil market continues and may become permanent.[1]

Commodity price movements explain considerable fluctuations in economic activity, particularly in EMDEs (Aguiar and Gopinath, 2007; Kose, 2002). Policymakers can smooth some of these fluctuations with policy stimulus or contraction – provided commodity price movements are temporary. For longer lasting shocks, policymakers need to facilitate their economies' smooth adjustment to a new normal.

Transitory shocks can originate from recessions, such as the 2009 global financial crisis and the 1997 East Asian financial crises (both of which impacted a wide range of commodities), trade tensions (such as in 2018-19 and of special relevance to metals and soybeans) or bans on grain exports during 2007 and 2011 (World Bank, 2019). They can also arise from adverse weather conditions, most common to agriculture, such as El Niño and La Niña episodes or drought-related production shortfalls (such as grains in 1995 and coffee in 1975 and 1985). Transitory shocks can also result from accidents (2019 Vale accident in Brazil which disrupted iron ore supplies), conflicts (the first Gulf War, when Iraq/Kuwait oil production was halted), or terrorist attacks (on the Saudi oil facilities in 2019, which halted oil exports temporarily) (World Bank, 2019).

Figure 1
Commodity Price Indexes
Commodity prices have been impacted differently by COVID-19. Energy prices, which declined more than 60 percent from January to April 2020, were still 32 percent lower in September 2020. Metals and food prices were impacted much less and have returned to pre-pandemic levels. The long-term effects of shocks on prices also varies across commodities.



Source: World Bank.

A.B. Shaded areas denote the pandemic period: January 2020 (when the first human-to-human transmission was confirmed) to September 2020 (last observation of the sample).

C.D. The indexes have been deflated by the U.S. CPI. Last observation is 2019.

Shocks can also exert a permanent impact on commodity markets. For example, the shale technology shock in the natural gas and oil industries rendered the United States a net energy exporter in 2019, for the first time since 1952 (EIA, 2020). The biotechnology shock of the 1990s increased crop productivity by more than 20 percent (Klümper and Qaim, 2014). Policy shocks can also have long-lasting impacts on commodity prices. Examples include government efforts to encourage biofuel production, which caused a 4 percent shift of global land from food to biofuel production (Rulli *et al*., 2016); interventions in agricultural markets by most Organization for Economic Co-operation and Development (OECD) countries, which have been shown to have long-term downward pressures on food prices (Aksoy and Beghin, 2005); and the Organization of the Petroleum Exporting Countries' (OPEC's) decisions to reduce oil supplies (Kaufmann *et al*., 2004).

Shocks, especially those related to energy markets, often propagate succeeding shocks. For example, the COVID-19 oil demand shock, which caused an estimated 10 percent decline in oil consumption during 2020, triggered a policy-driven supply shock of similar magnitude by the OPEC-plus group of a 9.7 mb/d oil production cut in April 2020.[2] The oil price increases of the mid-2000s (driven by EMDE demand, OPEC supply cuts, and geopolitical concerns) rendered shale technology profitable, pushed up the costs of food production, and triggered biofuel policies. Following the oil price collapse of 2014, food production costs declined, but production of shale (through innovation and cost reduction) and biofuels (diverted from food commodities) appear to have a permanent character.

Earlier literature on commodity price movements reached two broad conclusions: prices respond to shocks differently (Cuddington, 1992; Snider, 1924), and price movements are dominated by volatility rather than long-term trends (Cashin and McDermott, 2002; Deaton, 1999). More recent research, however, finds that commodity prices are subject to long-term cyclical patterns, the so-called super cycles (Cuddington and Jerrett, 2008).

This article examines how transitory and permanent shocks impact commodity price movements. Whereas the existing literature analyzes price movements in the context of either super cycles or cyclical versus trend behavior, this analysis allows for business- and medium-term cycles in line with the macroeconomic literature. Specifically, this paper addresses the following questions.

1) How much do transitory and permanent shocks contribute to commodity price variability?
2) How have transitory and permanent shocks compared across commodities?

How Much Do Transitory and Permanent Shocks Contribute to Commodity Price Variability?

