International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(2), 305-317.

Competitiveness of the Chinese Economy and its Link to the Global Energy Prices Development

Peter Baláž[1], Lukáš Harvánek[2*]

[1]University of Economics in Bratislava, Faculty of Commerce, International Trade Department, Slovakia, [2]University of Economics in Bratislava, Faculty of Commerce, International Trade Department, Slovakia. *Email: l.harvanek89@gmail.com

ABSTRACT

The article analyses the relationship between competitiveness of the Chinese economy and the prices of energy resources. Based on theoretical framework of the most important economists and international organizations in the field of research, the authors analyze statistical data concerning Chinese competitiveness embodied in real effective exchange rate and oil, natural gas and coal global prices using basic correlation and regression analysis and advanced quantitative methods (Granger causality test, cointegration analysis). Secondly, the authors choose the producer prices index as next indicator of competitiveness of the Chinese producers, as the one of the key inputs determining final selling prices are prices of energy carriers. By comparing these two indicators to global energy prices reflected by indexes or in real prices, the authors analyse to what extent these indicators affect each other and what are the ultimate implications for competitiveness of the Chinese economy.

Keywords: Chinese Economy, Competitiveness, Energy Resources, Energy Prices
JEL Classifications: F110, F14, F15

1. INTRODUCTION

Thanks to its grandiose economy and political reforms which Peking has undertaken since the end of 1990s, the Chinese economy has become one of the most influential global players. It has grown by more than 10% and experienced more than double export growth during the last three decades. Concerning the nominal gross domestic product (GDP), it became the second largest economy in the world and the first in terms of exports of goods and services. Both indicators represented also a significant manifestation of the growth of country's international competitiveness of the country. Based on that, China became one of the key importers of raw materials, machinery and equipment. Rapid growth of internal consumption and unique structural reforms, especially in construction of new infrastructure and its links with the world have further increased the consumption of all types of resources. China's suppliers became highly dependent on its demand, and together with the growing globalization the entire world economy experienced increasing interdependency with the development of the Chinese economy.

Particular importance has been attributed to energy supplies, since China is the second largest consumer in the world and of which the strategic importance for energy resources in the world is undisputed. Renowned specialists and authors dedicated less attention to these trends and arising risks, especially for less developed countries which are mostly the main suppliers of raw materials. The situation has changed during the last years and this started to be implemented in economy policies around the globe, as the slowing economic growth of this Asian economy, which since the end of 2014, has firstly started to be shown only in the field of slowing demand for primary resources and later for industrial products as well[1].

1 Chinese import decrease by about 20% y/y in July 2015. For the first seven months of the year 2015, crude oil, coal, irone ore and gold imports from Australia decreased by $15 billion, that represents approximately 1% of the GDP of given country. It is forecasted, that this number could reach $35 bilion till the end of the year 2015, approximately 2.4% of GDP. Affected is also trade in Indonesia, New Zeland, Malaisia and others (In: Merrill Lynch and World Bank, 2015).

Rapid economic growth of the PRC resulted in an enormous consumption of all types of energy resources. In 2000, China was still an important crude oil exporter, however, it became the second largest consumer and importer of this commodity in the world during the next decade and ultimately it became the world's largest energy consumer in 2012 (EIA, 2013). Energy mix of the country consists mainly of oil, natural gas, coal, nuclear energy and rapidly growing share of renewable energy sources. In 2013, coal contributed to the country's total energy consumption by 67%, crude oil (17%) and natural gas (5%)[2]. Fossil fuels covered over 90% of the country's energy consumption. This ratio confirmed the country's high dependence on fossil fuels, but also a low diversification of energy mix of the biggest air polluter in the world that China has become (Chart 1).

As can be shown on the Chart 2, the China overcome all the world key energy consumers and became the leader in this field during the last 15 years.

The increasing role in China energy market can be proven by the situation in the coal market, as the coal consumption highly correlate with the global coal energy prices development (Chart 3).

Crude oil is irreplaceable in the Chinese energy mix. Although in terms of volume of specific consumption, it has surged into second place behind coal, it is the key source in transportation without having any equivalent alternative. Since China has no sufficient reserves, it will be increasingly dependent on its imports. According to the estimates, under current consumption its proven reserves will be depleted in approximately 12 years (Table 1). According to the EIA, the global crude oil production will be relatively stable during the next decade, however, another increase of oil production and consumption should be expected, if the further rapid growth of the Chinese economy supported by growing income of 1.3 billion population continues.

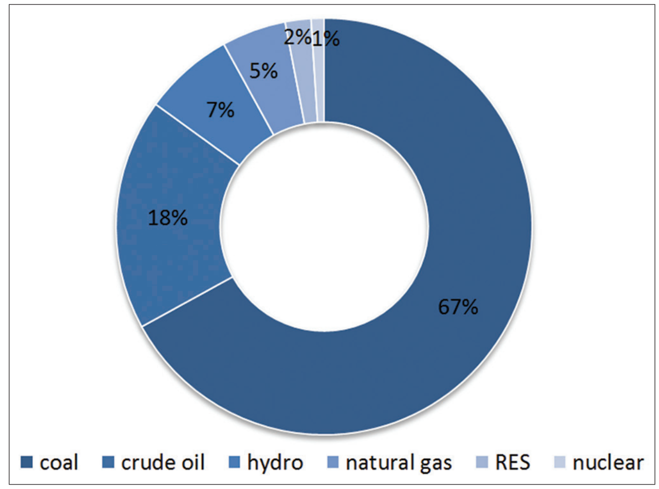
Assuming that China with the lower level of GDP per capita ($8,466 in 2012) should reach a level of GDP per capita, for example at the EU average ($32,642), energy consumption in the value terms should increase four times (World Bank, 2015). This assumption with a high probability of fulfillment would mean to the world that this increase of GDP will be transformed into a rapid growth of Chinese people demand based on their need, consequently increasing the demand for durable goods, what will ultimately lead to an enormous growth in energy demand[3].

Chinese crude oil reserves compared to coal (13.8% of world reserves) are only at the level of 1.1% of the global, even with the volume of 18.1 billion barrels being the highest from the region of East Asia and Pacific. Firstly, China was able to avoid the global financial crisis (2007-2008) as well as subsequent debt crisis that

2 For example, the EU energy mix consists of oil and oil products (34%), natural gas (23%), solid fuels (17%), nuclear energy (14%), RES (11%) and hydro (1%). (In. DG Energy, 2015).

