Resources Policy 39 (2014) 134–143

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Trends and developments in long-term steel demand – The intensity-of-use hypothesis revisited ☆

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ARTICLE INFO

Article history:
Received 26 January 2010
Received in revised form
19 December 2013
Accepted 19 December 2013
Available online 14 February 2014

JEL classification:
Q32
L61
C33

Keywords:
Intensity-of-Use
Steel demand
Economic growth
Panel unit root
Panel cointegration

ABSTRACT

Considering the past few years rapid increase in the demand for minerals and metals, mainly stemming from the strong economic growth in China and India, an understanding of the historical development of steel demand is of importance. The purpose of this paper is to analyze the trends and developments of steel consumption in the world by applying the so-called Intensity-of-Use (IoU) method. The empirical analysis is performed using steel consumption and GDP (in constant 2005 US Dollars) data for 61 countries over 42 years. The results show that the IoU hypothesis does not hold for the whole panel, but when dividing the sample into three income groups we find that the IoU hypothesis holds for the Middle income group, indicating that the countries in this income group have experienced the move from an industrialization phase towards a more service based economy in the time period investigated. However, when taking into account time series properties and applying panel unit root tests, the variables are confirmed as non-stationary. A panel cointegration test shows further that the variables are cointegrated, and an ECM model has been performed to test the IoU hypothesis. The results confirm that the IoU hypothesis holds for the Middle income group. Regarding the estimated turning point this is identified at a GDP per capita level of about 19,000 US. There are thus many countries that are far from the level of GDP per capita when steel IoU starts to decline. However, conclusions regarding the turning point should be made with caution.

Introduction

After the Second World War the consumption of metals increased rapidly, due to large investments in many developed countries to re-build their economies after the war. This rapid increase in metal consumption led to a concern about the supply of metals, and a fear of early depletion (see e.g., Labson, 1997). However, in the 1970s, the rate of the consumption of metals began to decline, mainly caused by the oil crises and a general decline in world economic growth. The metals market is known to be responsive to booms and recessions in the general economy, which is why the decline in metals consumption at first was believed to be temporary. However, the decline of the growth in metal demand turned out to be long-lasting (Radetzki and Tilton, 1990).

One possible explanation for this phenomenon was given by the Intensity-of-Use (IoU) hypothesis, first introduced by the International Iron and Steel Association (now World Steel Association) but popularized in Malenbaum (1973, 1978). According to the IoU hypothesis the intensity of metal use depends on the economic development in a country. The relationship between steel consumption and economic growth is however not believed to be linear. The reason for this is that the quantity of metals required changes over the development cycle of an economy. In relatively poorer countries, high economic growth is often related to an industrialization phase, which implies high growth in mineral consumption. When the economy matures the growth in metal consumption declines as the service sector grows. This sector demands less material, therefore, the intensity of use of metals first slows down and then starts to decline when GDP per capita increases. The intensity of use curve has thus an inverted U-shaped form. The level of GDP per capita where the intensity of use starts to decrease is often referred to as the peak (Radetzki and Tilton, 1990).

Steel is regarded to be one of the most important and useful metals. The industrial revolution in China and India has had a major impact on mineral raw material demand and has contributed to the rapid increase of the growth in metal consumption. The consumption of steel is no exception (Humphreys, 2007). The major impact these countries have on the steel market makes it interesting to investigate if these countries are close to the peak of the intensity of use curve. What is the shape of the IoU curve, and at which GDP level does steel use peak? Are China and India close

☆An early version of this paper was presented at Securing the Future and 8th ICARD conference, June 23–26, 2009, Skellefteå, Sweden.

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0301-4207/$ - see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.resourpol.2013.12.002

to the peak of the IoU curve? These are questions that are addressed in this paper.

The purpose of this paper is to investigate the relationship between intensity of steel use and economic development, and empirically test if this relationship exhibits an inverted U-shape. The IoU hypothesis has been tested on several metals, for example aluminum, copper, lead, steel, zinc and nickel (Tilton, 1990; Roberts, 1996; Canas et al., 2003; Guzmán et al., 2005; Focacci, 2005, 2007; Warell and Olsson, 2009; Jaunky, 2012). However, most of the studies does not account for time series properties of the data. This paper will examine steel demand and GDP per capita data for 61 countries over 42 years. An econometric approach to analyze steel consumption will be applied using both Ordinary Least Squares regressions, and time series econometrics (panel unit root and panel cointegration analysis) where an error–correction based model of IoU is analyzed. Statistical data on steel consumption (collected from World Steel Association) as well as GDP and population data (from the United Nations and World Bank respectively) for 61 countries between 1970 and 2011 is used.