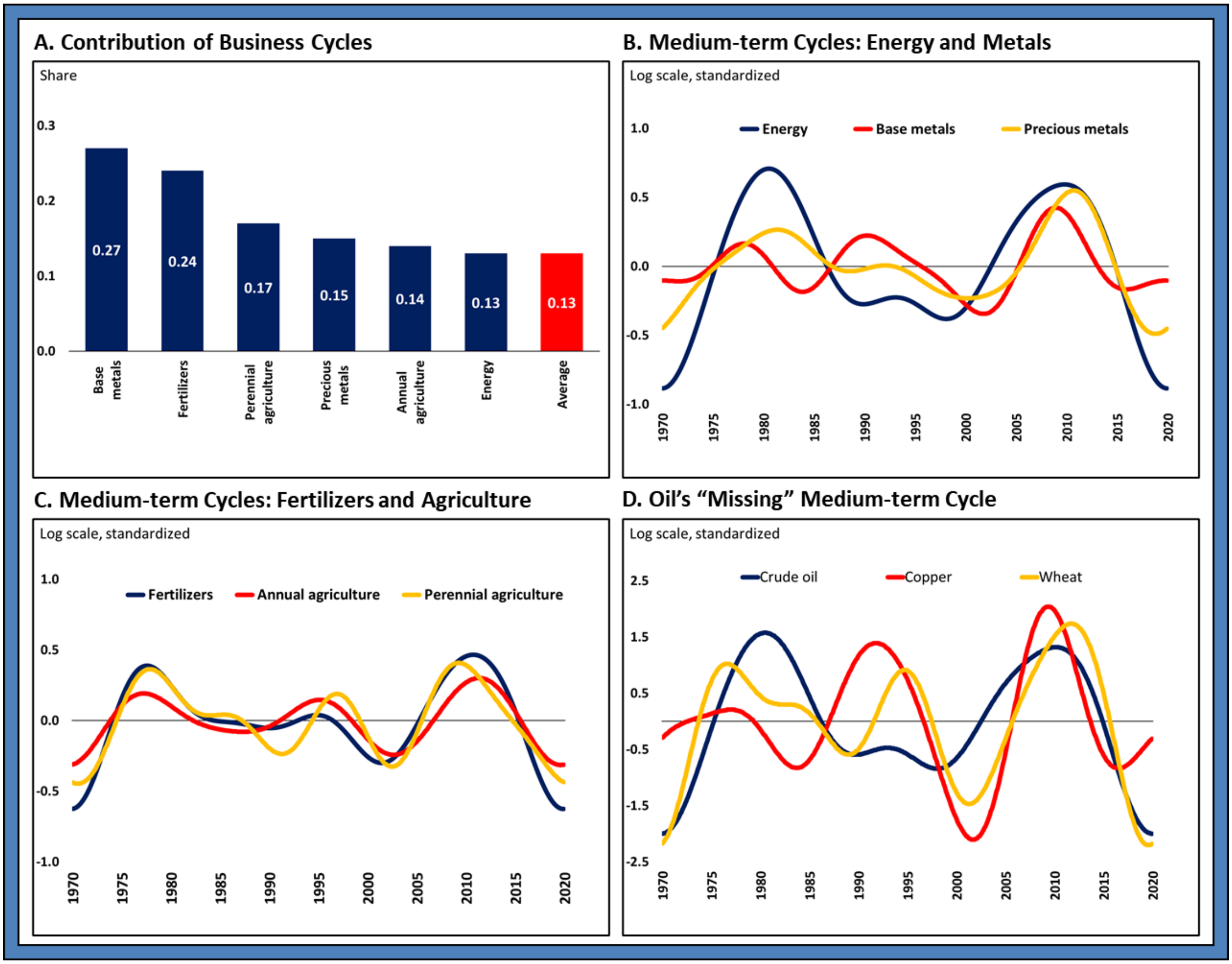
Methodology. To decompose commodity price movements into transitory and permanent components, a novel frequency domain approach is used that has thus far mostly been applied to economic business cycles (Corbae *et al*., 2002; Corbae and Ouliaris, 2006). The analysis rests on monthly data for 27 commodity price series over the period 1970-2019. It includes 3 energy prices, 5 base- and 3 precious-metals prices, 11 agricultural commodity prices (separated into annual and perennial crops) and 4 fertilizer prices.[3] The transitory shocks consist of three components—short-term fluctuations (that unwind in less than 2 years); traditional business cycles with frequency of 2-8 years, as are typically associated with economic activity (Burns and Mitchell, 1946); and medium-term cycles with periodicity of 8-20 years, which are often associated with investment activity (Slade, 1982). The permanent shock component captures movements with periodicity of more than 20 years—consistent with super cycles.

