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150 YEARS OF BOOM AND BUST: WHAT DRIVES MINERAL COMMODITY PRICES?

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This paper provides long-run evidence on the dynamic effects of supply and demand shocks on commodity prices. I assemble and analyze a new data set of price and production levels of copper, lead, tin, and zinc from 1840 to 2014. Using a novel approach to identification, I show that price fluctuations are primarily driven by demand, rather than supply shocks. Demand shocks affect the price for up to 15 years, whereas the effect of mineral supply shocks persists for up to 5 years. Price surges caused by rapid industrialization are a recurrent phenomenon throughout history. Mineral commodity prices return to their declining or stable trends in the long run.

Keywords: Mineral Commodity Prices, Demand and Supply Shocks, SVAR

1. INTRODUCTION

The prices of mineral commodities, including fuels and metals, have repeatedly undergone periods of boom and bust over the last 150 years [Cuddington and Jerrett (2008), Jacks et al. (2011)]. These long-term fluctuations affect the macroeconomic conditions of developing and industrialized countries [World Trade Organization (2010), International Monetary Fund (2012)]. Booms have repeatedly raised the issue of "security of supply," whereas bust periods have stirred fears about declining terms of trade and export revenues.

The theoretical literature is far from conclusive about the driving forces behind these long-term fluctuations, however.[1] Extensions of the Hotelling (1931) model

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explain price fluctuations by referring to irregular exploration for deposits and, hence, focusing on the supply side [Fourgeaud et al. (1982), Cairns and Lasserre (1986)]. The role of the Hotelling model itself to commodity markets has recently come under scrutiny [see Anderson et al. (2014), Stuermer and Schwerhof (2015)]. Competitive storage models ultimately leave open the source of commodity price shocks [Wright and Williams (1982)]. Another strand of literature stresses the role of storage in the presence of expected net supply shortfalls in explaining price fluctuations [Alquist and Kilian (2010), Kilian and Lee (2014), Kilian and Murphy (2014)]. Finally, Frankel and Hardouvelis (1985), Barsky and Kilian (2002), and other authors point to shifts in monetary policy as a major driving force.

Empirical work on the drivers of commodity prices tended to focus on the oil market. Hamilton (2008), for example, suggests that oil supply shocks account for the broad behavior of crude oil prices. In contrast, Kilian (2008, 2009) and Kilian and Murphy (2014) show that fluctuations in the price of oil are driven mainly by demand shocks due to global economic activity. These studies all focus on post-1960s data and examine high-frequency price movements based on monthly or quarterly data.

However, large swings in commodity prices occur at a low frequency. Understanding which shocks drive these low-frequency price movements and how long they persist is important for formulating environmental and resource policies, for the conduct of macroeconomic policy, and, most importantly, for investment decisions in the extractive industry. The literature on modeling oil markets, in contrast, has examined only a handful of boom and bust phases since the early 1970s.

This paper is the first to examine the effects of different shocks on mineral commodity prices based on a long period of historical data. This paper makes two main contributions: First, I compile a new annual data set for four mineral commodities, namely copper, lead, tin, and zinc, from 1840 to 2014. This makes it possible to examine low-frequency price fluctuations based on a large number of boom and bust periods.

Second, I contribute to the literature on identifying demand and supply shocks in vector autoregressive (VAR) models of commodity markets. Traditionally, this literature has used short-run exclusion and sign restrictions that restrict the slopes of the short-run demand and supply curves [see, e.g., Kilian (2009), Kilian and Murphy (2014)]. Such restrictions are credible only when working with monthly data or perhaps quarterly data, but are not suitable for models based on annual data. I therefore utilize an alternative identification scheme based on long-run restrictions that in this form is new to the literature and that is appealing when working with long time spans of data.

The key idea is that persistent commodity price increases caused by commodity demand shifts trigger technological advances and new discoveries, allowing commodity demand shocks to have long-run effects. In contrast, exogenous commodity supply shocks are modeled as having only short-run effects on world real gross domestic product (GDP), consistent with robust evidence that oil supply shocks, for example, have only small and short-lived effects on the real price of crude oil and US real GDP [Kilian (2009)]. These commodity supply shocks are best thought of as representing strikes, cartel action, and natural disasters, for example, which lead to temporary supply disruptions.

I assemble annual data for prices and world mineral production for copper, lead, tin, and zinc, as well as world real GDP. I chose mineral commodity markets that exhibit characteristics that make a long-run analysis feasible. The four commodities were traded on the London market as fungible and homogeneous goods in an integrated world market over the long period considered here. They exhibit a substantial track record in industrial use. Hence, they have long-term characteristics that other mineral commodities such as iron ore or crude oil have only gained in recent times.