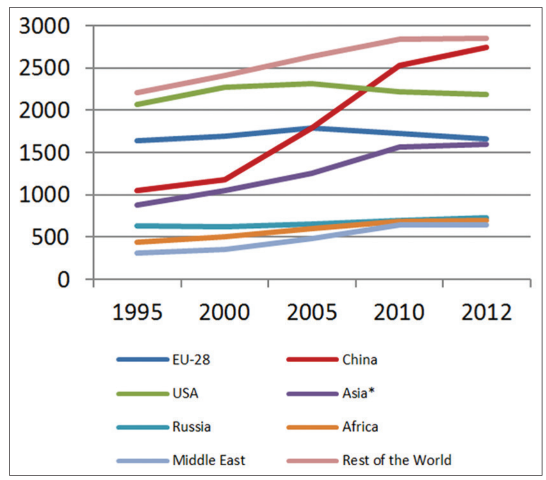
3 In 2014, there were 21 million cars sold in China, what constitutes nearly one third of the global sales. Every year, the number of sold cars in China incrases by about 20% and it is anticipated, that this trend will continue until 2020.

Chart 1: Chinese energy mix (2013)



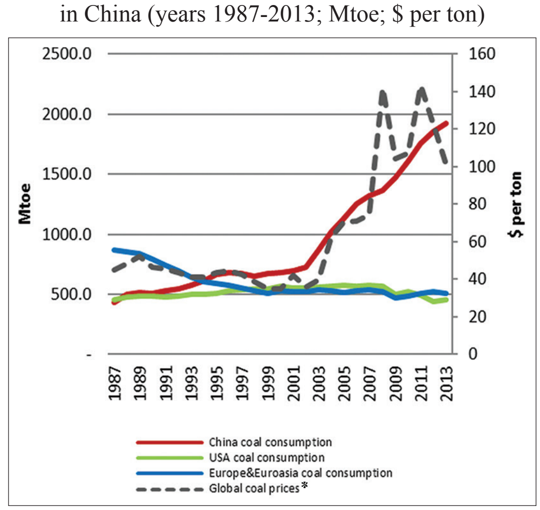
Source: Author's calculations based on data from: EIA, 2015

Chart 2: Development of the global energy consumption (1995-2012, Mtoe)



*Excluding China. Source: Author's calculations based on data from EU Energy Figuers, Statistical Booklet, 2014

Chart 3: Correlation between the global coal prices and consumption in China (years 1987-2013; Mtoe; $ per ton)



*The global coal prices = Average coal prices in the northwest of Europe, US, Japan and Asia. Source: Author's calculations based on data from BP Statistics, 2014

Table 1: The share of the reserves, production, consumption and imports of fossil fuels of China on the global indices (2014)

Type of fossil fuel	Reserves*	%	R/P	Production	%	Consumption	%	Import	%
Crude Oil	2.5	1.1	11.9	211.4	5.0	520.3	12.4	309.2	6.1
Natural Gas**	3.5	1.8	25.7	134.5	39.0	185.5	5.4	58.4	5.8
Coal***	114500	12.8	30.0	1844	46.9	1962.4	50.6	118.4	25.0

R/P: Reserves to production ratio, *Coal-mil. Ton, **billion m^3, ***million ton of oil equivalent. Source: Author's calculations based on data from BP Statistical Review of World Energy, 2015

has paralyzed the Eurozone thanks to government support policies and the resulting high economic growth, however, consequently, Peking was forced to support its own growth through infrastructure financing and so called soft loans in total of approximately $1-1.5 trillion. Crude oil consumption in China thus increased during this period not responding to the effects of slowing global economy. In 2008, crude oil consumption was 7.817 million bpd, the following year it increased to 7.937 million bpd and gradually increased to 10.75 million bpd in 2013, which represented the 3.8-percent increase in comparison to 2010 (BP, 2014). Domestic production reached daily average level of 4.18 million bpd in 2013 with crude oil imports of 6.57 million bpd. According to the EIA, in 2013 China was the most dependent on oil supplies from Saudi Arabia (19%), Angola (14%), Russia (9%), Iran (8%), Oman (9%), Iraq (8%), Venezuela (6%) and Kazakhstan (4%).

PRC economic expansion through dynamic industrialization is based on three key pillars, namely: A huge amount of available cheap labor, high inflows of foreign capital and technology and cheap energy, which is in the country yet available mainly due to the share of coal in its overall energy mix. Coal accounts for nearly 70% of energy consumption, so its good availability and low prices are critical to current and future economic growth and energy security. Coal market developments are not important only for the Chinese economy. Behavior of China, with implication on coal markets, is a decisive factor in the development of the situation in the global coal market ever since, since China consumes more than half of the total global consumption and imports nearly half of the global imports of this commodity. This significantly affects all actors of the global economy, and especially coal exporters.

China has the third biggest coal reserves in the world, however, with current robust production of 1.844 million ton of oil equivalent (46.9% of annual global coal production); the reserves would be depleted in 30 years (Table 1)[4]. China became a net coal importer in 2009, while before it even exported it. The markets reflected these developments in growing prices and important coal exporters, mainly Australia and Indonesia (which cover half of Chinese coal imports), Russia and Mongolia significantly increased investments in its production.

In terms of China's strategic intentions, it is not possible to avoid energy position and the importancy of natural gas. Consumption of this energy input in China has grown rapidly in the current years even though its share in the energy mix is low, at the level of approximately 4%. This low share is compensated by the high increase in consumption of all energy resources and the relatively high cost of production and transportation, which ultimately leads to a higher coal consumption. In 2013, the production of natural gas in China reached 134.5 billion m^3 with consumption in amount of 185.5 billion m^3, and the remaining volume was imported. In 2007, China became the net importer of this commodity. In 2013, the country covers nearly half of the imported natural gas through the supplies of liquefied natural gas (LNG), mainly from Australia (30%), Indonesia (17%), Qatar (19%), Malaysia (13%), Yemen (7%), Nigeria (6%), Trinidad (2%), Russia (2%) and Egypt (2%). Natural gas proven reserves stands at the level of 3.5 billion m^3 (1.8% of the total global proven reserves). With the current production, China could produce natural gas for the next 12 years.

