Difficulties in the forecasting of iron ore price: a review

Bazhanov, Andrei

Moscow School of Economics, Moscow State University

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Andrei Bazhanov[1]

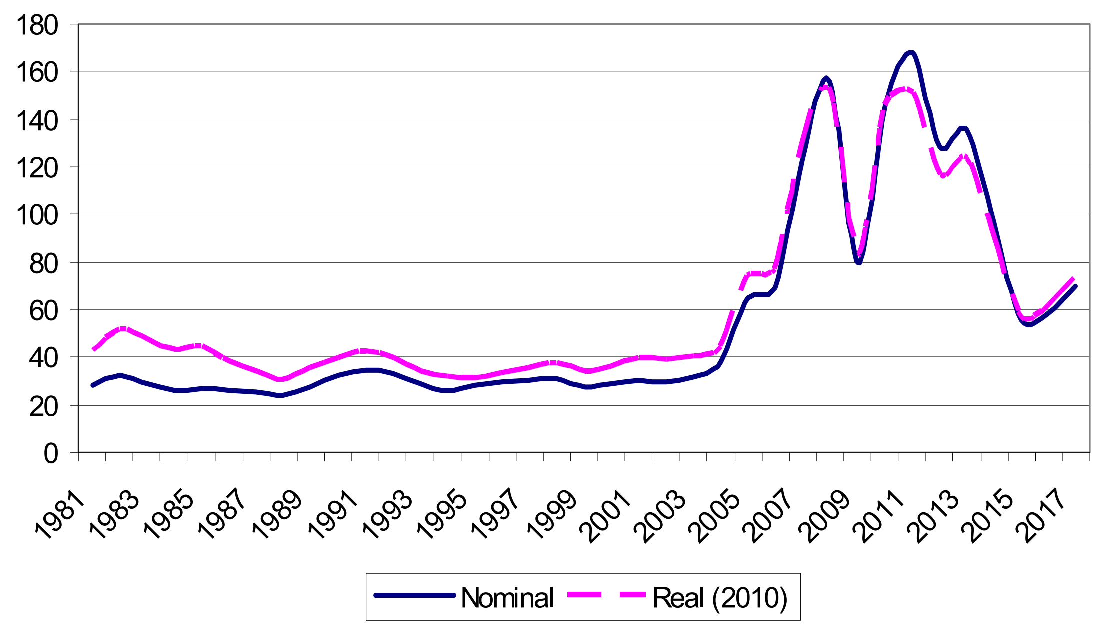
"Contemplation of the world's disappearing supplies of minerals, forests, and other exhaustible assets had led to demands for regulation of their exploitation. The feeling that these products are now too cheap for the good of future generations, that they are being selfishly exploited at too rapid a rate, and that in consequence of their excessive cheapness they are being produced and consumed wastefully has given rise to the conservation movement." *Harold Hotelling (1931)*

The interest in the analysis of the iron ore market significantly increased after a sharp spike in the iron ore price in 2008-2010 and consecutive decline; see Figure 1.

Understanding of the reasons for these shifts are crucial for further development of the industry because a high price motivates investments in developing new mines but a long lead time for new projects and high price volatility make these investments very risky.

Figure 1. Iron ore prices, annual averages, cfr (cost and freight) spot, $US/dmtu (dry metric ton unit).

Source: http://databank.worldbank.org/data



[1] Moscow School of Economics, Moscow State University; Smith School of Business, Queen's University, Kingston, Canada

