How to Measure Global Real Economic Activity when Modeling Commodity Prices

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Professor Lutz Kilian, Ph.D., University of Michigan, Ann Arbor, and member of the J.P. Morgan Center for Commodities' (JPMCC's) Research Council, presenting at the JPMCC's 2nd International Commodities Symposium, which was held at the University of Colorado Denver Business School in August 2018. From left-to-right are Dr. Kilian's fellow presenters at the JPMCC's Economics of Energy Markets panel: Dr. Reinhard Ellwanger, Ph.D., of the Bank of Canada and Dr. Hinnerk Gnutzmann, Ph.D., of Leibniz Universität Hannover (Germany). Dr. Ellwanger, in turn, also contributed an article to this issue of the *GCARD* on his JPMCC presentation.

Introduction

Indicators of global real economic activity are of central importance in modeling real commodity prices. They also play an important role in forecasting commodity prices, in studying the effects of commodity

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price shocks on commodity importers and exporters, in assessing the role of speculation and financial market integration, and in identifying short-run price elasticities in commodity markets.

Since Barsky and Kilian (2002), it has been widely understood that shifts in the consumption demand (also known as flow demand) for commodities are an important determinant of both real commodity prices and global real economic activity. What is not always appreciated by practitioners and economists is that global real activity is not a proxy for the global flow demand for commodities. An increase in global real activity, for example, may result from a positive oil supply shock or a positive shock to the flow demand for oil and other commodities. Thus, not every increase in global real activity reflects higher flow demand. Moreover, there is more than one demand shock in commodity markets. Other examples include shocks to the demand for storage driven by price expectations and preference shocks for particular commodities. Each of these shocks has different implications for global real activity that need to be taken into account.

Uncovering latent shifts in the flow demand for commodities thus involves disentangling all demand and supply shocks that jointly drive real commodity prices and global real activity. This requires estimating a structural model of the commodity market based on an appropriate measure of global real activity. Thus, the question of how to measure global real activity is crucial when modeling commodity prices.

What Makes a Good Indicator of Global Real Economic Activity?

Many macroeconomists still believe that conventional measures of global real Gross Domestic Product (GDP) or global industrial production already used in macroeconomic models of the global economy are also well suited for modeling and understanding real commodity prices. This is not the case. A recent study by Kilian and Zhou (2018) explains what properties an index of global real activity must satisfy to be useful for modeling industrial commodity prices:

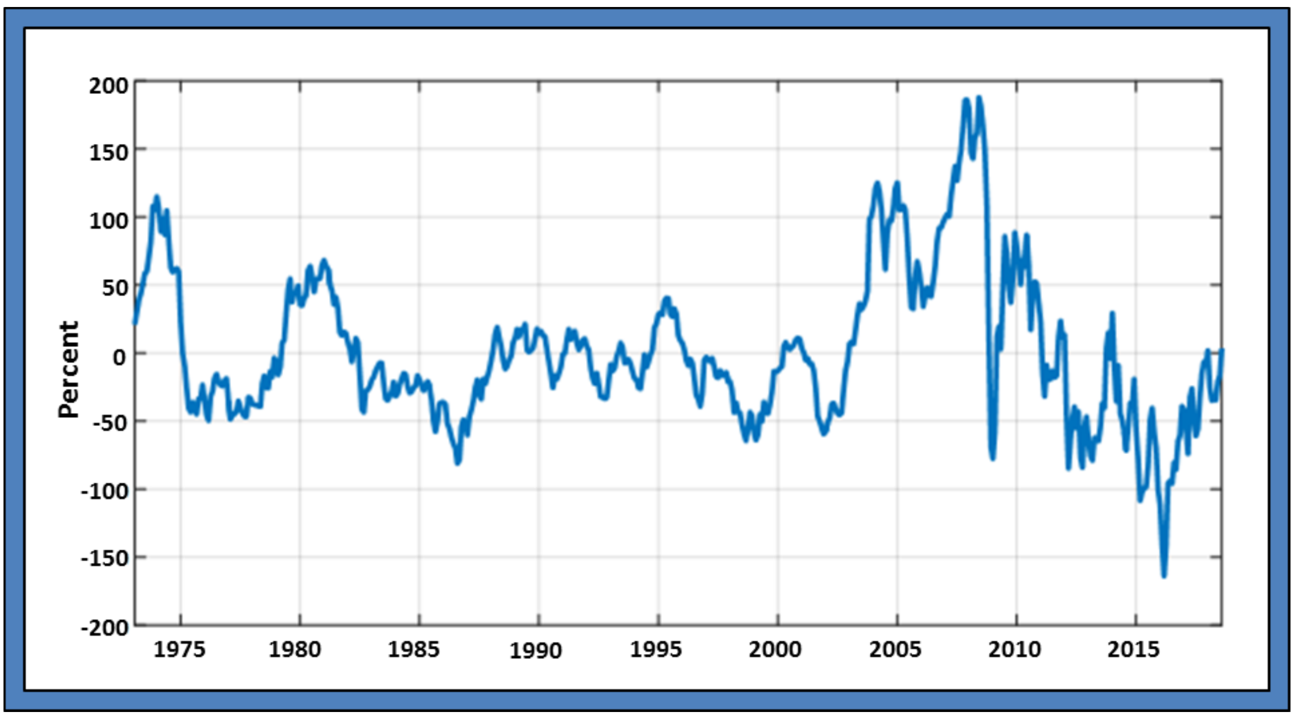
- The coverage of the index must be global.
- The index must span a long enough time period to facilitate the estimation of structural models of commodity markets.
- Monthly indices are preferred because the use of monthly data facilitates the imposition of identifying assumptions in structural models of commodity markets.
- The index must account for the fact that over time, the share of the industrial sector in output has declined while that of the services sector has increased.
- The index must be a leading indicator for industrial production. This requirement follows from the fact that inputs must be ordered and shipped before starting the production process. Because shipping takes time, the index must be a leading indicator for global industrial production. An immediate implication is that the amplitude of fluctuations in this leading indicator reflects firms' expectations of future production, so both the timing and magnitude of the index may differ from conventional real output proxies.