The development of new technologies for extracting unconventional natural gas for significantly lower cost than in the past has substantially changed the strategic position of oil and gas and can not be lose sight of[5]. It is expected that the share of unconventional natural gas on production in China will increase significantly too as its unconventional reserves are estimated at the level of 1.257 billion m^3, which is more than ten times the conventional gas reserves and is estimated to be the largest in the world[6]. Due to the significant growth in demand for transport fuels it is expected that the import of crude oil will increase significantly (Skeer and Wang, 2007). Since not only the transport sector but also other sectors will increase the demand for energy inputs, the aim of this paper is thus to examine the relationship between the global prices of energy carriers and their impact on competitiveness of the Chinese economy.

2. THEORY DEVELOPMENT

Since China is a country of which economy is directively driven by the state, its development is influenced by algorithm of direct energy price regulation. The entire system has undergone several phases of development, from strict state regulation in the 1980s, through two-tier pricing system to almost complete liberalization, under which the domestic oil prices are based on reference prices in the world markets (Hang and Tu, 2007). Oil is also a benchmark for other fossil fuels pricing. The reason for the relatively low increase in fuel prices was the fact that until the turn of the millennium most of them were even exported by China. It became net oil

4 The US has it at its present level of production for more than 266 years and Russan R/P ratio is 452 years (BP, 2014).

5 Outlok for natural gas market in US was changed dramaticaly due to the development of new technologies enabling hydraulical fracturing of the shales. US adapted to those developments by the new energy security strategy. New technologies of extracting natural gas and crude oil have changes the situation in the natural gas markets which does produce shale gas, as it is not economicaly feasible. Regrading China, Peking acquire Canadian company Nexen with those technologies for $15 billion in 2013.

6 At second place stands the US (862 billion m^3), Argenitna (774 billion m^3) a Mexico (681 billion m^3).

importer in 2001. The relation between the development of oil prices and other energy carries with other economic fundamentals started to grow on importance during the oil price shocks at the end of 1970s. The sharp rice in its price was considered as exogenous inflationary shock (Pierce and Enzler, 1974) or in the form of shifting the wealth from importing to exporting countries through amendments to the"terms of trade"(Hickman et al., 1987). The oil price growth also affected the development on the supply side (Rasche and Tatom, 1977), as energy constitutes the basic input in primary production. The price increase thus could be interpreted as a result of a lower availability of basic inputs for production, what could lead to overall growth of production factors. This consequently brings the decline of production and productivity (Lescaroux and Mignon, 2009) and ultimately the overall competitiveness of the given country (Baláž and Londarev, 2006). Other connection can be seen in the growth of the risks arising from such developments for international markets, as these have far-reaching implications for other segments of the world economy (Jamborová and Pavelka, 2013).

The inflationary shock resulting from the increase of consumer and producer prices (depending on the share of oil in the consumer basket) negatively affects the production costs in a country. Those are the important parts of every indicator concerning the national competitiveness, and are reflected into the real effective exchange rate (*REER*) development. When examining the development of the Chinese economy, *REER* is expressed by a comparison of RMB development with other key national currencies. As international competitiveness is not affected only by the exchange rate movements, but by the prices on domestic and foreign markets as well, by adding the price development into a nominal effective exchange rate, we get the *REER*, which offeres a relatively good picture regarding the competitiveness of the given country. *REER* as a indicator of competitiveness is used in research studies at IMF (Bella et al., 2007), the European central bank or the European Commission in comparison to the competitiveness of the EU Member States among themselves or the EU countries with the third countries (EC, 2015). Prices and production costs were used as inputs. *REER* is thus calculated as follows:

$$REER_t = \frac{NEER_t \times CPI_t}{CPT_t^{(foreign)}} \tag{1}$$

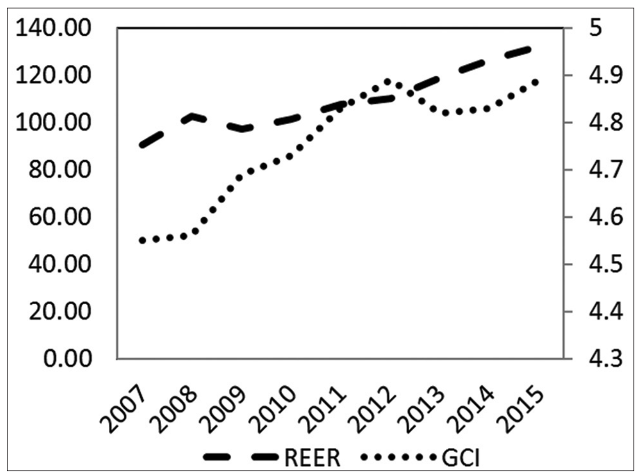
Where,

- $REER_t = \prod_{i=1}^{N} S(i) w^{(i)}$ - Nominal effective exchange rate of examined country
- $S(i)_t$ - Nominal bilateral exchange rate
- $CPT_t^{(foreign)} = \prod_{i=1}^{N} CPI(i)_t^{w(i)}$ - Geometrically weighted average of *CPI* of business partners.

Since the aim of this paper is not to calculate *REER* of the Chinese currency, but to use it as a proxy for benchmarking competitiveness, the authors based their calculations on the databases of the World Bank and the Federal Reserve System (FED). Both regularly calculate the *REER* on a monthly basis. Since the FED has provided monthly figures since 1994, the authors obtained a relatively objective statistical sample (257 observations), which was used as a "benchmark" when examining the impact of the exchange rate on the competitiveness of the Chinese economy.

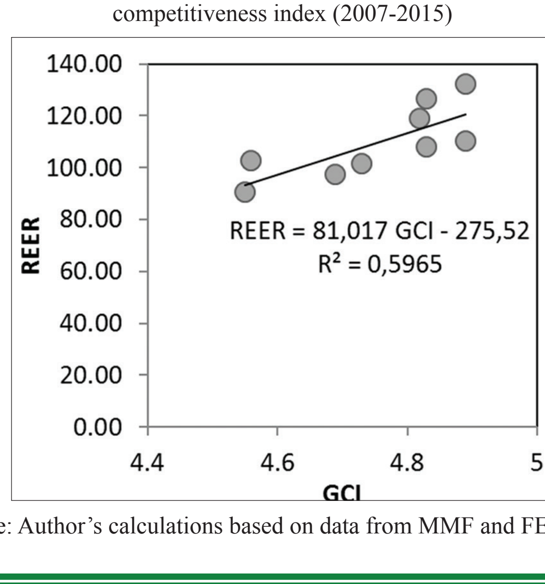
The appropriateness of choosing the *REER* has been tested by analyzing the relationship of the *REER* with the global competitiveness index (GCI) compiled by the World Economic Forum (WEF). Based on a comparison of the time series of China's *REER* developments and historical development of the GCI for the given country, a correlation of the two aforementioned indicators can be observed (Chart 4). In this case it is the inverse phenomenon whereas the increase in the *REER* index represents a decline of competitiveness of the country and on the other hand, increasing its GCI indicates growth. The interdependence of these two variables proved us presented empirical analysis by using coefficient of determination. As shown in Chart 5 and Annex 1 as the results of research (R^2), there is a relatively strong statistical dependence at the level of 59.65% ($R^2 = 0.5965$). Although GCI and *REER* are statistically deepened to almost 60%, looking at methods of