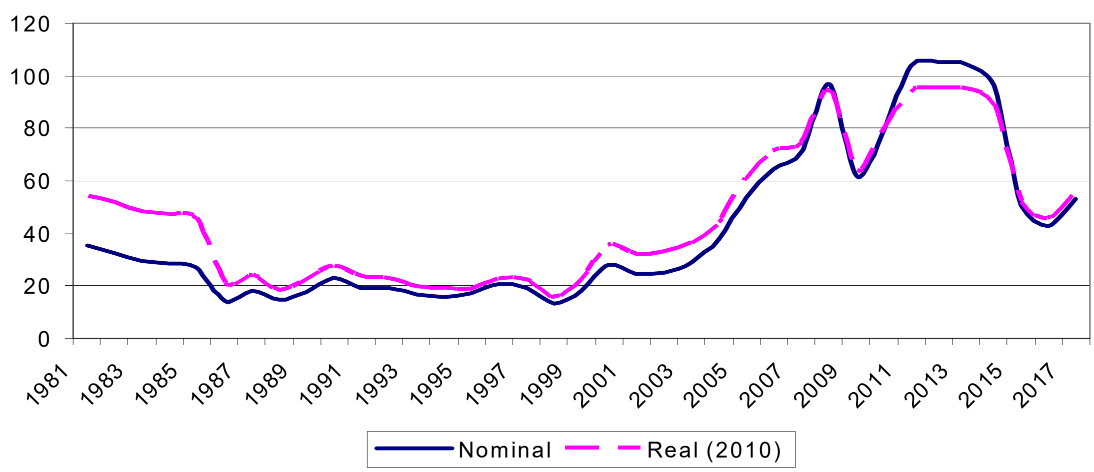
Long-term forecasts. Pustov et al. (2013) provide cost-based forecasts for real price of iron ore (CFR China) until 2022 using three different approaches usually used by commodity analysts from investment banks, e.g. Barclays (Berry and Cooper 2011), Merrill Lynch, Citi, Itau BBA, J.P. Morgan (Bussitil 2011, De Angele 2011), and analytical agencies, e.g. CRU (Brooks 2011). The forecasted price in all approaches ranges from \$85/t to \$125/t and rises to \$150-220/t by 2022. The consensus average forecast of Citi, Macquarie, J.P. Morgan, UBS, Merrill Lynch, Morgan Stanley, Credit Suisse, which is \$88/t (FOB Brazil) also fells in this range after adding transportation costs.

However, as it seen from Figure 1, the price dropped after 2013 and oscillates now around \$60/t meaning that multimillion-dollar investments in new mines, based on \$85/t – \$125/t forecasts, may turn into irreversible losses. *Why did it happen and how to avoid similar situations?*

Why it happened. Figure 1 may lead to an intuitive prior conclusion that the high volatility and high values of iron ore price were caused by switching pricing regime from yearly negotiated to market pricing in 2008, see, e.g., Wu et al. (2016). Another factor suggested in Wu et al. (2016) is the iron ore inventories at Chinese ports. When inventories are high, the price starts to decline and vise versa. However, Wårell (2014, 2018) shows that the dependencies of iron ore price and its volatility on switching the regime are insignificant if an econometric model includes transportation costs and GDP growth in China. That is, the increases in freight rates and its volatility were the important reasons for the sharp changes in the iron ore price.

Digging deeper. Why do freight rates increased in that period? The answer is illustrated by Figure 2, which indicates unusually sharp spike in oil price in 2008. Moreover, another determinant

Figure 2. Crude oil prices, annual averages, US\$/bbl. Source: http://databank.worldbank.org/data



of the iron ore price, GDP growth in China, may be also indirectly linked to oil shocks when these shocks contribute to economic recessions and slumps of demand for Chinese products, see, e.g., Hamilton (2009) and Kilian (2009).