This paper's primary conclusion is that price fluctuations have primarily been driven by commodity demand shocks, rather than by commodity supply shocks, over the last 150 years. It establishes that shocks to world demand due to, e.g., periods of rapid industrialization or economic crisis have always driven the large booms and busts in prices. These commodity demand shocks have large and statistically significant effects on prices, which persist for 5–15 years. Commodity supply shocks exhibit a pronounced impact on price for a maximum of about 5 years, only in tin and copper markets. These two markets exhibit highly concentrated industry structures and government intervention. Furthermore, world commodity production is positively affected by commodity demand shocks driven by world real GDP. The estimated deterministic trends are rather stable or even decreasing.

This paper is, to my knowledge, the first to provide long-term evidence regarding demand and supply shocks in commodity markets. In contrast to Erten and Ocampo (2013) and Jacks (2013), who extract "supercycles" from various commodity prices and indexes since the 19th century, I am able to identify the contribution of different commodity demand and supply shocks and to quantify the persistence of their effects on the real price of commodities. The strong contribution of commodity demand shocks to price fluctuations over the long run is in line with the results in the oil market for the period after 1973 by Kilian (2009) and Kilian and Murphy (2014). In contrast to these studies, I use data over a far longer time horizon, which makes it possible to examine many more boom and bust periods. I am also able to outline how different market structures across the four commodities affect the dynamic effects of the different shocks.

The results emphasize that extensions of the seminal Hotelling (1931) model, such as those by Arrow and Chang (1982), Fourgeaud et al. (1982), and Cairns and Lasserre (1986), which explain price fluctuations by commodity supply shocks, are of less relevance in explaining the observed fluctuations. My findings suggest an important role for demand shifts associated with the global business cycle and periods of industrialization [see also Stuermer (2014)]. My work also points to demand rather than supply shocks as an interpretation of shocks in competitive storage models [Gustafson (1958), Wright and Williams (1982)].

The empirical evidence on the different effects of commodity supply shocks on prices, which appears to increase with the importance of concentrated industry structures, is in contrast to industrial organization models that predict that a higher product market concentration will reduce price volatility [see Slade and Thille (2006)].

The results suggest that the price effects of the large commodity demand shocks attributable to China in 2003–2007 dissipate. In the absence of additional positive commodity demand shocks, this paper suggests that current prices might even further downswing, as supply catches up. Commodity exporters should thus prepare for a prolonged period of depressed mineral commodity prices. The results also illustrate that self-imposed supply restrictions by a group of exporting countries are effective only for at most 5 years in some markets, such as copper and tin, but are ineffective in increasing prices over the long run.

For countries that import mineral commodities, my results indicate that if the past is any guide to the future, apprehensions about the security of the supply are exaggerated for the broadly used mineral commodities examined here. Various forms of subsidies for overseas mining and the reduction of import dependencies as well as "resource diplomacy" are of questionable impact, given that these mineral commodities are traded on world markets and prices react only moderately to supply shocks.

The remainder of this paper is organized as follows. In Section 2, I describe the construction of my data set. Section 3 outlines on the econometric model and the identification of the demand and supply shocks. In Section 4, I present empirical estimates for copper, lead, tin, and zinc, and conduct sensitivity analysis. Section 5 concludes.

2. A NEW DATA SET FOR LONG-RUN ANALYSIS

This paper examines those mineral commodity markets, notably copper, lead, tin, and zinc, where a long-run analysis is feasible. First, there is strong evidence that these four commodities were traded in integrated world markets over most of the examined time period from 1840 to 2014, except for the two World War periods [see O'Rourke and Williamson (1994), Klovland (2005), Findlay and O'Rourke (2007), Labys (2008)]. Second, London has been and still is the principal marketplace to establish prices in these markets [Schmitz (1979), Slade (1991)]. Third, the four commodities have been traded as rather homogeneous goods across time. Fourth, these commodities exhibit a substantial track record in industrial use and are still among the top 25 in value of world production. They are inputs either in pure form or as alloys to a broad variety of manufacturing goods.

The annual data for real prices and the world production of copper, lead, tin, and zinc, as well as world real GDP, were constructed for the time period from 1840 to 2014.[2] I collect annual nominal price data for copper, lead, tin, and zinc from the London Metal Exchange and its predecessors. For robustness checks, I have collected US prices. All nominal prices were deflated by the respective consumer price indices for the UK and the US producer price indices are used as a robustness check.