The paper proceeds as follows. Section "Metal demand history" describes the relevant background such as metal demand history and recent developments on the steel market. Section "Intensity of use hypothesis" presents the theory of intensity-of-use, and discusses earlier studies of this phenomenon. In Section "Results intensity of use" the empirical results are presented and analyzed. In Section "Time-series properties of the data" the time series properties of the data is discussed, and results when considering this is presented. In the final section some overall conclusions are made and implications are discussed.

Metal demand history

In the years that followed after World War II the industrial development caused the consumption of metals to increase rapidly, and so did the consumption and production of steel. The regions/countries that led the growth in the steel market were Western Europe, North America, Japan and former Soviet Union (Labson, 1997). Many countries were had experienced that industries were destroyed by the war, especially in Eastern Europe, and the need to rebuild the economies and industries were thus high. The increase in metal consumption during this time period led to concerns about the supply of metals and a fear of early depletion. However, in the beginning of the 1970s the growth rate in the consumption of metals began to decline.

The metal market is known to be responsive to booms and recessions in the general economy (Tilton, 1990). The two oil shocks that occurred during the 1970s affected the overall economy, and hence the consumption of metals. The per capita metal consumption declined significantly after 1973 and again after 1979. The metal prices were also affected by the two oil shocks and the metal prices rose considerably both around 1973 and 1979. This rapid increase in metal prices is most likely one of the reasons why metal consumption decreased (Tcha and Takasina, 2002). As the world economic growth declined during this period, the decline in metal consumption was at first believed to be temporary. However, the decline of the growth in metal demand turned out to be long-lasting (Tilton, 1990).

In the 1980s and 1990s many believed that most metal industries, among those the steel industry, had expanded as much as it could and thus that steel IoU would not continue to rise (Humphreys, 2007). The increase in oil prices and macroeconomic policy implementations were reasons for the decline in growth of metal consumption traced to the 1970s. The first decline in 1973 was mainly caused by decline in economic growth and that the intensity of metal use fell in the developed countries. The second decline was caused by a new decline in economic growth and further falls in intensity of metal use in the developed countries together with a decline in economic growth also in the developing countries, partly because of the international debt crisis (Tilton, 1990).

Recent developments of the steel market

The steel market, as many other metal markets, has during the last decades undergone big regional changes, and these changes are still in progress. Steel consumption, production and trade patterns have changed dramatically and the new situation affects the whole world. Regions such as China and India currently gain shares on the steel market, and now lead the growth. At the same time industrialized regions, previously dominant, such as the European Union, North America and Japan declines. However, they continue to be important operators on the steel market (Labson, 1997). This geographical shift in the steel market is caused partly by faster economic growth and partly by increased intensity of use in developing countries. It is obvious that developing countries and especially the emerging developing countries are the new engines of the growth in metal demand (Tilton, 1990).

The overall economic growth was exceedingly high during the metals boom that ran from 2003 to 2008 (Humphreys, 2010). The most important factors that have influenced this unusually high economic growth are globalization and the positive development in China and other developing economies. The steel market has been a part in this expansion (OECD, 2004, 2008). The steel consumption in the world has increased considerably, and has accelerated rapidly since 2002, as can be seen in Fig. 1 (steel consumption presented in thousand metric tons of crude steel equivalent).

The growth in steel consumption rates in low and high income countries have thus moved in opposite directions (Choe, 1991).

China′s demand for industrial raw material is mainly the cause of the metal boom that took off in 2003 (Humphreys, 2010). China′s rapid steel consumption growth during the last years can be seen in Fig. 2 (expressed in thousand metric tons of crude steel equivalent). This figure thus illustrates that most of the increase in world steel demand stems from China. This means that China′s contribution to steel consumption has led to an increase in the world consumption of steel. In 2011, China′s share of world steel demand was almost 44 per cent, i.e., almost half of the apparent steel demand in the world stems from China. Along with China, India has increased their metal demand as well. The reason is an increase in per capita income together with an increase in the domestic consumption. There are, however, many differences between the two emerging economies. The intensity of metal use is unusually high in China whereas the increased consumption of metals in India has followed the GDP growth (Humphreys, 2007). This is confirmed when looking at India′s share of world

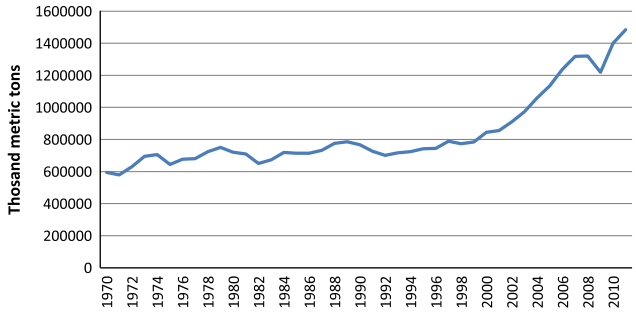

Fig. 1. World total apparent steel consumption, 1970–2011.
Source: World Steel Association (various years).