What was the nature of the 2008 oil price shock and is it possible to predict such price movements? The shock resulted from inability of OPEC to match unprecedented surge in demand in emerging economies (Hamilton, 2009) and "the first significant decrease in non-OPEC supply since 1973 (Smith, 2009). No noticeable organised actions of speculators or price fixing were reported in this period. The timeline of the contributing events was as follows:

February 2008: Venezuela cut off oil sales to Exxon Mobil during a legal battle over nationalization;

March: saboteurs blew up the two main oil export pipelines in the south of Iraq;

April 25: Nigerian union workers went out on strike, causing Exxon Mobil to shut in production;

April 27: Scottish oil workers walked off the job, leading to closure of the North Forties pipeline that carries about half of the United Kingdom's North Sea oil production;

April: Mexican oil exports had fallen sharply due to rapid decline in Cantarell oil field;

May: about 1.36 million barrels per day of Nigerian production was shut in due to a combination of militant attacks on oil facilities, sabotage, and labor strife;

June, Nigeria: militant attacks caused Shell to shut in an additional 225,000 barrels per day; protesters blew up a pipeline that forced Chevron to shut in 125,000 barrels per day.

All these events were registered in the spot market and hardly possible to predict. The cause of the sharp decline in oil price by 2009 was, indeed, the global economic recession.

If the short-run spikes in the commodity prices are unpredictable, then maybe it is possible to estimate a long-run trend? After all, this information can be more important for long-term projects than the attempts to forecast the oscillations around the trend.

Nonrenewable resource prices and the Rule of Hotelling. Hotelling (1931) introduced the rule that the price p of a nonrenewable natural resource (*in situ*) must grow at the rate of interest r ($dp/dt = p\cdot r$)[2]. Hotelling derived this rule as an equilibrium condition on the asset markets under some simplifying assumptions. This rule emerges also as a necessary condition of dynamic efficiency in a simple resource economy, see, e.g., Dasgupta and Heal (1979).

A number of empirical studies, e.g. Krautkraemer (1998), Gaudet (2007), Hart and Spiro (2011), Radetzki and Wårell (2017) show that the real prices of nonrenewable resources such as fossil fuels and metals including iron, in fact, do not follow a growing trend but rather oscillate around some constants. The explanation is that the price, besides the "scarcity" part or Hotelling rent, contains various costs of bringing the resource to the market and depends on other factors such as market structure (the resource markets usually are not perfectly competitive), product durability (metals serve longer than fuels, which flattens the price path), technical progress and uncertainties in the future. Moreover, real economies are not dynamically efficient, which makes the formula for the price path essentially more complicated than in the basic Hotelling rule, see, e.g., Bazhanov (2015).

Can we use this info to predict the price trend? A standard econometric approach to forecasting is to assume that the past patterns will not change dramatically in the nearest future. Then, the empirical results above imply a simple rule of thumb that the nominal price of a specific ore should grow with a rate of inflation.

However, even this simple rule is not free from some difficulties. First, there is a lack of consistent data for estimation of the average real price. The data for Fe 62% CFR in $US/t is available from 1981 to present, e.g., in the World Bank as annual averages yielding the average real price (2010)

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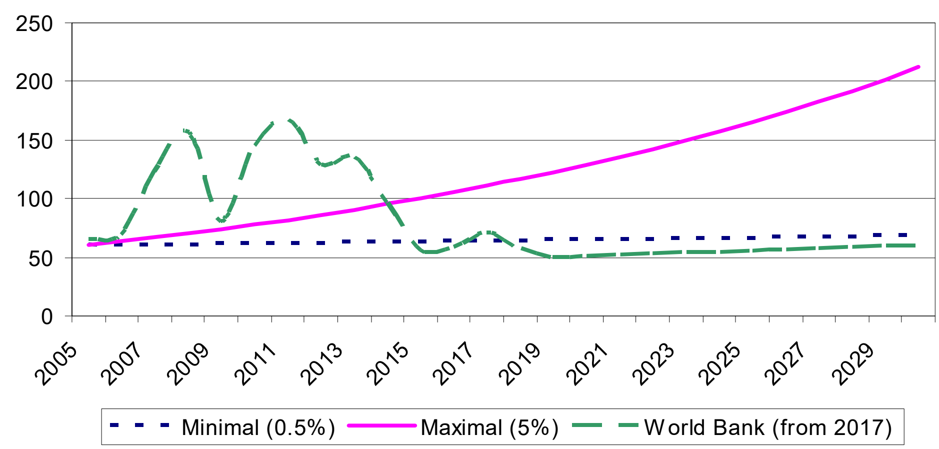
[2] This formula assumes that the cost of extraction is normalized to zero. Otherwise, the Hotelling rule requires that the resource rent, which is the price less the cost, grows at the rate of interest.