Permanent and transitory shocks account for roughly equal shares. On average across commodities, permanent shocks accounted for 47 percent of price variability. Of the remainder (i.e., transitory shocks), medium-term cycles accounted for 32 percent of price variability and business cycles for 17 percent. Only a small portion (4 percent) of price variability is due to shocks that are unwound in less than two years. The large role of the permanent component is in line with the findings of research into commodity price super cycles (Erten and Ocampo, 2013; Fernández *et al*., 2020). Furthermore, the predominance of the medium-term cycle in the transitory component is in line with recent research that finds a greater role of medium-term cycles than shorter business cycles in output fluctuations or domestic financial cycles (Aldasoro *et al*., 2020; Cao and L'Huillier, 2018).

The composition of transitory shocks differs across commodities. Shocks at medium-term frequency accounted for 55 and 27 percent of price variability in energy and metals, respectively, and only 14 percent for agriculture. In contrast, business cycles accounted for 24 percent of price variability for metals (Figure 2). This greater contribution of business cycle shocks to metal commodity price fluctuations is in line with the strong response of metal consumption to industrial activity.[4] Some of the commodities that exhibited the highest contribution of transitory shocks to price variability are used mainly within the transportation sector. For example, nearly two-thirds of crude oil is used for transportation, three-quarters of natural rubber goes to tire manufacturing, and half of platinum is used in the production of catalytic converters (World Bank, 2020b).

These averages mask heterogeneity across commodities. Transitory shocks were more relevant to the price variation of industrial commodities, while permanent shocks mattered most in agricultural commodity price movements (Figure 3). For agricultural commodities, permanent shocks accounted for two-thirds of price variability, for metals (including base and precious) they accounted for about 45 percent while for energy they accounted for less than 30 percent. Precious metals exhibited the largest heterogeneity as a group, with gold prices driven mostly by permanent shocks, silver driven equally by permanent and transitory shocks, and platinum exhibiting one of the highest shares of medium-term cyclicality.

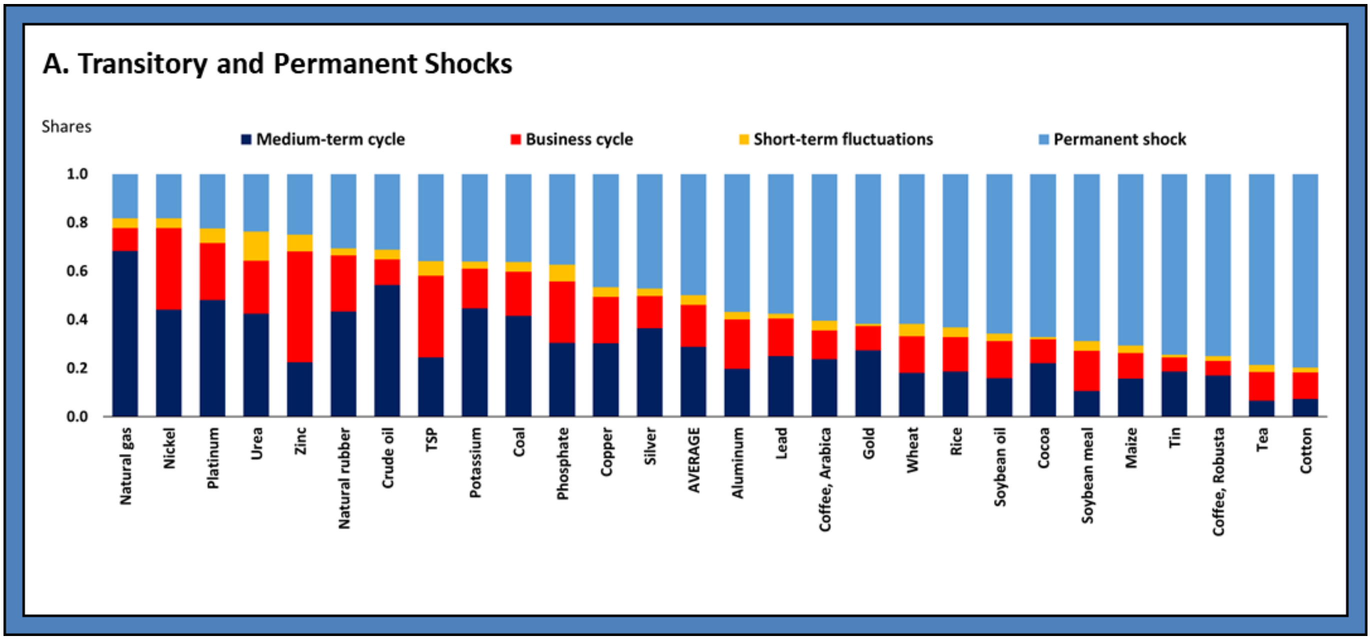
Figure 2
Transitory shocks
The business cycle component of transitory shocks is highest in the metals, consistent with the response of metals demand to industrial activity. There have been three medium-term cycles, peaking in 1978, 1994, and 2020. However, oil was subjected to only two medium-term cycles.



