Output Value Risk for Commodity Producers: The Uncertain Benefits of Diversification

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Summary. — Commodity price volatility has long been recognized as a main risk for commodity producers' welfare and has led to diversification efforts. Less noticed has been the importance of commodity correlations, and their increase after 2006, in the risk faced by producers. To assess their impact, we perform an empirical analysis of the market value of commodity producers' output. In a sample of 56 countries producing 26 commodities we find that diversification and correlations strongly explain output value volatility. During 1987–2006, producers effectively specialized in a single commodity had an average output value volatility of 27.0% while producers of three or more commodities had a 12.7% volatility. In this period average correlation was 8% and diversification was very effective. In the 2007–12 period, correlations averaged 26% and output volatilities for specialized and diversified commodities were 30.4% and 19.5% respectively, thus reducing the benefit of diversification at a time of macroeconomic distress. In 2013–16, output volatilities reverted to levels close to those in 1987–2006 as commodities decorrelated again. Our findings should be relevant to policy makers embarking in diversification efforts and in the analysis of macroeconomic risk of commodity producers.
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Key words — natural resources, volatility, specialization, co-movement, diversification

1. INTRODUCTION

Commodity price volatility has long been recognized as a main risk for commodity producers' welfare. This has led, in turn, to deliberate diversification efforts in terms of enlarging the set of commodities produced locally or developing manufacturing and service sectors.[1,2,3] In addition, diversification occurs sometimes involuntarily through the discovery of a previously unknown natural resource such as the recent discovery of one of the largest shale oil and gas fields in Argentina.[4] However, little attention has been paid to the potential impact of commodity correlations, which measure the propensity of prices of commodities such as corn and copper to move in tandem, on the risk faced by commodity producers. This article explores the risk represented by the volatility of commodity output value for 56 commodity-producing countries during 1987–2016, taking into account the changing impact of commodity correlations. For these countries, commodity output value is a significant fraction of GDP and it is strongly correlated with exports. Hence, variability in commodity output value is economically significant. We are motivated by two observations. First, the recent decade has witnessed a large increase in commodity return correlations. Commodity price percentage changes (monthly returns), which exhibited pairwise correlations close to 8% on average during 1987–2006, became much more correlated in 2007–12, when pairwise correlations for returns in agricultural, mineral, energy, and soft commodities were on average close to 26%. The increase in co-movement during the 2007–12 period has been associated in the literature with growing world demand for commodities and global economic activity. This period also witnessed a strong increase in speculative activity although its impact on co-movement has found uneven support. In this article, rather than exploring the causes of higher correlations, we aim to quantify the consequences of such a stronger co-movement. Second, commodity producers differ strongly in their degree of diversification. For example, 90% of Russia's commodity output value during the 2007–16 period was due to oil. By contrast, commodity output value from Brazil was 38% from oil,

18% from iron ore, 14% from soybeans, and it also included significant components in corn, sugar, orange juice, and others. Motivated by these two observations we bring a portfolio perspective to the risk faced by commodity producers and perform an empirical exploration of the volatility of commodity output value for the cross section of commodity producers and across time. We ask the following questions. First, a portfolio perspective suggests that diversified commodity producers should have experienced lower volatility than specialized producers. How significant was this effect? Second, a portfolio perspective also suggests that the observed increase in commodity correlations during 2007–12 should have narrowed the difference in risk between diversified and specialized producers. What was the magnitude of this effect? Third, is there a simple relationship between the output volatility of a commodity producer, its degree of diversification, and overall commodity market conditions?

We explore these issues empirically on a sample of 56 countries for which the ratio of commodity output value to GDP exceeds 5%. Our sample includes mostly developing countries but also a few developed economies such as Australia, Canada, and Norway. For each country we construct measures of national diversification based on the relative contribution of 26 agricultural, mineral, soft, and energy commodities to the dollar value of national commodity output. We also compute, for each country, the historical time series of commodity output value using local physical output and contemporaneous global market prices, and the historical time series of commodity exports. We verify that, at 55% on average, national output value returns were strongly correlated with commodity export returns in our sample period. Then, we

proceed to explore the interplay between commodity market dynamics, diversification, and output value risk. Our main findings are as follows.

First, during 1987–2006, specialized commodity producers defined as those countries significantly engaged in the production of a single commodity, experienced a 27.0% average volatility of output value from price changes. By contrast, producers that were diversified in three or more commodities, faced an average volatility of 12.7%. Hence, the risk faced by specialized producers was more than twice as large as that of diversified producers. This is economically significant because commodity output contributes a significant fraction of GDP and exports for the countries in our sample. Average pairwise commodity correlation during this period was close to 8%. Second, the gap in volatility between specialized and diversified producers narrowed in 2007–12 to 10.9%, primarily driven by an increase in the risk faced by diversified producers to 19.5%. The volatility for specialized producers varied slightly (in relative terms) to 30.4%. This reduction in the benefits of diversification occurred at a time of global macroeconomics distress and followed directly from higher pairwise commodity correlations, averaging 26% during 2007–12. Finally, in 2013–16, volatilities for specialized and diversified producers reverted to 29.3% and 13.5% as commodities decorrelated again to 10.0%. The sizeable variation in commodity output volatility for diversified producers should therefore be taken into account by policy makers in their design of diversification efforts. Third, we find that a theoretical relationship between specialization and output variance holds approximately in the cross-section and across time, with parameters solely determined by the overall level of commodity volatility and average commodity correlation. This formula is very similar to that used by Giovanni and Levchenko (2009) for the aggregate variance of manufacturing sectors.