for this period around \$61. Potter and Christy (1962) and Manthy (1978) provide the prices for pig iron from 1870 to 1973 measured in 1951-53 index. Krautkraemer (1998) considers the Pittsburgh real price of iron in ¢/lb. Despite these discrepancies, the comparison of studies of Slade (1982) and Krautkraemer (1998) testify that the prices before 1980 were higher than in 1980s. Slade (1982) conjectured that the prices of nonrenewable resources follow a U-shape trend but later studies did not confirm this conjecture because the prices dropped in 1980s.

Assume that the average real (2010) price in 1870–2017 was \$65US/t. The real price crosses this average approximately in 2004Q3 (2004.75) and around 2015 (Figure 1). Then a forecast for nominal price starting from 2005 is $p(t) = p(2004.75)\cdot\exp[r\cdot (t - 2004.75)]$, where $t>2004.75$ is the year for the forecasted price; $p(t)$ is the forecasted nominal price at year t; $p(2004.75)$ is the *nominal* price in 2004Q3 (around 60); and r is the rate of inflation. Assuming $r_{min} = 0.005$ (0.5%) and $r_{max} = 0.05$ (5%) we obtain the forecasts of the average nominal price in Figure 3.

Figure 3. Iron ore nominal average price forecasts, CFR. Source: author's estimates using constant-real price assumption; World Bank (http://databank.worldbank.org/data/)



The minimal and maximal forecasts are between the "consensus" and World Bank forecasts. The World Bank nominal and real price indexes for base metals, which are used to calculate real price for iron ore, follow decreasing trends starting from 2011 (deflation). If we assume that these trends will continue until 2019-2020 and then apply a constant-real-price forecast with 1% inflation, we will obtain a forcast that is very close to that of the World Bank.

Possible failure of low-price forecasts. Since iron ore is a nonrenewable resource, the scarcity rent may cease to be masked by other factors such as declining (due to technological progress) costs of delivery to the market. Then the average *real* price will grow exponentially with the rate close to the interest rate and the scenarios predicted by Pustov et al. (2013) may be realized. However, as Pustov et al. (2013) admit, "currently proved iron ore reserves would suffice as many as 40 years of consumption at today's rates." Therefore, unfortunately for resource sellers, low-price forecasts look plausible for the nearest 10-20 years.

Possible actions of resource sellers and policy makers. Low prices of nonrenewable resources are unfavourable not only for resource sellers. Hotelling (1931), whose quote heads this paper as well as Krautkraemer (1998), recalled that low prices lead to wasteful resource use, raising a need for regulations in favor of future generations. This concern is echoed in Ali et al. (2017) who conclude that "Global coordination is needed to ensure that minerals are produced in the most ecologically and economically efficient way." Moreover, "international legal mechanisms may be needed to anticipate and respond to future mineral availability constraints." A realization of this regulatory approach may lead to increases in the real prices of nonrenewables in the nearest future.

As a response to Ali et al. (2017), Tilton et al. (2018) offer a "modestly optimistic perspective" for the problem of nonrenewable resource depletion. This approach relies mostly on market forces, but recognizes "that government intervention is needed to correct serious market failures" such as air and water pollution. The main argument is that the long-run persistent resource shortages should manifest themselves via growing trends of real costs and prices, which should provide incentives for development of substitute technologies. If this approach dominates public policies, the resource prices *may* continue to oscillate around relatively low averages for rather long period.