Source: World Bank.

A.-D. Authors' calculations.

Figure 3
Price Variation According to Type of Shock
Transitory and permanent shocks contribute almost equally, on average, to commodity price variation. However, these shares mask large heterogeneity across commodities. Transitory shocks account for most of industrial commodity price variability, while permanent shocks dominate agricultural commodity price movements.



Source: World Bank.

How Have Transitory and Permanent Shocks Evolved?

<u>Transitory Shocks</u>

Almost all commodities have undergone three medium-term cycles since 1970. The first medium-term cycle, which involved all commodities, began in the early 1970s, peaked in 1978, and lasted until the mid-1980s. The second, which peaked in 1994, was most pronounced in base metals and agriculture (with similar duration and amplitude to the first cycle) but did not include energy commodities. The third cycle, which again involved all commodities, began in the early 2000s, peaked in 2010, and for some commodities is still underway as of October 2020.

Crude oil's "missing cycle" reflected offsetting oil-specific shocks. Of the 27 commodities, crude oil and natural gas (whose price is highly correlated with oil) are the only commodities that exhibited two, instead of three, medium-term cycles. During the period spanning the second medium-term cycle, the oil market was subjected to three shocks.

- ***Unconventional and offshore oil.*** New production from unconventional sources of oil came into the market (North Sea, Gulf of Mexico, and Alaska). This was a result of innovation and investment in response to the high prices during the 1970s and early 1980s, partly caused by OPEC supply restrictions (World Bank, 2020b).[5]

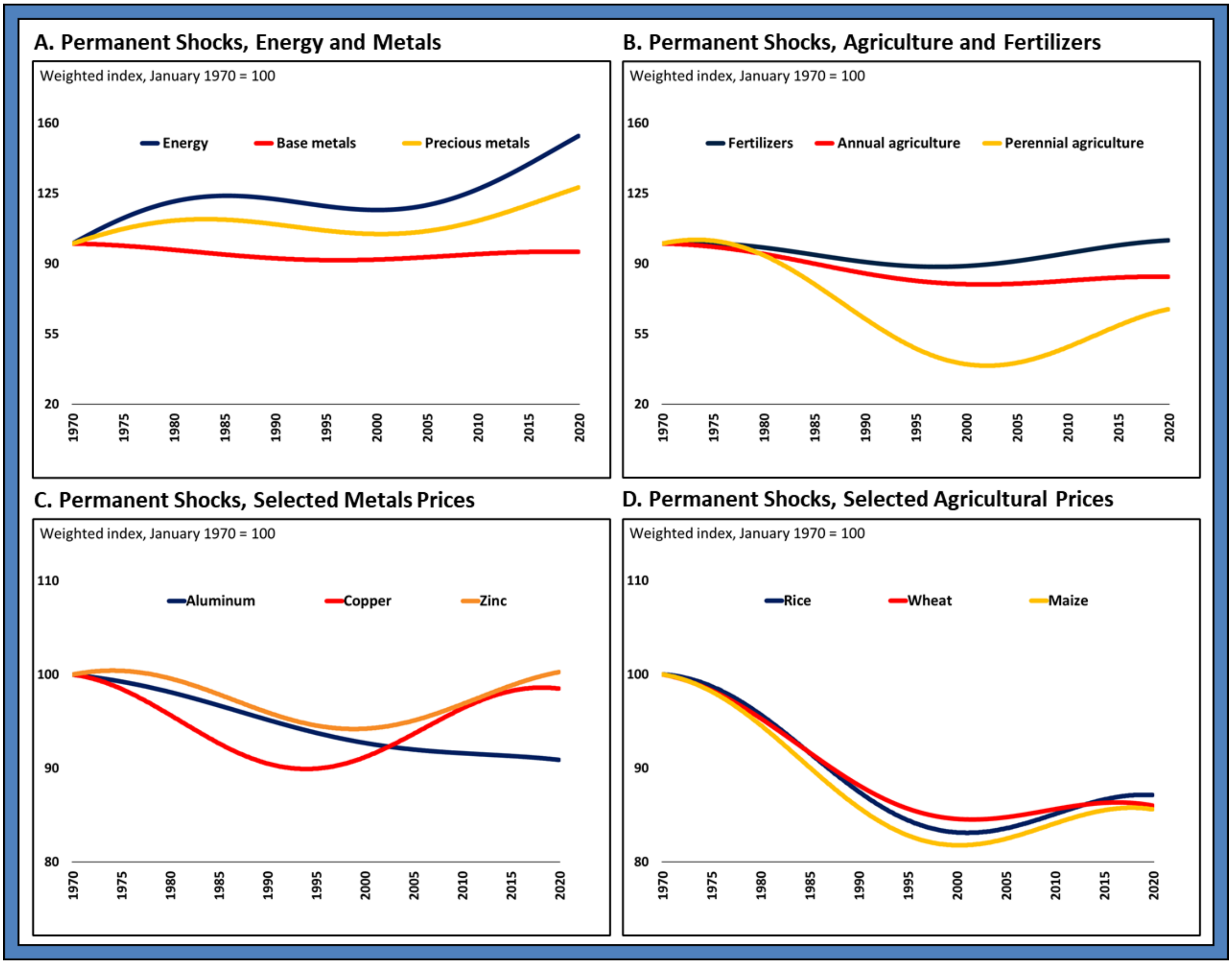
- ***New spare capacity from the former Soviet Union.*** Considerable spare capacity became available in the global oil market following the collapse of the Soviet Union. Prior to its collapse, the Soviet economy featured both inefficient production and energy-intensive consumption (World Bank, 2009).[6]