In our analysis we focus on the volatility of national output value which, to keep a parsimonious approach, we compute as the sum of the market value of produced metals, minerals, soft, and agricultural commodities. We recognize, however, that there might be significant differences in the ownership of the revenues accrued in the production of different commodities. Agricultural and soft commodities are typically produced by locally owned farms. Oil production is often shared by multinational firms and by government-sponsored firms. Minerals in developing countries are predominantly produced by multinationals. In this case, an alternative measure of output value could be computed based on taxes or other benefits accrued locally from mining activity (Otto, Andrews, Cawood, & Doggett, 2009; Söderholm & Svahn, 2015). This approach, although desirable, seems unfeasible for a sample of countries and time interval as comprehensive as ours.

This article is related to several strands of the literature in international and development economics as well as on commodity markets. Output volatility is correlated with GDP volatility and it has long been understood as detrimental for economic performance in dimensions such as development, growth, investment, inequality, and institutional stability. Works in the extensive literature dealing with these issues include Ramey and Ramey (1995), Turnovsky and Chattopadhyay (2003) on a negative relationship between volatility and growth, Aizenman and Marion (1999) on a negative correlation between volatility and private investment, and Lutz (1994) on a negative relationship between terms-of-trade volatility and growth. More recently, the causes of output volatility have been explored extensively. Koren and Tenreyro (2007) found that GDP growth volatility is higher in poor countries due to, among other reasons, their degree of specialization in manufacturing. Giovanni and Levchenko (2009) explored the effect of trade openness on volatility using industry-level data and, among other findings, identified a positive relationship between trade, specialization, and output volatility. The riskiness of exports, taking into account specialization effects, was studied by Giovanni and Levchenko (2010). These articles focus on the volatility of manufacturing and non-manufacturing output but with no detailed focus on the composition and behavior of commodity output. Our article, by contrast, focuses on the volatility of commodity output value, its relationship with the underlying structure of production and overall dynamics in the global commodity markets. Unlike Kalemli-Ozcan, Srensen, and Yosha (2003), which study to what extent the degree of specialization in manufacturing in countries and regions emerges as a consequence of the possibility of risk-sharing, we focus on the production of commodities for which the degree of specialization is largely a consequence of natural resource endowments and therefore mostly exogenous.

The relative contribution of world prices of capital goods and commodities to the business cycles of small open economies, including many countries in our sample, was studied by Kose (2002). The macroeconomic performance of commodity producers is also affected by commodities prices through their impact on exchange rates (Chen & Rogoff, 2003; Clements & Fry, 2008). The volatility of commodity output value is a first order risk for commodity producers and therefore merits risk management. In this regard, precautionary saving for oil producers has been studied by Cherif and Hasanov (2013). The gains associated with hedging against commodity price volatility at the national level were quantified by Borensztein, Jeanne, and Sandri (2013).

We focus in this paper on the effectiveness of diversification at the national level. Significant diversification efforts might occur simultaneously at the farm or firm level. Diversification, or its absence, at the single farm level involves a trade-off between the gains from economies of scale and the higher risk implied by specialization (Kurosaki, 2003; Chavas & Di Falco, 2012; Michler & Josephson, 2017among others). Diversification at the micro level contributes to diversification at the macro level but for the reverse to hold a smoothing effect through exchange rates (Cashin, Céspedes, & Sahay, 2004) or a redistribution mechanism is needed. The impact of commodity shocks and their management on the development and welfare of commodity producers have received attention, including Van der Ploeg and Venables (2012), Arezki and Brückner (2012), Bellemare, Barrett, and Just (2013).

There is also a large literature exploring the behavior and determinants of commodity prices and their co-movement, including Pindyck and Rotemberg (1988), Borensztein and Reinhart (1994), Frankel (2006), Ai, Chatrath, and Song (2006). Most recent works on commodity co-movement, including some that cover part of the 2007–12 period in their analysis, have found a dominant effect of fundamentals, global economic activity, and macroeconomic variables in explaining correlations (Lescaroux, 2009; Casassus, Liu, & Tang, 2013; Byrne, Fazio, & Fiess, 2013; Alquist & Coibion, 2014; Myers, Johnson, Helmar, & Baumes, 2014). Increased financial speculation has also been prevalent on 2007–12 but its relationship with correlations has found uneven support (Tang & Xiong, 2012; Janzen, Smith, & Carter, 2013; Janzen, Carter, Smith, & Adjemian, 2014; Basak & Pavlova, 2015).

The article is structured as follows: In Section 2 we describe our data on commodities and certain aspects of commodity price dynamics during 1987–2016. In this section we also