The data on the world production of the four mineral commodities were assembled from several sources. I use mine output or smelter output for earlier times and refined output where available for the 20th century. World production includes production from primary as well as recycled materials.

World real GDP data are used as a measure of global economic activity that drives the demand for mineral commodities.[3] I use the seminal real GDP data set by Maddison (2010). For the time period before 1950, country-based annual data are summed up. For those years where annual data for a certain country are missing, I linearly interpolate the data. For European countries and western offshoots, I compute their respective shares of output relative to neighboring countries, where data are available. These shares are then linearly interpolated and multiplied with data from those countries, where annual data are available. This process assumes that the business cycle of these countries moves in tandem with that of their neighboring countries.

3. IDENTIFYING SHOCKS TO MINERAL COMMODITY PRICES

I use a three-variable, structural VAR model with long-run restrictions to decompose unpredictable changes in real mineral commodity prices into three mutually uncorrelated shocks, which I interpret as a commodity demand shock, a commodity supply shock, and a commodity-specific demand shock.[4]

The vector of endogenous variables is $z_t = (\Delta Y_t, \Delta Q_t, P_t)^T$, where ΔY_t refers to the percentage change in world real GDP, ΔQ_t denotes the percentage change in world primary production of the respective mineral commodity, and P_t is the log of the respective real commodity price. The matrix of deterministic terms D_t consists of a constant, a linear trend, and annual dummies during the two World War periods and the three years immediately after. The structural VAR representation is

$$Az_t = \Gamma_1^* z_{t-1} + \cdots + \Gamma_p^* z_{t-p} + \Pi^* D_t + B\epsilon_t. \quad \mathbf{(1)}$$

The reduced-form coefficients are $\Gamma_j = A^{-1}\Gamma_j^*$ for $j = 1, \ldots, p$ and $\Pi^* = A^{-1}\Pi^*$. A and B are $K \times K$ matrices. K is the number of endogenous variables. The vector ϵ_t is a vector of serially and mutually uncorrelated structural innovations. The relation to the reduced-form residuals is given by $u_t = A^{-1}B\epsilon_t$. I choose the number of lags p according to the Akaike information criterion: four lags for copper, three for tin and zinc, and two for lead.

To compute the structurally identified impulse responses, I first set $A = I_K$, with I equal to a $K \times K$ identity matrix. I estimate the contemporaneous impact matrix $C = A^{-1}B$ by $\hat{C} = \hat{\Phi}^{-1}\hat{\Psi} = \hat{\Phi}^{-1}\text{chol}[\hat{\Phi}\hat{\Sigma}_u\hat{\Phi}']$. The matrix of accumulated effects of the impulses is $\Phi = \sum_{s=0}^{\infty}\Phi_s = (I_K - \Gamma_1 - \cdots - \Gamma_p)^{-1}$. I need $K(K-1)/2 = 3$ restrictions on the long-run matrix of structural shocks Ψ to

TABLE 1. Zero restrictions on the long-run multiplier matrix

	World real GDP	Commodity production	Real price
Commodity demand shock	*	*	*
Commodity supply shock	0	*	*
Commodity-specific demand shock	0	0	*

Note: The matrix has been inverted for illustrative purposes. $*$ signifies an unrestricted coefficient.

identify three uncorrelated structural shocks. I assume that the long-run impact matrix Ψ is lower triangular, which means that I place three zero restrictions on the upper-right-hand corner. I obtain the estimated long-run impact matrix from a Cholesky decomposition of the matrix $\hat{\Phi}\hat{\Sigma}_u\hat{\Phi}'$.

The key idea of my identification is that commodity demand shocks lead to price increases, which trigger new exploration and technological changes. Anderson et al. (2014) provide theoretical and empirical evidence that this is the case in drilling for crude oil. Stuermer and Schwerhoff (2015) set up an endogenous growth model, where growth in world total output increases the demand for commodities as inputs, but also endogenously increases commodity production in the long run through research and development (R&D) investment in mining technology.[5] Based on these considerations, I place three zero restrictions on the long-run impact matrix and identify three different shocks (see Table 1).

I construct the first shock, a commodity demand shock, to capture unexpected strong expansions or contractions of the world economy at a low frequency, e.g., the recent period of rapid industrialization in China or the Great Depression. Since commodities are used as inputs to produce total world output, this type of shock affects the demand for all commodities at the same time. In line with this model, I restrict the long-run effects of this type of shock neither on world GDP, nor on world commodity production.[6]

The second shock is a commodity supply shock, e.g., an unexpected disruption in the physical production of a commodity due to strikes, cartel action, or local wars. I do not constrain the long-run effect of the commodity supply shock on world production of a commodity because the effect of this shock on commodity production might still be quite persistent. However, I impose the zero restriction that there is approximately no long-run effect of the commodity supply shock on world real GDP because the effects of unexpected production shortfalls due to, e.g., strikes subside. This is consistent with the robust evidence that oil supply shocks, e.g., have only small and short-lived effects on US real GDP [Kilian (2009)].