- ***Substitution and demand contraction.*** High oil prices during the late 1970s and early 1980s led to substitution of oil by other energy sources (especially coal and nuclear energy) in electricity generation. Policy-mandated efficiency standards in many OECD countries lowered global demand for energy (Baffes *et al*., 2020).

Permanent Shocks

The evolution of permanent shocks differed markedly across commodity groups. For energy commodities, the permanent shock component of prices has trended upward, for agricultural and fertilizer prices downward, and for most base metals they have been largely trendless (Figure 4). The upward trend in energy prices may reflect resource depletion and the largely trendless nature of long-term metals price movements may reflect the opposing forces of technological innovation and resource depletion (see discussions in Hamilton (2009) and Marañon and Kumral (2019) on oil and metals, respectively). The downward trend in permanent shocks to agricultural prices is consistent with low-income elasticities of food commodities (Baffes and Etienne, 2016). Commodities with a history of widespread policy interventions (cotton) or subjected to international commodity agreements (cocoa, coffee, crude oil, cotton, natural rubber, and tin) followed a highly non-linear path (see Table 1).[7]

Figure 4
Permanent Shocks
The permanent shock component trends upward for energy and precious metals, is nearly trendless for precious metals and fertilizers, and trends downward for agriculture. These trends are homogenous for agriculture but heterogenous for other groups.



Source: World Bank.

A.-D. Authors' calculations.

- **Annual agricultural price trends are highly synchronized and differ from those of other commodity groups.** The contribution of permanent shocks to annual agricultural price variability (68 percent) is the highest among all six commodity groups, and these permanent shocks have evolved in a similar manner across annual agricultural prices (Figure 4).[8] This similarity reflects a diffusion of shocks across commodities due to input substitutability, consumption substitutability, and agricultural policies, which are similar across most crops.

- ***Input substitution.*** Annual agricultural commodities tend to be farmed using the same land, labor, machinery, and other inputs. As a result, reallocation between different annual crops from one year to another prevents large price fluctuations in individual crops. The impact of the restrictions in soybean imports by China from the United States in 2008 was short-lived due to land reallocation and trade diversion. Separately, despite a policy-induced increase in demand for maize, sugarcane, and edible oils over the past two decades, price increases in these three crops were in line with those of other annual crops (e.g., rice and wheat) as land was reallocated (World Bank, 2019).[9]

- ***Consumption substitution.*** Since annual crops have overlapping uses, substitution in consumption can dampen price fluctuations in any one of them. In the example of import restrictions on soybeans discussed earlier, soybean meal was substituted by maize for animal use in China while soybean oil was substituted by palm oil for human consumption (World Bank, 2019).[10]

- ***Policy synchronization.*** Policy interventions for agricultural markets tend to apply to the entire sector and stay in place for several years, even decades, with few or no changes. For example, agricultural policies in the United States and the European Union (EU), the world's largest producers in several agricultural commodity markets, are renewed every few years and apply to the same crops. Indeed, the 1985 Farm Bill reform in the U.S. and the 1992 Common Agricultural Policy reform in the EU applied to all commodities of the respective programs (Baffes and De Gorter, 2005).