- Finally, if the index is to be used for out-of-sample forecasting, it must also be available in real time.

How Do Existing Proposals for Measuring Global Real Activity Stack up by These Criteria?

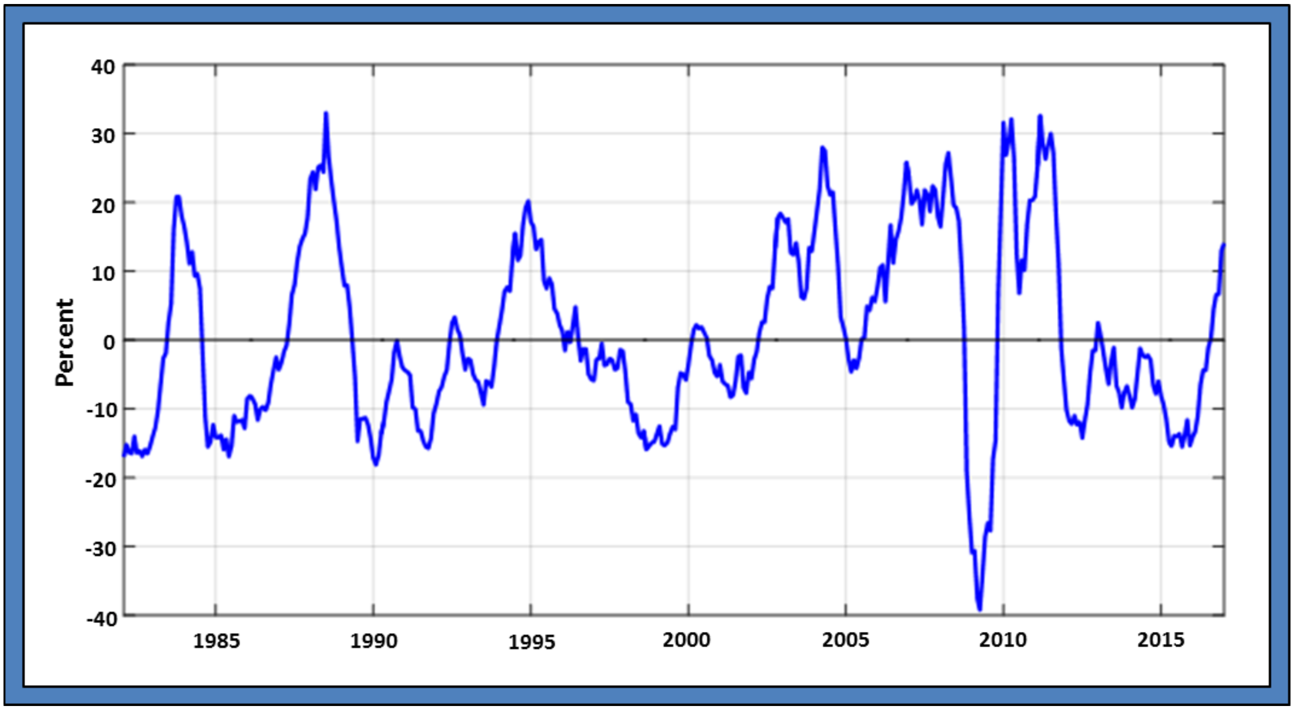
There have been many proposals for measuring global real activity including global real GDP, global industrial production, world steel production, measures of fluctuations in the volume of ocean freight shipping, and common factors in real commodity prices. Only two of these proposals, however, satisfy all six of the criteria laid out above. One is the index of global real economic activity proposed by Kilian (2009), which is designed to measure cyclical variation in the volume of the shipping of bulk dry cargoes such as iron ore, coal, fertilizer and scrap metal (see Figure 1 below). The other is indices based on the common factor in the real prices of commodities that are traded globally, as proposed by Alquist and Coibion (2014) and Delle Chiae *et al*. (2016) (see Figure 2 on the next page).