The third shock, a residual shock, encompasses all innovations to the respective real mineral commodity price that are driven neither by a commodity demand shock, nor by a commodity supply shock, and hence are uncorrelated to these two shocks. I label this shock as a commodity-specific demand shock. I interpret this type of shock as basically capturing changes in the demand for inventories of mineral commodities, which arise from (1) shifts in expectations of the downstream processing industry about the future supply and demand balance [see Kilian (2009), Kilian and Murphy (2014)], (2) government stocking programs, and (3) producers with market power, who increase their inventories in an attempt to increase prices. I do not directly include a proxy for inventories in this study because long-term data are missing.

I assume that the commodity-specific demand shock affects only the capacity utilization of the extractive sector but not long-term investment decisions about capacity expansion. It, hence, exhibits only a transitory effect on the world production of the respective mineral commodity. This is plausible, given that expanding extraction capacities exhibits high upfront costs and takes many years [Wellmer (1992), Radetzki (2008)]. I also make the assumption that shocks to mineral commodity prices due to a commodity-specific demand shock exhibit no long-term effect on world real GDP. This is in line with a model where long-run changes in world real GDP are basically driven by changes in total factor productivity.

As the commodity-specific demand shock is a residual shock, it may also include unexpected changes in a commodity's intensity of use with regard to world real GDP. These changes may be driven by several factors (e.g., production technologies, tastes, or government regulation), which have partly offsetting effects and are rather gradual, long-term processes, especially on the global level for the examined commodities [see, e.g., Pindyck (1980)]. These gradual processes are assumed to be primarily captured in the long-run deterministic trend in the regression.

The use of long-run restrictions is appealing, especially when working with long time spans of data. Like any other approach to identification, it is not without limitations. I therefore check the plausibility of the identified shocks through narrative evidence from the economic history of the examined markets. The reader is referred to the online appendix for details.

4. EMPIRICAL RESULTS

I employ least-squares to consistently estimate the reduced-form coefficients of the VAR models of each of the four mineral commodity markets. On the basis of these estimates, I obtain the contemporaneous and long-run matrices by the Cholesky decomposition, as described above. I use a recursive-design wild bootstrap with 2,000 replications for inference, following Goncalves and Kilian (2004). The reader is referred to the online appendix for the estimated coefficients and plots of the structural shocks.

I present results for the historical decompositions, the impulse response functions, and the estimated trends in the following sections. I complement my statistical analysis with narrative evidence in the online appendix.

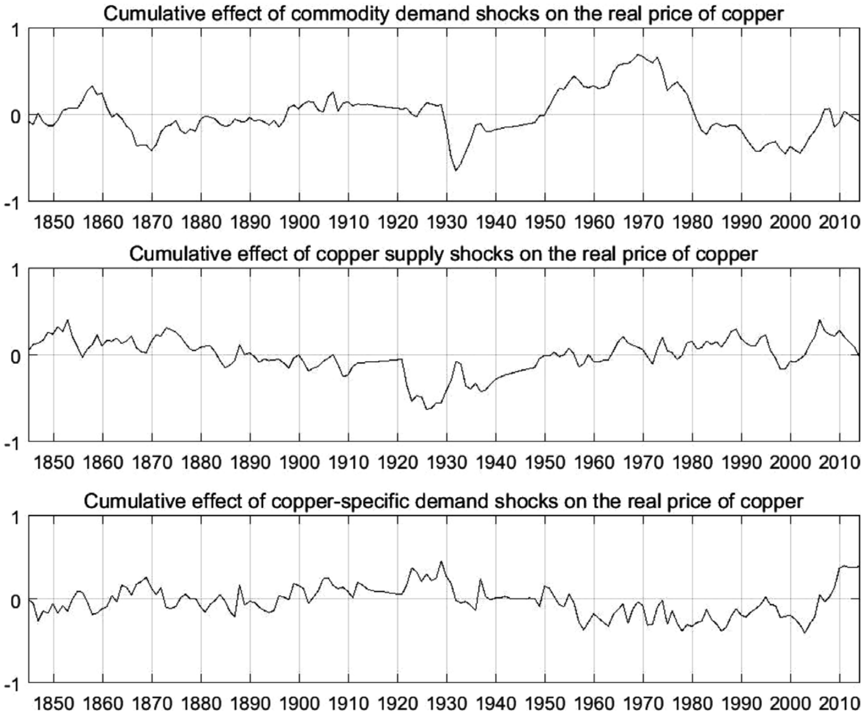

FIGURE 1. Historical decomposition of the real price of copper.