Chart 4: Relation between *REER* (y-right) and global competitiveness index (y-left) (2007-2015)



Source: Author's calculations based on data from MMF and FED

Chart 5: Regression analysis between *REER* and global competitiveness index (2007-2015)



Source: Author's calculations based on data from MMF and FED calculating the GCI, the results are shown in Chart 4 are negligible having in mind the meteorology using to determine the GCI. GCI indeed includes broad range of comprehensive assessment factors of determining competitiveness (institutions, infrastructure, education, healthcare, labor market effectiveness, financial market development, innovations, etc.) and its objective measurement is difficult. Often it relies only on parameter estimation and its objectivity is low. On the other hand, *REER* is indeed specifically profiled indicator comparing the effect of exchange rate of the given country with the exchange rate of key trading partners and development of domestic inflation in comparison with business partners, but clearly quantifiable and therefore represents a more objective indicator of competitiveness.

In the presented research, the authors analyse the relation of the *REER* and global prices of energy carries including crude oil, natural gas and coal, while the IMF monthly data are available since 1992. Another indicator complied by this institution and used in presented analysis is oil price index, which consists of a simple average of three key types of oil: Brent (Europe), West Texas Intermediate (South and North America) and Dubai Fateh (Asia). Those data are available since 1980, while the base year for both indices is 2005. IMF initially calculated the price of individual commodities in $ and SDR (times series based on the currencies from the year 2005). When indices include more variables, their calculation is based on weighted average of individual items price indices, and their weight in the index is derived from their relative share on the global trade with given commodity, in accordance with the UN Comtrade database (IMF, 2015). Another indicators examined in the research model are global oil prices, which are a simple average of three spot oil prices (Brent, WTI a Dubai Fateh) and global natural gas prices calculated as the simple average of three prices (the price at the border in Germany, the spot price on the terminal Henry Hub in Louisiana and Indonesian LNG price in Japan). All based on IMF data. For further fossil fuels, the analysis focuses on coal (Australian cooking coal with the sulfur content of <1%, FOB Newxastle/Port Kembla, $/per metric ton).

One other indicator of competitiveness is the price level among producers. Companies, which are able to sell its production at lower prices may gain comparative advantage over their global competitors. However, price competitiveness is influenced by a number of other important factors, in particular the level of fixed and variable costs. Energy prices as one of the most important inputs into production necessary to be monitored for securing or increasing competitiveness (Baláž, 2013). Thus, the indicator used in this analysis to quantify competitiveness was producer price index (PPI), through which the average change of prices of the basket of representative goods and services sold by producers is measured. PPI consists of three sub-indexes (finished goods, semi-finished goods and raw materials or commodities) and is used as an indicator of inflation or deflation as well (US Department of Labor, 2015).

The relationship between energy prices and the Chinese economic indicators has not addressed many authors yet among those, as one of the most important should be mentioned the research analyzing the relationship between the energy consumption in industry and the GDP development in Shanghai between 1952 and 1999 using modified version of Granger causality (Wolde-Rufael, 2004). This research indicated that there is unilateral Granger causality of coal, electricity and overall energy consumption and GDP, but there are no ones that would be dedicated to oil consumption and its relation to the real GDP of the country. Another study, by using cointegration theory, examined the relationship between the electricity consumption and the real GDP in China during the years 1978 and 2004. The estimated results indicated that the real GDP and the energy consumption in China are cointegrated and there is an unilateral Grange causality between the electricity consumption and the real GDP, but not vice versa (Yuan et al., 2007).

In his study, Lin Mu (Chen and Hamorui, 2009) pointed out what implication has the energy prices increase on different sectors of the Chinese economy. It concluded that it not only influenced the economic growth, but accelerated structural changes in the industries. The impact of coal price development is two to three times higher than the same development of crude oil. This finding could also be applied to sectors requiring less energy inputs. According to other study (Lescaroux and Mignon, 2009), significant fluctuations in oil prices caused the increase of consumer and producer prices, and also lead to an increase in interest rates, which with a certain delay has a negative impact on GDP growth, investment and consumption.

To determine the relationship between the development of global crude oil prices and the *REER*, the authors applied the method of Granger causality. In the past, causual relationship was applied mainly to the relationship between the energy consumption and the economic growth. Firstly it appeared in empirical analysis of Kraft and Kraft in 1978. This method is used to study the time series of consistent, whilst ensuring that the variable X (in our case the global crude oil price) affected the variable Y (development of *REER*) and that can be interpreted as the effect of the variable X. The impact between stationary time series is defined as Granger causality if lagged values of X enhance the ability to predict the current value of Y. Putting together such a model, it could explain the value y_t using lagged value of y_{y-k} and lagged value of x_{t-k}. Consequently, the hypotheses according to which the coefficients for x_{t-k} are zero were tested. In this case, it is referred as a null hypothesis when "*x* does not Granger cause *y*" (Zábojník, 2010). In contrast to the regression and correlation analysis, this model includes the trend of the previous years. By utilizing the model, our analysis could be enriched by whether the increase or loss of competitiveness in current period is not influenced by the development of global energy prices from the previous years. The authors thus could identify to what extent is the competitiveness of Chinese economy affected by the development of global energy prices with the utmost precision. Several studies investigating this relationship led to contradictory conclusions (Kraft and Kraft, 1978; Barleet and Gounder, 2010).

Correlation, causality and the individual findings vary depending on the country, period under research or the methodology of used variables. Empirical reasoning of the causality direction, respectively, the intensity of its meaning remained controversial (Obadi and Korček, 2014). On the other hand, e.g., Eddrief-Cherfi and Kourbali (2012) declare implications of four eventualities that may arise in the relationship between energy consumption and economic development in the application to a case which is the subject of research (development of oil prices - OP and competitiveness developments - CD), this relationship can be expressed as follows:

- Unilateral causality from OP to CD
- Unilateral causality from CD to OP
- Zero causality
- Bi-directional causality.