Figure 1
Updated Kilian (2009) Index of Global Real Economic Activity, 1973.1-2018.7



In contrast, quarterly global real GDP is a poor measure in this context because of the increasing importance of the service sector in the global economy and because a monthly index is preferred over a quarterly index. While global monthly industrial production does not suffer from these two limitations, proxies for global industrial production are not leading indicators for global real output, making global industrial production poorly suited for modeling commodity markets. Likewise, world steel production cannot be recommended because changing the global coverage of this index results in jumps in the index, and because it is another coincident indicator rather than a leading indicator.

Figure 2
Global Real Commodity Price Index of Delle Chiae *et al*. (2016) in Year-on-Year Growth Rates



What Are the Drawbacks of the Kilian Index of Global Real Activity?

As the popularity of the Kilian index of global real activity has grown, a number of objections to this index have been raised. One claim has been that this index should not be used because exogenous increases in the real price of oil raise the cost of the bunker fuel used to run bulk dry cargo vessels and hence raise the bulk dry cargo shipping rates from which the Kilian index is constructed, making it impossible to identify shifts in the volume of bulk dry cargo shipping.

It can be shown that this claim is invalid. Not only is the link from oil prices to bunker fuel rates much weaker than sometimes thought, but time charter shipping rates, as captured by the Baltic Dry Index (BDI) used in the construction of the Kilian index since 1985, do not respond to changes in bunker fuel. The reason is simple. Time charter rates refer to the rate charged by the owner for leasing a vessel for, say, one year. Since the lessee is responsible for the fuel charges incurred when running this vessel, increases in bunker fuel prices do not affect the rate charged by the owner of the vessel.

A similar conclusion is reached, if we are relying on single voyage rates, as the Kilian index did prior to 1985. Single-voyage rates refer to the rate charged for moving a vessel from one port to another port (say, an iron ore freighter from Brazil to China). In that case, we know from industry sources that the owner sets the shipping rate based on the fuel costs in the preceding quarter, making the single-voyage rate predetermined with respect to the changes in the price of oil. Thus, feedback may occur only with considerable delay.

Moreover, since the Kilian index looks much the same whether it is constructed from time-charter or single-voyage rates, the claim of reverse causality from oil prices to the index can be easily rejected. This means that the well-documented positive co-movement between the real price of oil and the Kilian index simply results from flow demand shocks simultaneously raising global real activity and the real price of oil.

Another claim has been that the Kilian index is distorted by changes in the stock of bulk dry cargo vessels. This claim as well can be refuted. First, changes in the bulk dry cargo fleet are too smooth to explain the variability of the Kilian index. Second, it can be shown that the changes in real shipping rate match quite closely annual data on changes in the tonnage of bulk dry cargo, when such data are available, suggesting that the index is a good measure of changes in the volume of seaborne bulk dry cargo trade. Third, the cyclical decline in the Kilian index since 2011, which originally prompted the concern about changes in the fleet size, is corroborated by a wide range of alternative proxies for global real activity that do not depend on data from shipping markets.