4.1. Historical Decomposition

Figures 1–4 plot the respective cumulative contributions of each structural shock to the real (detrended) prices of copper, lead, tin, and zinc based on a historical decomposition of the data. Each of the three panels shows how prices would develop if there were only the respective shock. Since the vertical scales across the three panels are identical, the figures illustrate the relative importance of a given shock.

The results show that the large fluctuations in the four respective prices are mainly driven by commodity demand shocks and commodity-specific demand shocks. These two types of shocks basically cause the long- and medium-run fluctuations. Commodity supply shocks play some role in driving the prices of copper and tin. They are a source for short-run fluctuations in these two markets.

The historical decompositions illustrate that the cumulative contributions of commodity demand shocks follow the same pattern across the four commodities. This is as expected, as shocks to world output are common shocks and affect the price at the same time. However, this type of shock seems to affect copper and tin prices in a slightly more pronounced way than zinc and lead prices.

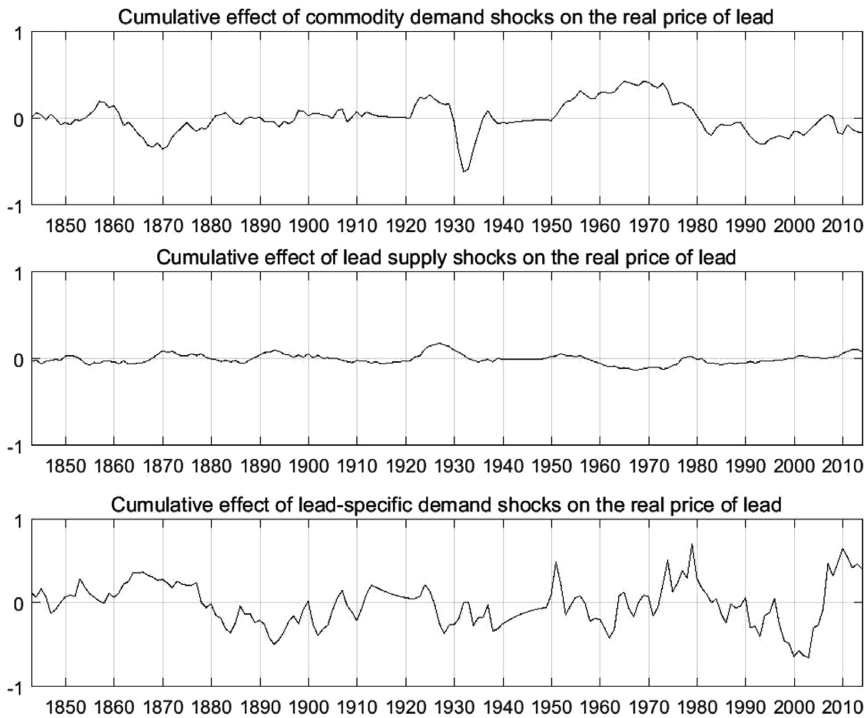

FIGURE 2. Historical decomposition of the real price of lead.

The cumulative effects of the commodity demand shock on the real mineral commodity prices are in line with narrative evidence from economic history. In the late 1840s, the prices of the four commodities were low, owing to the British railway crisis, which caused a negative commodity demand shock. In the 1850s, prices underwent a major upswing, driven mainly by a positive commodity demand shock due to the world economic boom at that time. Prices experienced a long downturn during the 1860s, reaching a trough around 1870. This was due to negative commodity demand shocks triggered by the Panic of 1857, the US Civil War, the Overend–Gurney Crisis in 1866, and their respective economic aftermaths.