Conclusion

This paper finds that commodities are subject to a multitude of different shocks. Permanent shocks account for two-thirds of agricultural price variability but less than half of industrial commodity price variability over the past fifty years. Meanwhile, business cycle shocks play the largest role for base metals, reflecting their heavy use in highly cyclical industries. The COVID-19 pandemic appears to have caused a series of largely temporary shocks for oil prices. Permanent shocks have trended upward for energy and precious metals prices but downward for agricultural prices and have been largely trendless for base metals prices. Annual agricultural commodities were the commodity group with the most homogeneous price trends, reflecting high substitutability in inputs and uses, and similar policies.

The heterogenous behavior of shocks suggests a need for policy flexibility, especially in commodity-exporting countries. Countercyclical macroeconomic policies can help buffer the impact of transitory shocks. Countries that depend on exports of highly "cyclical" commodities that are buffeted by frequent transitory shocks may want to build fiscal buffers during the boom phase and use them during the bust period in order to support economic activity. In contrast, in countries that rely heavily on commodities that are subject to permanent shocks, structural policies may be needed to facilitate adjustments to new economic environments.

Appendix
Model and Data Description
Decomposing Commodity Prices into Cycles and Long-Term Trends

The real price of the commodity, p_t, is expressed as the following sum:

$$p_t \equiv PC_t + TC_t^{[8,20]} + TC_t^{[2,8]} + S_t.$$

PT_t, which represents the permanent component, can be a linear trend, perhaps subjected to structural breaks. $TC_t^{[8,20]}$ denotes the medium-term cycle with a periodicity of 8-20 years as proposed by Blanchard (1997) and popularized by Comin and Gertler (2006). $TC_t^{[2,8]}$ represents the business cycle with a periodicity of 2-8 years, following NBER's traditional definition (Burns and Mitchell, 1946). Lastly, S_t captures fluctuations with periodicity of less than 2 years, which may reflect short-term movements in economic activity or other macroeconomic variables (such as exchange rates and interest rates), seasonality or weather patterns (in the case of agriculture), and *ad hoc* policy shocks. These fluctuations are typically studied within the context of Vector Autoregressive (VAR) models (Baumeister and Hamilton, 2019; Kilian and Murphy, 2014) and Generalized Autoregressive Heteroskedastic (GARCH) models by utilizing high-frequency data, focusing mostly on volatility (Engle 1982). The decomposition is based on the frequency domain methodology developed by Corbae *et al.* (2002) and Corbae and Ouliaris (2006).

The price data were taken from the World Bank's world commodity price data system. The sample covers 50 years: January 1970 through December 2019 (600 observations). The prices, which are reported in nominal U.S. dollar terms, were deflated with the U.S. Consumer Price Index (CPI) (taken from the St. Louis Federal Reserve Bank). Although the World Bank covers more than 70 commodity price series, this paper uses only 27 series. The selection was based on the following criteria:

- **Substitutability**. If commodities are close substitutes, only one was included. For example, because the edible oils are close substitutes, only soybean oil is used in the analysis.

- **Importance**. Commodities whose share in consumption diminished throughout the sample (either because of changes in preferences or substitution to synthetic products) were not included in the sample. Notable exclusions include wool, hides and skins, sisal, and tobacco.

- **Price determination process**. Commodities whose prices are not determined by market-based mechanisms (e.g., commodity exchanges or auctions) are excluded. Notable exclusions are iron ore (its price used to be the outcome of a negotiation process among key players of the steel industry until 2005), bananas (its price reflects quotations from a few large trading companies), sugar (policy interventions reduce the significance of the world price indicator), groundnuts (thinly traded commodity), and timber products (not traded on commodity exchanges).

Following the decomposition analysis, prices were grouped into six broad categories, each of which contained at least three series:

- **Energy**: Coal, crude oil, and natural gas
- **Base metals**: Aluminum, copper, lead, nickel, tin, and zinc
- **Precious metals**: Gold, platinum, and silver
- **Fertilizers**: Phosphate rock, potassium chlorate, TSP, and urea
- **Annual agriculture**: Cotton, maize, rice, soybean meal, soybean oil, and wheat
- **Perennial agriculture**: Cocoa, coffee Arabica, coffee Robusta, natural rubber, and tea

Decomposition results are reported in Table 1. The numbers in the square brackets of the first column represent weights and add to 100 for each commodity group, subject to rounding. The shares of each component add to 100, subject to rounding. For example, coal's shares are: 0.36 + 0.42 + 0.18 + 0.04 = 1. The penultimate column reports the parameter estimate from the regression of T_t on a time trend while the last column reports the Root Mean Square Error (RMSE) – a proxy for nonlinearity.