It is known that free (unregulated) competitive resourse market may lead, besides wastefully low prices, to other failures such as tragedy of the commons (Hardin 1968), Dutch disease, and resource curse (Humphreys et al. 2007). Government bodies, as possible regulators, usually solve short-term problems linked to the goals for the next elections. Moreover, a unilateral regulation of resource extraction by one country cannot solve the global problem due to international competition. Therefore, the questions of international and intergenerational justice such as protection of ozone layer, climate change, or *regulation of nonrenewable resource extraction can be solved only at the international level by agreements that set constraints on all parties*.

The market-based approach, however, does not necessarily imply low resource prices. The levels of average prices and price volatilities depend on a specific market structure. Ceteris paribus, it is easier for the sellers to set higher prices and to reduce price volatility in more concentrated markets. That is, *an increase in the market power of resource sellers can stabilize their profits, reduce the risks of investment in new mines and, at the same time, benefit future generations by increasing the time of resource extraction*.

Hotelling (1931) showed that a monopolist, by setting a high price, extracts a limited resource longer than under competition. Solow (1974) put it as follows: "The amusing thing is that if a conservationist is someone who would like to see resources conserved *beyond* the pace that competition would adopt, then the monopolist is the conservationist's friend." That is, *an increase in the sellers' market power can provide more resources to future generations*. The following simple example illustrates this result.

Example. Assume that there is a deposit of 10 units of a nonrenewable resource. The per-period demand for the resource is D = 10 – p, where p is the resource price. Normalizing cost to zero, the *current* profit is $\Pi^c = p(10 - p)$, where 10 – p is the resource supply. Perfect competition sets the optimal price to cost yielding zero profit, and the resource is extracted in one period.

A *myopic* monopolist maximizes the *current* profit by setting the price p=5 leading to extraction of the resource in two periods with the total (undiscounted) profit 50. A *forward-looking* monopolist maximizes undiscounted *total* profit $\Pi = \Sigma_i \Pi_i$, where $\Pi_i = p_i(10 - p_i)$ is the period i profit for i=1,…,T-1, and $\Pi_T = p_T(10 - S_{T-1})$ is the profit from selling the rest of the resource in the last period. Here T is the number of periods, p_i is the price in period i, and S_{T-1} is the total supply in T-1 periods. In this case, the monopolist allocates the resource equally in T-1 periods by setting p_i = 10(T-2)/(T-1) with the total profit 100(T-2)/(T-1), which goes to 100 when T goes to infinity. That means that the monopolist would sell in each period infinitesimally small amount of the resource to the most efficient customer at the highest price. In practice, this price should yield the current profit that is just enough to cover the costs, and this price results already in a final time of extraction.

Moreover, in practice, businesses usually discount future profits, which also leads to a finite time of extraction. However, if a social planner discounts welfare of future generations in an economy that depends on a nonrenewable resource, the consumption may eventually go to zero (extinction of the economy)[3] (Dasgupta and Heal, 1974). This happens because discounting reallocates the resource in favor of current generations. Therefore *the monopolist's* current *resource price can be considered only as a lower bound for an intertemporally fair price path*.

What is the upper bound for an intergenerationally just resource price? In the example above, the forward-looking monopolist sets the price equal to the highest customer valuation because the demand schedule does not depend on price. In fact, despite low short-run price elasticities of demand for nonrenewable resources (see, e.g., Zhang and Lawell, 2017), demand do declines when the shocks in commodity prices contribute to economic recessions,[4] see Kilian (2009); and, as, e.g., Cashin et al. (1999) show, slumps in commodity prices usually last longer than booms. Therefore, a forward-looking monopolist with a low rate of intertemporal discount is not interested in a too high a price, which may be consistent with *an intergenerationally just price that do not lead to recessions*.

However, an increase in market power is not enough to stabilize the price.[5] As shown above, the dependence of freight rate on oil prices plays a crucial role in iron ore price volatility. A gradual shift to non-fossil-fuel transport can eventually solve this problem[6].