In the interwar period, the Great Depression caused a major negative commodity demand shock that drove down all prices in 1929. From the end of World War II until the mid-1970s, postwar reconstruction and the economic rise of Japan generated strong, positive commodity demand shocks, which mainly determined price fluctuations. The recession in 1974 caused a strong negative commodity demand shock, which led to a serious decline in prices from about 1975. In the following three decades, prices fell mainly because of negative commodity demand shocks caused by the recession in 1981, the economic impact of the breakup of the USSR, and the Asian crisis. The sharp rise in prices from around 2003 to 2007

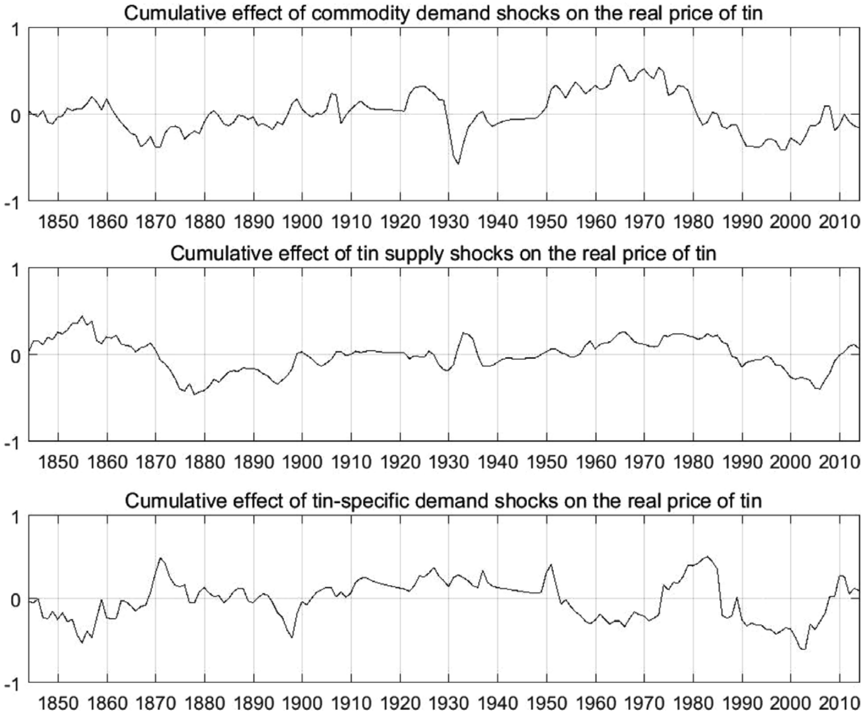

FIGURE 3. Historical decomposition of the real price of tin.

was basically driven by the cumulative effects of large commodity demand shocks due to China. Since the onset of the Great Recession in 2008, commodity demand shocks have had a negative effect on prices.

Commodity supply shocks play a modest role in determining short-term fluctuations in copper and tin prices. Narrative evidence suggests that copper and tin markets are characterized by a long history of oligopolistic structures and continued attempts to manipulate prices by output restrictions and stock holdings. Copper production also has always been strongly concentrated, with the main producers in Chile and the United States [Schmitz (1979), Chandler (1990)]. Recurrently appearing cartels were able to influence the price by both output restrictions and by attempts to corner the markets through inventories. The tin market is also characterized by a strong geographic narrowness of supplies in the Earth's crust [Gibson-Jarvie (1983)]. Tin supply depends strongly on less-developed countries [Thoburn (1994)]. Governments have attempted to control the market since after World War I.

In contrast, commodity supply shocks do not play a major role in driving the prices of lead and zinc. My historical account in the online appendix reveals that the two markets do not have a strong oligopolistic structure so that supply is quite elastic. This is due to the fact that lead and zinc resources are relatively