Table 1
Real Commodity Price Decomposition

	Share of variance explained by				Number of cycles		Trend	
	T_t	$C_t^{[8-20]}$	$C_t^{[2-8]}$	S_t	$C_t^{[8-20]}$	$C_t^{[2-8]}$	β	$RMSE$
ENERGY								
Coal [**4.6**]	0.36	0.42	0.18	0.04	3	11	0.43	5.31
Crude oil [**84.6**]	0.31	0.54	0.11	0.04	2	12	1.02	7.65
Natural gas [**10.8**]	0.19	0.68	0.10	0.03	2	11	0.57	2.50
AVERAGE	**0.29**	**0.55**	**0.13**	**0.04**	**2**	**11**	**0.95**	**6.99**
BASE METALS								
Aluminum [**32.9**]	0.57	0.20	0.20	0.03	4	10	-0.14	0.64
Copper [**47.4**]	0.47	0.30	0.19	0.04	3	9	-0.80	3.31
Lead [**2.2**]	0.57	0.25	0.16	0.02	3	8	-0.54	4.75
Nickel [**9.9**]	0.18	0.44	0.34	0.04	3	11	-0.78	1.63
Tin [**2.6**]	0.74	0.19	0.06	0.01	3	12	0.05	4.38
Zinc [**5.0**]	0.25	0.22	0.46	0.07	3	8	-0.09	2.08
AVERAGE	**0.46**	**0.27**	**0.24**	**0.04**	**3**	**10**	**-0.52**	**2.46**
PRECIOUS METALS								
Gold [**77.8**]	0.62	0.27	0.10	0.01	3	8	1.28	5.38
Platinum [**18.9**]	0.22	0.48	0.23	0.06	3	11	-0.22	1.85
Silver [**3.3**]	0.47	0.36	0.13	0.03	3	11	0.27	13.47
AVERAGE	**0.44**	**0.37**	**0.15**	**0.03**	**3**	**10**	**0.96**	**4.98**
FERTILIZERS								
Phosphate [**16.9**]	0.37	0.30	0.25	0.07	3	9	-0.40	6.48
Potassium [**20.1**]	0.36	0.45	0.16	0.03	3	10	-0.46	3.43
TSP [**21.7**]	0.36	0.24	0.34	0.06	4	9	-0.52	3.91
Urea [**41.3**]	0.24	0.42	0.22	0.12	3	12	-0.02	4.44
AVERAGE	**0.33**	**0.35**	**0.24**	**0.07**	**3**	**10**	**-0.28**	**4.47**
ANNUAL AGRICULTURE								
Cotton [**8.5**]	0.80	0.07	0.11	0.02	3	13	-0.07	9.00
Maize [**20.5**]	0.70	0.16	0.11	0.03	3	10	-0.50	3.55
Rice [**15.2**]	0.63	0.19	0.14	0.04	3	9	-0.43	3.29
Soybean meal [**29.0**]	0.69	0.10	0.17	0.04	3	10	-0.48	3.48
Soybean oil [**14.3**]	0.66	0.16	0.15	0.03	3	11	-0.72	3.15
Wheat [**12.5**]	0.62	0.18	0.15	0.05	3	9	-0.42	2.60
AVERAGE	**0.68**	**0.14**	**0.14**	**0.04**	**3**	**10**	**-0.47**	**3.78**
PERENNIAL AGRICULTURE								
Cocoa [**25.6**]	0.67	0.22	0.10	0.01	3	11	0.03	15.41
Coffee Arabica [**15.7**]	0.61	0.24	0.12	0.04	3	14	0.22	10.38
Coffee Robusta [**15.7**]	0.75	0.17	0.06	0.02	3	13	0.42	15.86
Natural Rubber [**30.6**]	0.31	0.43	0.23	0.03	3	10	-0.36	17.39
Tea [**12.4**]	0.78	0.07	0.12	0.03	3	13	-0.17	9.47
AVERAGE	**0.62**	**0.23**	**0.13**	**0.03**	***3***	***12***	**-0.03**	**14.56**
ALL AVERAGE	***0.47***	***0.32***	***0.17***	***0.04***	***3***	***11***	***0.10***	***6.21***

Notes: Description of terms appear in the text.

Endnotes

This paper is based on the October 2020 Special Focus article in the World Bank's *Commodity Market Outlook*.