A third claim has been that the Kilian index has been excessively volatile, especially in early 2016, when the index shows a negative spike for two months (see Figure 1). This concern is driven by the common misperception that the evolution of the Kilian index should somehow match that of measures of global real output. As noted earlier, this is not the case because the Kilian index may respond to fluctuations in expected real output that never materialize in actual real output. Thus, there is no reason to expect the Kilian index to mirror subsequent fluctuations in real output, although often it does. Nor is there a mystery as to the origin of the negative spike in early 2016, which can be traced to a temporary drop in the demand for iron ore and coal from China that is not reflected in subsequent drops in steel production or industrial production and hence appears based on expectations that did not materialize.

Finally, it should be noted that the Kilian index, as shown in Figure 1, is consistent with what we know from extraneous sources about the global business cycle in commodity markets since the 1970s. It is also consistent with information from recent survey data about the global economy and highly correlated with survey data for export orders. Recently, it has been suggested that one could have expressed real bulk dry cargo freight rates in 24-month cumulative growth rates rather than removing a linear time trend, as proposed by Kilian (2009). The resulting time series, however, makes no economic sense as a measure of the global business cycle. It implies a recession in 2005, when the global economy was booming and a protracted recession after 2009, when real commodity prices and the global economy recovered sharply.

What Are the Drawbacks of Real Commodity Price Indices?

Likewise, common factors extracted from real commodity prices, as shown in Figure 2, are not without limitations. First, not all important commodities are freely traded. For example, before 2009 iron ore was not freely traded. Second, there is no consensus yet on how to select the real commodity prices from which the common factor is extracted and how to extract that factor. Which way this is done also affects for how long real commodity price indices may be constructed. Finally, constructing these indices may require additional smoothing. Researchers have made different choices in that regard.

Did Global Real Activity Slow Down after 2011?

One of the implications of the Kilian index in Figure 1 as well as the real commodity price index in Figure 2 is that there was a sustained slowdown in global real activity starting in about 2011. This pattern is consistent with the sustained decline in many real commodity prices (see Table 1). Such a broad-based decline is unlikely to be explained by favorable supply shocks in individual commodity markets. Even for crude oil, we know that supply shocks have been of limited importance in explaining the decline in the real oil price (see Kilian, 2017).

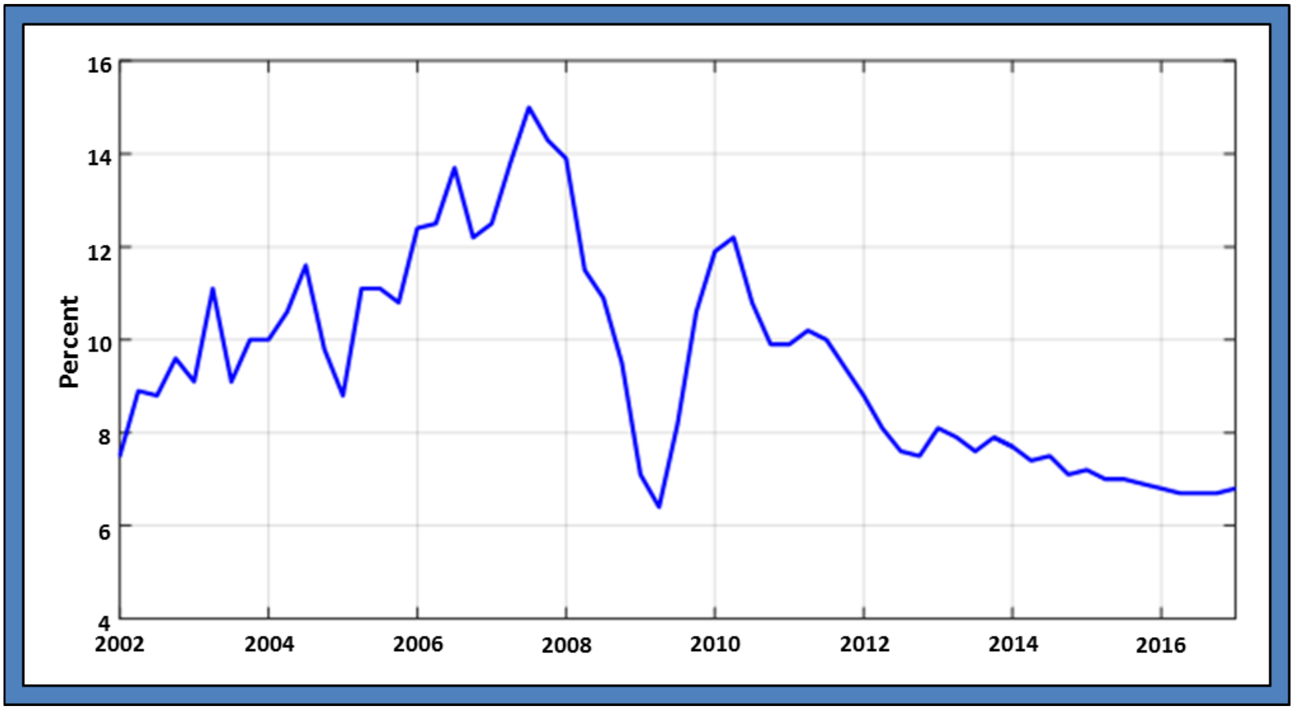
Table 1
Cumulative Changes in Real Commodity Prices, 2010.5-2015.12