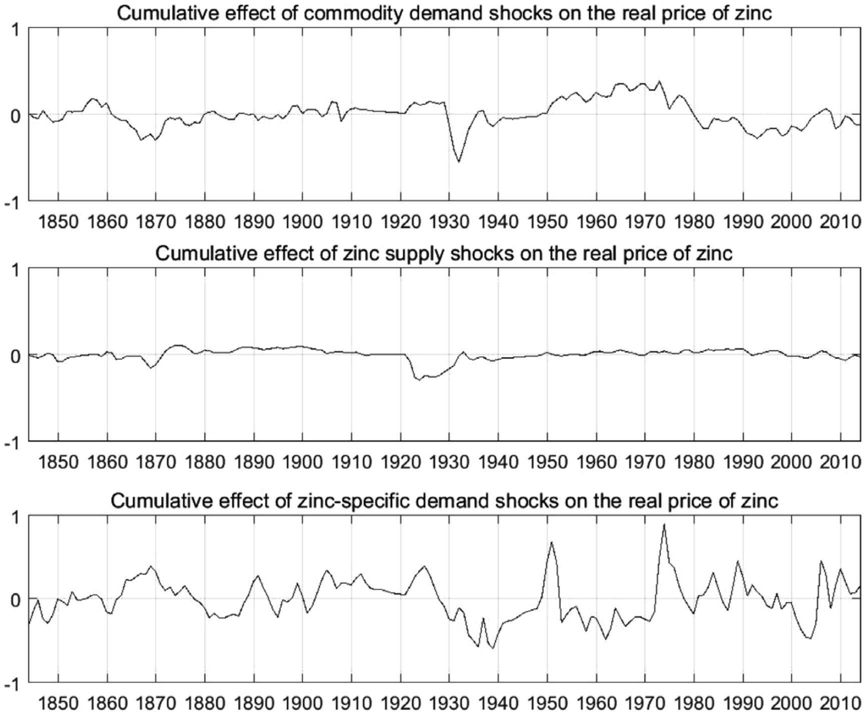

FIGURE 4. Historical decomposition of the real price of zinc.

widespread and production takes place mainly in the industrialized countries. As a consequence, the formation of cartels to restrict output has not been successful in the history of these markets.

The historical decompositions show that the accumulated contribution of commodity-specific demand shocks plays an important role in driving short- to medium-run fluctuations in all considered markets. The historical accounts in the online appendix provide evidence that the markets have been basically driven by changes in inventories by cartels, the US government, and recently by increases in demand for inventories at metal exchanges. In the case of lead, lead-specific demand shocks also encompass negative shocks to the use of lead due to environmental regulation in the 1970s and 1980s. Another unusual episode is in the tin market after World War II. The accumulated tin-specific demand shocks nicely show the buildup and collapse of the International Tin Agreement, which influenced the price strongly over several decades.

4.2. Impulse Responses

The impulse response function in Figure 5 plots the respective responses of the percentage change in world real GDP, the percentage change in world copper

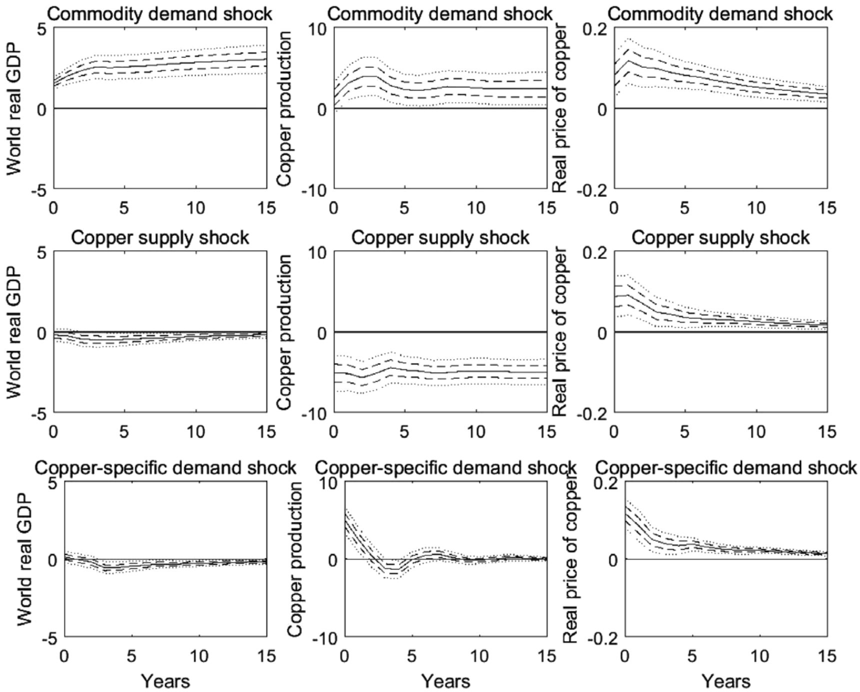

FIGURE 5. Impulses to one-standard-deviation structural shocks for copper. Point estimates with one- and two-standard error bands. All shocks have been normalized such that an innovation will tend to raise the price of the respective commodity. I use accumulated impulse response functions for the shocks to world mineral commodity production and world real GDP to trace the effects on the level of these variables. The reader is referred to the online appendix for the impulse response functions of the other three commodities.

production, and the log in the real copper price to a one standard deviation of the three respective structural shocks. The respective functions for the other commodities can be found in the online appendix. All shocks have been normalized such that an innovation will tend to raise the price of the respective commodity. I plot accumulated impulse response functions for the shocks to world mineral commodity production and world real GDP to trace the long-term effects on the levels of these variables.

A positive commodity demand shock, e.g., an expansion of the world economy, triggers a major increase in the real prices of copper and tin for a maximum of about 1 year after the shock. The effect of this shock continues to persist significantly over a period of 15 and 10 years, respectively. The commodity demand shock also exhibits major increases in the prices for lead and zinc, which persist significantly for about 5 years. At the same time, this shock causes a positive and significant increase in production that lasts for about 5 years in the cases of tin and zinc and for about 10 years in the case of copper. The production of lead increases persistently. As expected, the shock has a positive effect on world real GDP.