In the case of unilateral causality from OP to CD, the country competitiveness expressed by *REER* is highly dependent on the development of global crude oil prices. The significant increase in oil prices translates into increased input costs and inflation in the country reducing its advantage over other countries. Unilateral causality leading from CD to OP suggests that the country's competitiveness is less dependent on global oil prices. It suggests that the country is able to adapt to fluctuations in world oil prices by diversification, reducing power consumption or switching to the production requiring less energy inputs. Bi-directional causality is known as a feedback hypothesis (Eddrief-Chefri and Kourbali, 2012) and indicates the interdependence of indicators development. Evidence of a lack of causality is also known as the hypothesis of neutrality.

3. METHODOLOGY

A number of distinguished experts devoted their work to the analysis of competitiveness and its quantitative expression. As a single factor theory, perhaps the most common method is the index of revealed comparative advantage, unit labor costs and *REER* (Balassa, Sieggel, Langhammer, Kaldor). The second group consists of multifactor methods (WEF, IMD). One of the key methods of empirical analysis that is used in this scientific paper and had the best potential to assess the causality between the competitiveness of the Chinese economy and the developmental trajectory of the international commodity (energy) markets is regression. The decisive parameter in this regard is the coefficient of correlation, which is determined by the formula:

$$r_{x,y} = \frac{S_{x,y}}{S_x.S_y} = \frac{\frac{1}{n}\sum(x_i - \overline{x}).(y_i - \overline{y})}{S_x.S_y} \tag{2}$$

The relatively high value of the correlation coefficient indicates that between the variables X and Y is a high mutual linear dependence, although it does not necessary mean that there is a high casual dependence between them as there may be other variable Z, wherein the variable Y is also linearly dependent. The degree of dependence of the two variables is determined by the coefficient of determination and the determination index. In our simplified model, variable Z was rejected.

Another method used in this analysis, was the Granger causality test which requires stationary time series. Testing the stacionarity is used by subtracting from autoregression model form both sides the value y_{t-1}, whereby the model is obtained in the form:

$$\Delta y_t = (\beta_1 - 1)\, y_{t-1} + u_t \tag{3}$$

Dickey-filler test (DF test) was used for testing the time series stacionarity, which compared tabulated value of τ with the estimated parameter δ and calculation of Student's statistics t_δ. The lower negative statistics t_δ means rejection of the null hypothesis and thus stacionarity of the series. When a null hypothesis of non-stationary is not rejected, the testing process can be repeated with higher-difference models, up until the null hypothesis is rejected. Consequently, the degree of integration of the time series is determined in relation to the degree of difference variable, when rejecting the null hypothesis of its parameters (Lukáčik and Baker, 2006). By utilizing the regression and stacionarity the Granger causality test could be applied. Methodically, it is based on the assumption that past events could determine the emergence of different current events, but this does not apply retrospective - Future events cannot cause the current ones. This causality therefore means that by receiving the historical value of one variable, we could get information which helps us to predict the other variable (Obadi and Korček, 2014). This idea could be expressed by a model consisting of two equations:

$$\Delta \ln HDP = a_1 + \sum_{i=1}^{m} \beta_i \ln HDP_{t-i} + \sum_{j=1}^{n} \delta_j \ln RZP_{t-j} + v_t \tag{4}$$

$$\Delta \ln RZP = a_2 + \sum_{i=1}^{m} \gamma_i \ln RZP_{t-i} + \sum_{j=1}^{n} \varepsilon_j \ln HDP_{t-j} + \mu_t \tag{5}$$

Where:

a_1, a_2 - Constants

v_t, μ_t - White noise

i, j - Number of delays

t - Time interval.

The null hypothesis (H_0) takes into the account the lack of causality during the test. If the coefficients ɗ and ε are statistically significant, the null hypothesis is rejected and the alternative hypothesis of the existence of Granger causality is accepted.

4. RESULTS AND DISCUSSIONS

4.1. Analysis of *REER* as Benchmark for Measuring Competitiveness

Within the first step of testing stacionarity, the two variables, in their initial form were examined, while H_0 at global prices and *REER* was accepted, i.e., the variables have "unit root" (not stationary), and therefore cannot be used in their current form (Annex 2). The result to reject H_0 was received at the significance level of 10%, 5% and 1%. To obtain stationary series, the variables were differentiated, while the stacionarity was tested again. DF test was used. In this case, the value t_δ for both variables reached a value lower than critical value tested on the significant level of 10%, 5% and 1%. H_0 is thus rejected; series are stationary and suitable for another testing. To choose the right delay of time series Akaike information criterion was chosen, where a lower value means a better number of delays. As shown in Table 2, the lowest level is received with the delay of 1 that is the best explanation for one of the variables can be obtained by the delayed of the second by 1, in our case by 1 month.

Analysis of the relationship between the development of China's competitiveness expressed by the *REER* and global energy prices by using Granger causality (with 1 month delay) has shown that prices development affects the Chinese competitiveness. This could be proven at the 0.05 significant level (i.e., with 95% confidence, P = 0.0753, H_0 rejected). However, the correlation was not confirmed in regards to opposite relationship, competitiveness does not influenc energy prices (P = 0.2229 > 0.05, H_0 accepted), as shown in Table 3. The relationship between the oil prices expressed in $ and the *REER* was also studied. In this respect there is a causality between the oil prices and *REER* (P = 0.0359, H_0 rejected), but this is not the case regarding the opposite relationship (P = 0.2613, H_0 accepted). When the relationship of global gas prices and *REER* was analyzed, no relationship was confirmed (P = 0.2470 and P = 0.4298, H_0 accepted). There was no causality between the coal prices and *REER* as well (P = 0.1047 and P = 0.4614). Unilateral causality was confirmed only in the case of crude oil index and *REER* (P = 0.0419).

To determine to what extent the *REER* is explained by variables (prices of oil, coal, gas) the regression analysis was used. It includes the determination of a mathematical model that would express the relationship with the highest confidence. Index of global energy prices, oil price index, oil prices in $, gas prices in $ and coal prices in $ represented explanatory variables and the *REER* represented explaining variable. Based on the findings presented in Table 4, it can be concluded that the variability of the *REER* explained by changes in global energy prices reached the level of 31.95%. Consequently, the relationship can be set as *REER* = 0.118x 83.539 + Energy Index, which means that any increase of the index by 1 will cause an increase in the *REER* by 0.118 points. Obtained was approximately the same dependence (31.48%) when the relationship of oil price index and the *REER* was analyzed (Table 4 and Annexs 3.1-3.5, Chart 6). Looking at individual energy prices expressed in $, about the same level of dependence was obtained as for the index of energy prices, oil price index, with the exception of the coal prices, as the *REER* variability in this case was only 18.88%. The explanation is that the foreign trade in coal is mostly restricted, since about 85% of coal is consumed in the country of its production (IEA, 2014).