These possible properties of a monopolist price, again, do not contradict the idea of intergenerational justice expressed in the notion of *sustainable development*, which, according to the Brundtland Report (WCED, 1987), is the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Problems with increasing market power. According to Jones (1986), "the chances of a cartel being successful are enhanced if:

1) The number of producers is small.
2) A sense of common purpose exists amongst producers (usually emanating from a mutual feeling of an external threat).
3) Members are able to withstand temporary revenue shortfalls.
4) A high proportion of total output is controlled by the cartel.
5) The product has few substitutes.
6) Supply outside the cartel cannot readily be increased."

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[3] As Ramsey (1928) put it, the discounting of the welfare of future generations "is ethically indefensible."

[4] There are studies showing that recessions may result from the *rate* in resource price change rather than from its absolute value, i.e., only fast price jumps may lead to output decline, see, e.g., Bazhanov (2008), Corollary 1.

[5] Newbery and Stiglitz (1981) provide a general theory on commodity price stabilization.

[6] The examples of non-fossil-fuel passenger trains and ships are on the web site of World Steel Association (http://stories.worldsteel.org/innovation/hydrogen-power-trains-future-rail/ and http://stories.worldsteel.org/innovation/green-future-cruise-liners/. Accessed 12 July 2018). The same approaches can be used for cargo carriers. The efficiency of electric heavy-duty trucks is discussed in Sen et al. (2017).

After a detailed analysis of these factors, Jones concludes that "in many ways the iron ore industry is a prime candidate for cartelization." The arguments leading to this conclusion are still valid, although, the rebuttals are also in force. One of the counterarguments is that "The interests of iron ore companies may not coincide with those of the host governments." That is, a state-run cartel similar to OPEC has more chances for success.

Another problem associated with an increase in market power is that monopolization usually entails legal actions. As Worstall (2016) put it, "if you try that sort of action inside the European Union you can be fined up to 10% of your global turnover for trying it on." However, cartel OPEC, being a governmental organization, avoids these problems. In a detailed study, Desta (2010) concludes: "OPEC production restriction measures fall completely outside the scope of national competition law as well as WTO law."[7]

The main reason of cartels' failures, as stressed by all authors starting from Jones (1986), is an incentive for cheating: "This fundamental instability stems from the 'freerider problem': producers as a group gain by restricting total supply, but each member of the cartel would profit even further by raising its own market share while others continued to restrict production. The basic conflict within a cartel is that it requires reduced production to operate while creating the incentive to increase it. If the problem cannot be resolved, the cartel will fall apart." This is what happened with OPEC in 1986 when Saudi Arabia, tired of cheating of other OPEC members, who increased their market shares, decided to punish them and began producing at full capacity (Yergin, 1991). Similar failure followed an attempt of OPEC and some non-OPEC countries, such as Russia, to raise oil prices in 2016 (Worstall, 2016).[8] *Is it possible to avoid the incentive for cheating in cartels*?

Incentive compatibility. A possible mechanism for avoiding the cheating problem may involve financial commitments of all members of the agreement. For example, if an agreement is subject to annual renegotiation, all the members lock some assets in a reliable third-party financial institution for one year (security or warranty deposits), which is a regular practice for risky operations. The assets should be proportional to the current market shares of the participants, and each asset equals a possible gain of the correspondent participant in the case of this participant's cheating, assuming that other members keep to the agreement. Then, in the case of cheating, the financial institution reallocates the asset of the cheating member among other participants proportionally to their shares. Under such a commitment, every member knows that nobody has an incentive for cheating. A practical realization of such an agreement requires, of course, full transparency of the sales.