A negative commodity supply shock reduces the real price of copper significantly for about 10 years and the one for tin for more than 15 years. However, the impact is pronounced for up to only about 5 years. There is no statistically significant impact of the commodity supply shock on the prices of lead and zinc. The effect on the price of lead is even slightly negative, but there is no statistically significant evidence on the direction of the effect. An explanation for these variations is different market structures between the rather concentrated tin and copper markets and the rather competitive markets of lead and zinc [Schmitz (1979)]. As a consequence, shocks to supply, in the form of coordinated production decreases by a cartel, for example, have an impact on the price of copper, but not on the price of lead. A negative shock to the supply of tin or copper affects real GDP negatively and significantly for 3 to 7 years, respectively, and then approaches zero, in accordance with our identifying assumptions. It does not have any significant effect on real GDP in the cases of the lead and zinc markets.

A positive commodity-specific demand shock has an immediate and statistically significant impact on all four commodities, which levels off in a period of about 15 years. This shows how persistent the effects of stock holdings on price are. This type of shock exhibits some significant negative effect on real GDP in the copper market and some positive effect on production in the first couple of years in both the copper and tin markets.

4.3. Sensitivity Analysis

The empirical results confirm the robustness for different specifications, including different lag lengths and a more conventional identification scheme based on short-run restrictions, but also for different subperiods of the data set. The results hold if different data sets are used, including New York instead of London prices, and different deflators are employed. The reader is referred to the online appendix for further details.

5. CONCLUSION

This paper has examined the dynamic effects of demand and commodity supply shocks on the real prices of copper, lead, tin, and zinc over the time period 1840–2014. Using a historical decomposition based on a structural VAR model with long-term restrictions, my results show that these prices are mainly driven by commodity demand shocks and commodity-specific demand shocks. Commodity supply shocks play a role only in the cases of tin and copper, possibly due to the oligopolistic structure of these markets. Demand shocks affect the price for up to 15 years, whereas the effect of mineral supply shocks persists for up to 5 years.

Two major limitations to my analysis may guide further research. First, my model does not allow for asymmetric responses of the variables to positive or negative shocks. This may be particularly important for the effect of positive and negative price shocks on commodity production. Many firms in the extractive sector keep their utilization rates high even after negative demand shocks, which drive the price down, hit the market.

Second, the importance of commodity-specific demand shocks points to inventories as a source of fluctuations, rather than a calming agent. This contrasts to the classical competitive storage models and provides long-term evidence in support of Alquist and Kilian (2010), Kilian and Lee (2014), Kilian and Murphy (2014), and others who maintain that storage in the presence of expected supply shortfalls helps to explain price fluctuations. Disentangling this residual shock by controlling for changes in inventories or the resource intensity of the economy would shed further light on the sources of these shocks.

NOTES

1. See Carter et al. (2011) for a detailed summary of theories on fluctuations in commodity markets.
2. The data set and an online appendix including sources, descriptions, and figures of the data are available at https://sites.google.com/site/mstuermer1 or from the author upon request.
3. This is in contrast to Kilian (2009) and Kilian and Murphy (2014), who create and employ an index of global real economic activity based on global dry cargo freight rates. They argue that this is a better proxy for business-cycle-driven demand for oil as it does not include, e.g., effects of fluctuations of economic activity in the service sector. However, I use world real GDP because, to my knowledge, it is the only proxy for which data are available over the period considered.
4. Blanchard and Quah (1989) have introduced this methodology to explain fluctuations in GNP and unemployment. I use it to explain fluctuations in commodity prices. It is therefore important to keep in mind that they identify and interpret demand and supply shocks at the aggregate level, whereas I do so at the level of a specific commodity market.
5. An analogous argument has been made by earlier contributions to the literature on exogenous growth models and natural resources [see, e.g., Stiglitz (1974), Aghion and Howitt (1998), Groth (2007)], which argue that increases in factor productivity drive up not only total output, but also productivity involving the use of nonrenewable resources.
6. It is important to not confuse this commodity demand shock with the traditional aggregate demand shock identified in the empirical macroeconomics literature. The former encompasses all different types of shocks to world real GDP that drive the demand for a certain commodity. These include the traditionally identified aggregate supply shocks (such as changes to total factor productivity), but also aggregate demand shocks (such as monetary policy shocks).

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