Whereas individual variables do not affect the *REER* individually, but they collectively influence the development of competitiveness, a model examining the impact of these three variables on the *REER* can be created. As confirmed by the data in Table 4 and Annex 5 the price of oil, gas and coal explain the variability of *REER* (36.15%). This is approximately the same level as in the previous measurement. This dependence is also apparent from following equations:

$$REER = 1.4694 \text{ Crude Oil (\$)} - 87.93 \quad (6)$$

$$REER = 2.4577 \text{ Natural gas (\$)} + 79.963 \quad (7)$$

$$REER = 0.1611 \text{ Coal prices (\$)} + 85.34 \quad (8)$$

At the significance level of 1%, or with a 99 percent confidence level, the similar coefficient of determination can be confirmed for the coal and gas prices as well. Regarding oil prices, the significant level is lower (calculation 1, 2, 3). By removing the trend from the data (Table 4) even a lower coefficient of determination at the level of 0.048 (4.8%) was confirmed.

Table 2: Testing the number of delay in GC

Number of delay	Akaike information criterion
1	10.13244
2	10.15228
5	10.23767
10	10.34267
20	10.59056
30	10.71982

Source: Author's calculations based on data from the program E-views. GC: Global competitiveness

Table 3: Granger causality between *REER* and energy prices (1994M1-2015M7)

Pairwise Granger causality tests				
Sample: 1994M01-2015M07				
Lags: 1				
Null hypothesis	**Observations**	**F-statistic**	**P**	**Finding**
DREER does not Granger cause DPRICESOIL	257	1.26731	0.2613	Accepted
DPRICESOIL does not Granger cause DREER		4.44892	0.0359	Rejected
DREER does not Granger cause DPRICESGAS	257	1.34643	0.247	Accepted
DPRICESGAS does not Granger cause DREER		0.62527	0.4298	Accepted
DREER does not Granger cause DPRICESCOAL	257	2.65202	0.1047	Accepted
DPRICESCOAL does not Granger cause DREER		0.54403	0.4614	Accepted
DREER does not Granger cause DOILI	257	1.36981	0.2429	Accepted
DOILI does not Granger cause DREER		4.18057	0.0419	Rejected
DREER does not Granger cause DPRICES	257	1.50312	0.2213	Accepted
DPRICES does not Granger cause DREER		3.18957	0.0753	Rejected

Source: Author's calculations based on data from FED and MMF, 2015

4.2. Analysis of the PPI as a Benchmark for Measuring Competitiveness

Within the stacionarity test, variables in their original forms were tested, whereas for all of them the H_0 was accepted (variables had unit root and therefore are stationary). For their further use in the presented model, it was necessary to remove the trend component by their first differentials. For the GC model was further important to correctly estimate the number of lags. As in the case of the *REER*, and to determine the number of lags, Akaike information criterion for the PPI was chosen. As shown in Table 5, the lowest value is obtained for the delay of 3, which is therefor applicable to the model, as best explained by the fact that one of the variables is obtained the way that the other will be delayed by 3 units, in our case 3 years. In this case, the number of lags is very limited, as time series are not as long as in the case of the *REER*. The presented model thus uses the delay of 1, meaning 1 year. For achieving the best reliability level of the model, there must be at least 20 units.

An analysis of the relationship between the development of China's competitiveness expressed by the PPI and global energy prices by using Granger causality (with 1 year delay) has shown (Table 6), that prices development affects the PPI, however, this is not the case vice versa. This could be proven at the 0.05 significant level (i.e., with 95 % confidence, $P = 0.0336 < 0.05$, H_0 rejected). The zero causality could be seen concerning the relationship between the natural gas prices and the PPI ($P = 0.4134$; $0.6821 > 0.05$). Unilateral causality was confirmed in the case of energy index and the PPI ($P = 0.0164 < 0.05$) and the coal prices and the PPI ($P = 0.0164 < 0.05$), however, this is not the case vice versa. It could be concluded that Granger causality test confirmed the direct impact of the oil and coal prices and energy index on the PPI, bud not vice versa (unilateral causality).

As confirmed by the data in Table 7 and Annexs 4.1-4.4, there is a high statistical dependence between the index of global prices (x) and explaining variable - PPI (y) at the level of 79.79%. This dependency could be stated as follows:

$$PPI = 0.0019 \text{ energy index} + 0.7135 \quad (9)$$

Which means that every increase of index by 1 will cause an increase of the *REER* by 0.0019 points. About the same dependency was shown in case of crude oil and coal prices on explaining variable PPI (78.63% and 74.79% respectively).

Table 4: Relation between the individual variables (x) and the explaining variable y-*REER* (1994M1-2015M7)

Relationship of the *REER*	R^2 (%)	Increase of x by 1 caused the growth of x by
Energy index	31.95	0.118
Crude oil index	31.48	2.7729
Crude oil (USD)	31.36	1.4694
Natural gas	35.23	2.4577
Coal prices	18.88	0.1611
Oil, coal, NG	36.15	-
Oil, coal, NG (1st difference)	04.81	-

Source: Author's calculations based on data from FED and MMF, 2015

$$PPI = 0.0034 \text{ crude oil} + 0.7212 \quad (10)$$

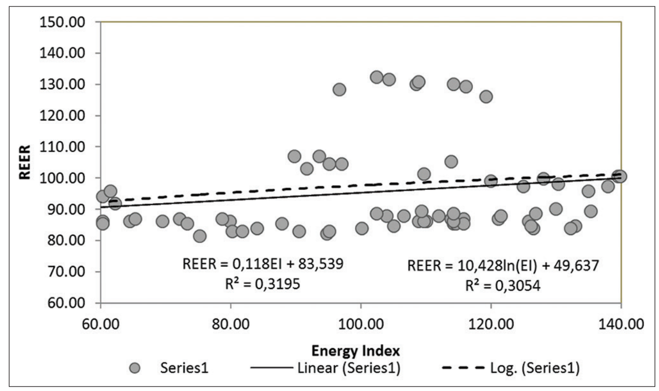
$$PPI = 0.0031 \text{ coal prices} + 0.6965 \quad (11)$$

$$PPI = 0.0137 \text{ natural gas} + 0.8023 \quad (12)$$

Increase in prices of crude oil by 1 causes the PPI growth by 0.0034 points and increase of coal prices by 1 will cause increase of PPI by 0.0031 points. Concerning natural gas prices, growth by 1 causes an increase of the index by 0.0137 points.