Conclusion. The short-run behavior of iron ore price is highly dependent on oil price and variations in supply and demand, and is very difficult to predict. There are strong chances that the iron ore price will remain highly volatile with a low average in the long-run. The dependence on the price of oil and the corresponding volatility can be reduced by a gradual shift of iron ore sellers to non-fossil-fuel transport. This shift can be facilitated by the public policy regulations, offered in Ali et al. (2017) if this approach dominates the "modestly optimistic perspective" offered in Tilton et

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[7] Chimni (1987) provides a fundamental research on legal issues of international commodity agreements.

[8] For the steel industry, Malanichev (2015) claims that state-run cartelization would benefit the industry in all four scenarios considered in the paper. The scenarios are based on uncertainties in steel capacity utilization and raw material prices. This option, however, is difficult to implement due to the same free rider problem that was pointed out by Jones (1986) as the main obstacle for cartelization of the iron ore industry.

al. (2018). The latter approach relies mostly on market forces in the intergenerational distribution of nonrenewable resources. However, this approach also allows for a more stable iron ore price in the case of cartelization of iron ore sellers. Using the arguments of Jones (1986), which can be fortified by an incentive compatibility mechanism, the current situation in the iron ore market is quite favorable for coordinated actions of iron ore sellers.

References

Ali S.H., Giurco D., Arndt N., Nickless E., Brown G., Demetriades A., Durrheim R., Enriquez M.A., Kinnaird J., Littleboy A., Meinert L.D., Oberhänsli R., Salem J., Schodde R., Schneider G., Vidal O., Yakovleva N. (2017) Mineral Supply for Sustainable Development Requires Resource Governance. *Nature*, 543, 367–372.

Bazhanov A.V. (2015) Inefficiency and Sustainability. *Resources Policy*, 45, 210–216.

Bazhanov A.V. (2008) Sustainable Growth in a Resource-Based Economy: the Extraction-Saving Relationship. *MPRA Paper* No. 23299.

Berry G., Cooper S. (2011) Metal Magnifier: Suspicious Mind. *Barclays Capital Equity Research*, 24 Aug., 1-65.

Brooks L. (2011) Long-term Outlook for Iron Ore. In: *CRU Presentation for EU Iron ore Conference*, 10 Oct.

Bussitil M. (2011) West Africa: The New Iron Ore Province. *J.P.Morgan Australia Equity Research*, 09 Dec., 1–85.

Cashin P., McDermott C., Scott A. (1999) Booms and Slumps in World Commodity Prices. *IMF Working Paper* WP/99/155, International Monetary Fund.

Chimni B. (1987) *International Commodity Agreements: a Legal Study*. London; New York: Croom Helm.

Dasgupta P., Heal G. (1974) The Optimal Depletion of Exhaustible Resources. *The Review of Economic Studies*, 41, 3–28.

Dasgupta P., Heal G. (1979) *Economic Theory and Exhaustible Resources*. Cambridge: Cambridge University Press.

De Angele R.R. (2011) Iron Ore: Fundamentals in Favour of Suppliers, Raising Price Forecasts across the Curve. *J.P. Morgan Latin America Equity Research*, 1–13.

Desta M. (2010) OPEC Production Management Practices under WTO Law and the Antitrust Law of Non-OPEC Countries, *Journal of Energy & Natural Resources Law*, 28(4), 439–463.

Gaudet G. (2007) Natural Resource Economics under the Rule of Hotelling. *Canadian Journal of Economics*, 40(4), 1033–1059.

Hamilton J. (2009) Causes and Consequences of the Oil Shock of 2007-08. *Brookings Papers on Economic Activity*, Economic Studies Program. Brookings Institution, 40(1), 215–283.

Hardin G. (1968) The Tragedy of the Commons. *Science*, 162(13), 1243–1248.

Hart R., Spiro D. (2011) The Elephant in Hotelling's Room. *Energy Policy*, 39, 7834–7838.

Hotelling H. (1931) The Economics of Exhaustible Resources, *Journal of Political Economy*, 39, 137–175.