Responsibility for the content remains solely with the authors and should not be attributed to the World Bank.

1 According to BP (2020), 2019 may have been the year during which global oil consumption peaked, marking a considerable revision to earlier projections which placed the "peak demand" year in the early 2030s. For example, IEA (2019) projected that global oil consumption would plateau around 2030. Peak demand discussions, which emerged after the 2014 price collapse (Dale and Fattouh, 2018), replaced the "peak oil supply" debate of the early 2010s (Helbling *et al*., 2011; Kumhof and Muir, 2014).

2 The demand plunge and production cuts following COVID-19 were the largest in history.

3 The selection of commodity prices analyzed in this paper was based on unique selection criteria by excluding commodities (a) that are close substitutes (e.g., selecting only one edible oil), (b) that are no longer economically important (e.g., hides and skins), or (c) whose prices are not determined at an exchange (e.g., bananas). Following the decomposition, the individual commodities were combined into six groupings, based on the uses and production characteristics of commodities (see Appendix). A few studies that have used both individual commodity price series and indexes (e.g., Erten and Ocampo, 2013; Jacks, 2019; Ojeda-Joya *et al*., 2019) used data obtained directly from the International Monetary Fund or World Bank commodity price databases without applying selection criteria.

4 The relationship between metals prices and economic activity has been well-established by numerous authors. See, for example, Baffes *et al*. (2020), Davutyan and Roberts (1994), Labys *et al*. (1999), Labys *et al*., (1998), Marañon and Kumral (2019), Roberts (2009), Stuermer (2017), and Tilton (1990).

5 The three unconventional sources of oil – U.S. shale oil, Canadian oil sands, and biofuels – are also associated with the third medium-term cycle (Baffes *et al*., 2015). In the first and third medium-term cycles, these unconventional sources of oil account for about 10 percent of global oil supplies (measured at the end of the cycle).

6 The collapse of the Soviet Union played a similar role in metals and grain commodities. However, the increase in supplies of those commodities was much smaller and gradual.

7 Cotton has been subjected to a high degree of government intervention by most major producers, including subsidies by the United States and the EU, taxation of Sub-Saharan cotton producers, and various types of policy interventions by Central Asian producers. Throughout the 1960s and 1970s the cotton market was also subjected to policy distortions by the Soviet Union (Baffes, 2011).

8 Permanent shocks to agriculture have lasting effects on economic activity in low-income countries through their impact on labor productivity (Dieppe *et al*., 2020).

9 Global demand for maize, a key feedstock for ethanol production in the United States, doubled over the past two decades. This compares with 26-28 percent increases in global demand for rice and wheat, broadly in line with the 27 percent global population growth over this period.

10 The imposition of tariffs by China on U.S. soybean imports resulted in trade diversion. As China's soybean imports from the U.S. declined and increased from Brazil, the EU began importing more from the U.S. and less from Brazil.

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Author Biographies

JOHN BAFFES, Ph.D.
Senior Agriculture Economist, Prospects Group, World Bank

Dr. John Baffes, currently a member of the World Bank's Prospects Group, heads the Commodities Unit and is in charge of the *Commodity Markets Outlook*, a World Bank publication focusing on commodity market analysis and price forecasts. Dr. Baffes' experience spans several regions and units, including Latin America, South Asia, East Africa, Evaluation, and Research. He specializes in commodity markets analysis and resource economics.

Dr. Baffes, whose work appears in media outlets and academic journals, also teaches an executive M.B.A. course on Applied Econometrics for Commodity Markets. Prior to entering graduate school, Dr. Baffes managed a commodity trading company. He holds degrees in Economics from the University of Athens, Greece (B.S.), University of Georgia, U.S. (M.S.), and University of Maryland, U.S. (Ph.D.).

Dr. Baffes had last contributed an article to the *GCARD* on "Commodity Markets in a Post COVID-19 World."

ALAIN KABUNDI, Ph.D.
Senior Economist, Prospects Group, World Bank

Dr. Alain Kabundi is a Senior Economist in the World Bank's Prospects Group. Prior to joining the World Bank in 2018, Dr. Kabundi worked in the Research Department of the South African Reserve Bank where he focused on monetary policy, international macroeconomics, financial economics, and forecasting. He was previously Professor of Economics at the University of Johannesburg in South Africa. Dr. Kabundi has published on a wide variety of topics, including on the synchronization of business cycles, monetary policy credibility, and global spillover of shocks. He holds a Ph.D. in Economics from the University of Johannesburg.