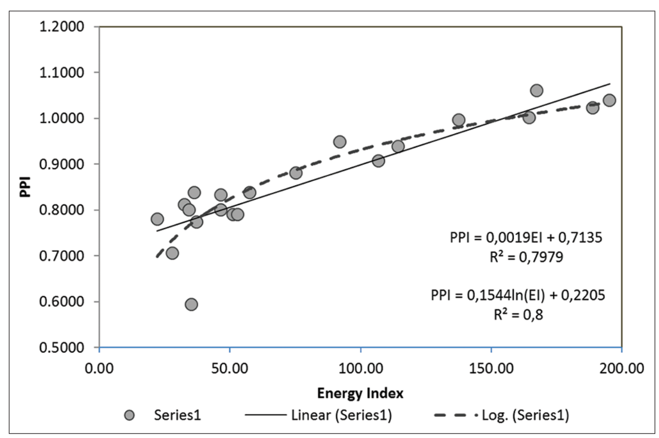
As in the case of *REER*, the individual variables do not affect the PPI individually, but they collectively influence the development of competitiveness, the model examining the impact of these three variables on the PPI was thus created. As shown in Table 7, the price of oil, gas and coal explained the variability of PPI at the

Chart 6: Regression analyses between the producer price index and the global energy prices index



Source: Author's calculations based on data from MMF and FED, 2015

Chart 7: Regression analyses between the REER index and the global energy prices index



Source: Author's calculations based on data from FED and MMF, 2015

Table 5: Testing the number of delay in GC for PPI

Number of lags	Akaike information criterion
1	19.63619
2	16.17129
3	4.719213

Source: Author's calculations based on data from E-views. PPI: Producer price index, GC: Global competitiveness

Table 6: Granger causality between the PPI and energy prices (1993-2013)

Pairwise Granger causality tests				
Sample: 1993-2013				
Lags: 1				
Null hypothesis	**Observations**	**F-statistic**	**P**	**Finding**
DOILPRICES does not Granger cause DPPI	19	5.40140	0.0336	Rejected
DPPI does not Granger cause DOILPRICES		0.03358	0.8569	Accepted
DGASPRICES does not Granger cause DPPI	19	0.70518	0.4134	Accepted
DPPI does not Granger cause DGASPRICES		0.17408	0.6821	Accepted
DENERGYINDEX does not Granger cause DPPI	19	7.19516	0.0164	rejected
DPPI does not Granger cause DENERGYINDEX		0.14806	0.7055	Accepted
DCOALPRICES does not Granger cause DPPI	19	8.04032	0.0119	Rejected
DPPI does not Granger cause DCOALPRICES		1.48104	0.2413	Accepted

Source: Author's calculations based on data from FED and MMF, 2015. PPI: Producer price index

Table 7: Relation between the individual variables (x) and explaining variable y-PPI (1993-2013)

Relationship of the PPI	R^2 (%)	Increase of x by 1 caused the growth of x by
Energy index	79.79	0.0019
Crude oil (USD)	78.63	0.0034
Natural gas	10.75	0.0137
Coal prices	74.78	0.0031
Oil, coal, NG	78.95	-
Oil, coal, NG (1st difference)	21.07	-

Source: Author's calculations based on data from FED and MMF, 2015. PPI: Producer price index

same level as individual variables, at the level of 78.95%. This is approximately the same level as in the previous measurement. At the significant level of 1%, this trend could be confirmed in case of natural gas prices and coal prices. Regarding oil prices, the significant level is lower. By removing the trend (Table 7 and Chart 7), the coefficient of determination was calculated at the level of 0.022017 (21.07%).

5. CONCLUSION

Slowing economic growth in China may have more negative impact on the global economy than was initially anticipated. This situation is logical to some extent. It is a natural translation of decreasing global demand, which due to the high volatility in global capital markets and a number of other uncertainties also supports deflationary tendencies. Domestic economic reforms within the Chinese economy which had the ultimate aim to increase domestic demand mainly through the support of middle class population where the consumption still lagged the middle class of developed countries (1/2-2/3), supplemented by soft loans with the amount of more than 1 trillion $ or devaluation of Juan supporting employment growth and revenues, turned out to be non-effective. Significant price decline of raw materials and energy inputs for which China creates massive demand helped to soften the impacts of Chinese economy slowdown. It should be noted, that the slowing Chinese demand was one of the causes of declining energy and raw material prices.

Chinese global economic position and ultimately its international competitiveness were affected by the aforementioned development only marginally. Chinese business partners, mainly raw materials and energy inputs suppliers, suffered far more negative consequencies. This background was also one of the reason initiating the research, the results of which are presented in this scientific paper. While analyzing the relationship between competitiveness and the energy inputs prices, applied to the Chinese economy, the long-term economic consequences had to be bore in mind, specifically after the year 2008 when this process was radically changed. It was confirmed that the key events affecting the relationship between the energy prices development and main economic indicators were oil price shocks from the 1970s and 1980s. The oil price growth as inflationary shock driven by demand and supply ultimately through higher production costs has affected the entire competitiveness and could cause the inversion between prices of raw material and energy input on one side and the finished goods on the other.

The selected indicators of competitiveness in this scientific paper, namely the development of *REER* and PPI, were analyzed in relation to global energy price index, crude oil index and crude oil prices, natural gas and coal prices in value terms. Although, the desirability of using the indices of *REER* was tested by comparing it to GCI compiled by WEF, its negative correlation could be explained by many other factors which are included in GCI. According to the authors this demonstrates less objective explanatory power of the GCI as closely profiled indices *REER* or PPI, which are clearly quantifiable.

The results of the research confirmed, that there is a long-term unilateral Granger causality between the *REER* and global energy prices, crude oil in terms of value and indexed prices, however this relationship does not apply vice versa. As a result, authors concluded that the competitiveness of the Chinese economy is highly dependent on global energy price and crude oil price development. The significant increase in energy prices translates into production inputs causing the inflation increase in the given country. The hypothesis of neutrality, meaning the evidence of no relationship was confirmed in the relationship between the global natural gas and coal prices and the *REER*. This situation is for several reasons somewhat paradoxical. China performs in international market as a net importer regarding nearly all energy commodities; however, it has significantly stronger position in case of coal than in other commodities. One of the reasons lays in a fact that China imports a half of global exports of coal and exports are dominated only by a few players. On the other hand, the coal consumption in many other countries specifically developed ones, is decreasing rapidly due to higher environmental standards and a pressure to lower carbon emissions.