Humphreys, M., Sachs, J., Stiglitz, J. (Eds.) (2007) *Escaping the Resource Curse*. Columbia University Press.

Jones A. (1986) Prospects for an Iron Ore Cartel. *Resources Policy*, 12, 103–115.

Kilian L. (2009) Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review*, 99(3), 1053–1069.

Krautkraemer J. (1998) Nonrenewable Resource Scarcity. *Journal of Economic Literature*, 36(4), 2065–2107.

Malanichev A. (2015) Contemplation of Global Steel Industry Future Using Scenario Approach. *Mineral Economics*, 28, 53–63.

Manthy R. (1978) *Natural Resource Commodities – A Century of Statistics*. Johns Hopkins Univ. Press, Baltimore.

Newbery D., Stiglitz J. (1981) *The Theory of Commodity Price Stabilization: a Study in the Economics of Risk*. Oxford: Clarendon Press; New York: Oxford University Press.

Potter N., Christy F.T. (1962) *Trends in Natural Resource Commodities: Statistics of Prices, Output, Consumption, Foreign Trade, and Employment in the U.S., 1870-1973*. Johns Hopkins Univ. Press, Baltimore.

Pustov A. et al. (2013) Long-Term Iron Ore Price Modeling: Marginal Costs vs. Incentive Price. *Resources Policy*, 38, 558–567.

Radetzki, M., Wårell, L. (2017) *A Handbook of Primary Commodities in the Global Economy*. Second ed. Cambridge University Press, Cambridge, UK.

Ramsey F. (1928) A Mathematical Theory of Saving. *The Economic Journal*, 38(152), 543–559.

Sen B., Ercan T., Tatari O. (2017) Does a battery-electric truck make a difference? – Life cycle emissions, costs, and externality analysis of alternative fuel-powered Class 8 heavy-duty trucks in the United States. *Journal of Cleaner Production*, 141, 110–121.

Slade M. (1982) Trends in Natural-Resource Commodity Prices: An Analysis of the Time Domain. *Journal of Environmental Economics and Management*, 9, 122–137.

Smith J. (2009) World Oil: Market or Mayhem? *Journal of Economic Perspectives,* 23(3), 145–164.

Solow R. (1974) The Economics of Resources or the Resources of Economics. *The American Economic Review,* 64(2), 1–14.

Tilton J.E., Crowson P.C.F., DeYoung J.H., Eggert R.G., Ericsson M., Guzmán J.I., Humphreys D., Lagos G., Maxwell P., Radetzki M., Singer D.A., Wellmer F.W. (2018) Public policy and future mineral supplies. *Resources Policy*, 57, 55–60.

Tonks A., Blanch F. (2011) Iron Ore: Prices Up, Volume Down. *Merrill Lynch Bulk Strategist* 07, Jun., 3–6.

Wårell L. (2014) The Effect of a Change in Pricing Regime on Iron Ore Prices. *Resources Policy*, 41, 16–22.

Wårell L. (2018) An Analysis of Iron Ore Prices During the Latest Commodity Boom. *Mineral Economics*, 31, 203–216.

WCED (1987) *Our Common Future*. London: Oxford University Press.

Worstall T. (2016) Now OPEC Faces the Problem of All Economic Cartels: Enforcement. *Forbes / Opinion/ Economy.* https://www.forbes.com/sites/timworstall/2016/12/01/now-opec-faces-the-problem-of-all-economic-cartels-enforcement/#4c0c4f648bee (Accessed 12 July 2018).

Wu J., Yang J., Ma L., Li Z., Shen X. (2016) A system analysis of the development strategy of iron ore in China. *Resources Policy*, 48, 32–40.

Yergin, D. (1991) *The Prize: The Epic Quest for Oil, Money, and Power.* Simon & Schuster.

Zhang W., Lawell C. (2017) Market Power in Nonrenewable Resource Markets: An Empirical Dynamic Model. *Land Economics*, 93, 74–86.