Global Commodity Price Indices	Cumulative Change in Real Price (%)
Industrial Raw Materials Price Index	-40.93
Metals Price Index	-51.46
Copper Price	-38.12
Iron Ore Price	-76.87
Brent Price of Crude Oil	-54.32

Given that the surge in commodity prices in the 2000s was associated with an economic expansion in emerging Asia led by China, a natural conjecture is that this decline reflected a slowdown of China's economy. Figure 3 on the next page supports this conjecture. There is clear evidence of high year-on-year growth rates from 2002 to 2007, followed by a sharp decline during the global financial crisis, and a partial recovery in 2009. Since 2011, however, year-on-year growth has been sliding to levels last seen during the financial crisis or in 2002. Arguably, the official Chinese data understate the true extent of the decline after 2011, but the pattern is clear even in the official data. Similar patterns are also found in data on Chinese electricity production and industrial value added.

This evidence, in conjunction with survey data on the global economy as well as proxies for global real output, confirms that global real activity by 2016 was back to where it had been before the surge in global real activity that started in 2002. In other words, the boom in emerging Asia appears to have been largely transitory, in contrast to the perception of many observers in the 2000s who regarded the Asian boom as a permanent shift in the global economy.

Figure 3
Year-on-Year Growth in China's Real GDP



The slowdown in global real activity after 2011 may be related to a reduction in overall trade growth from 7.4% at annual rates during 1995-2007 to 3.1% during 2012-15. At the same time, the income elasticity of trade for emerging economies also fell from 1.5 to 0.8. The decline in the volume of bulk dry cargo shipping, in particular, may also be explained by the increased importance of the service sector, slowing growth in infrastructure, and the increased reliance of the Chinese economy on domestic consumption rather than exports.

This point has important implications for commodity exporters and for commodity price forecasting. Interestingly, the partial recovery in the Kilian index since mid-2016 back to the long-run average is not driven by China, but apparently reflects an economic expansion in the United States, Japan and Europe.

Concluding Remarks

Differences in how one measures the global business cycle can easily affect conclusions about the timing and magnitude of an economic slowdown or expansion, and using inappropriate proxies is likely to distort estimates of commodity market models and of price elasticities. Our analysis supports the use of indices of real activity derived from dry bulk cargo freight rates such as the BDI as well as the use of indices based on real commodity prices, but raises concerns about the use of measures of world real GDP and of global industrial production.

This does not mean that traditional measures of world real GDP or world industrial production should never be used in empirical work, but rather that the intended use of these time series matters. Data that are appropriate for modeling cyclical fluctuations in global real output in macroeconomic models, for example, may not be appropriate for identifying shifts in the demand for global commodities, and conversely many indicators of global real economic activity in the literature are poor measures of fluctuations in global income.

We explained why, in modeling industrial commodity markets, changes in the volume of shipping of industrial raw materials are a better proxy for global real activity than changes in the overall real output of the global economy because they more accurately capture the timing and magnitude of shifts in demand. In contrast, in modeling food commodities such as wheat, corn, or rice, the case can be made that demand depends on global real income, making world real GDP a potentially more suitable measure of global real economic activity.

Endnotes

The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Bank of Canada.

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