The situation is different concerning crude oil, as it is the key bourse benchmark with its irreplaceable technological characteristics, while its reserves are time limited and the whole trade is under control of transnational oil companies. Furthermore, through the development of decoupling it also affects international prices of natural gas. When analyzing the extent to which variability of competitiveness of the Chinese economy determined by the *REER* is influenced by the energy and crude oil price development, it can be concluded that changes in energy prices affect the variability of the *REER* index with the 99% probability, at 31.95%. Expressed mathematically, it confirms that every increase in the index of energy prices results in higher *REER* of 0,118 points. Approximately the same relationship was observed concerning crude oil prices; however, every increase of oil prices by one caused the *REER* increase by 2.4577 points. Whereas the *REER* is not affected by variables individually, but as a whole set of factors, the model which explores the collective impact of those three variables on *REER* was compiled. It was shown, that those three factors together had nearly the same effects on the *REER*, at the level of 36.51%

In analysis including the PPI as an indicator of the Chinese competitiveness, the unilateral causality for energy prices, oil and coal prices with the PPI was confirmed. It means that the rise in energy prices; oil and coal prices directly enter the input prices of individual companies, increase their costs and thus decrease their international competitiveness. This relation, however, was not confirmed vice versa. In the case of relationship between the natural gas prices and the PPI, the hypothesis of neutrality was confirmed. In the case of crude oil and natural gas, the explanation could be found in its significant share in the global energy mix, especially in the products design for export or in the relation to the pillar of the economic growth as such. The variability of the PPI is, however, influenced by variables volatility (as in the case of *REER*), at the level at nearly 80% (in case of *REER* the determinant coefficient reaches the level around 35%). Every increase in energy index by one causes the PPI increase by 0.0019 points; regarding crude oil the increase represented 0.0034 points, coal prices 0.0031 points. Approximately the same determination level was confirmed in a model with three variables (crude oil, natural gas and coal) with the PPI at the level of 78.95%.

Current situation in terms of global coal prices development which is, according to the authors, linked with slowing of the Chinese economy is documented by the European coal prices development which decrease from $220 in 2008 to under $50 in 2015.

Presented economic outcomes create a need to predict the future development of the Chinese economy, its international competitiveness and the degree of its international dependence on commodity market, especially energy resources. It was confirmed, that a rapid economic growth secured through foreign trade activities and liberalization decreased domestic protecting mechanism and thus increased the dependence on market mechanisms. Simultaneously, it has created a bigger space for globalization processes which are in contradiction with restrictive regulatory mechanisms and the Chinese government efforts to dictate economic decision having direct impact on domestic economic balance.

Analysis confirmed that the level of economic interdependency is growing. To what extent the Chinese economy is able to withstand those developments will be determined by the outcomes of domestic economic reforms translated through the production shift to product with higher value added and lower specific consumption, environment protection measures and macroeconomic decisions by respecting international commitments and strategic documents. It is also questionable to what extent the production and consumption growth in China continues. Currently, it reaches approximately one third of the GDP and has a significant growth potential. Once this potential is activated, it will have a massive impact on the energy consumption ultimately increasing the Chinese economy vulnerability to the external shocks. Gradually, all developments in China economy will have increasing impact on global economy, what should be reflected in economic strategy of every single nation in the world. That certainly fully applies to the case of the European Community, where ensuring energy security of the community with all consequences with direct or indirect impact on its overall competitiveness. It was confirmed that Asian economy has become a continuous part of the global economy and in the case of maintaining its high growth it will gain the dominance inthe long-term economy growth. The key motions of this paper was to outline the possibilities of effective responses to those developments in energy sector.

6. ACKNOWLEDGMENT

This paper is a part of a research project of Ministry of Education, Family and Sports of the Slovak Republic VEGA for years 2014-2016, No. 1/0550/14: New Challenges in European Energy Security and Their Impact on EU Competitiveness in Horizon by 2020.

REFERENCES

Baláž, P. (2013), Čínska Ekonomika: Nová dimenzia Globalizácie Svetového Hospodárstva: (Bude XXI. Storočie Storočím Číny?). Bratislava: Sprint dva. p279.

Baláž, P., Londarev, A. (2006), Ropa a jej postavenie v globalizácii svetového hospodárstva. In: Politická Ekonomie. Vol. LIV. Praha: VŠE. p508-528.

Bartlett, M., Gounder, R. (2010), Energy consumption and economic growth in New Zealand: Results of trivariate and multivariate models. Energy Policy, 38(7), 3508-3517.

Bella, G., Lewis, M., Martin, A. (2007), Assesing Competitiveness and Real Exchange Rate Misalignment in Low-Income Countries. IMF Working Paper. WP/07/201.

BP Energy Outlook. (2014). Avalable from: http://www.bp.com/extendedsectiongenericarticle.do?categoryId=9048887&contentId=7082549.

Chen, G., Hamorui, S. (2009), Energy Prices and China´s International Competitiveness. MPRA Paper No. 18827.

DG ENERGY. (2015), EU Energy in Figures. Statistical Pocket Book 2015. Energy. Available from: https://www.ec.europa.eu/energy/sites/ener/files/documents/PocketBook_ENERGY_2015%20PDF%20final.pdf.

Eddrief-Cherfi, S., Kourbali, B. (2012), Energy consumption and economic growth in algeria: Cointegration and causality analysis. International Journal of Energy Economics and Policy, 2(4), 238-249.

EIA. (2013), China Energy. Available from: http://www.eia.gov/countries/cab.cfm? fips=CH.

EIA. (2015), China. Available from: https://www.eia.gov/beta/international/analysis.cfm?iso=CHN.

European Commision. (2015), Price and Cost Competitiveness. Available from: http://www.ec.europa.eu/economy_ finance/db_indicators/competitiveness/index_en.htm.

FRED. (2015), Producer Prices Index (PPI). Economic Research. St. Louis: Federal Reserve Bank. Available from: https://www.research.stlouisfed.org/fred2/categories/31.

Hang, L., Tu, M. (2007), The impacts of energy prices on energy intensity: Evidence from China. Energy Policy, 35, 2978-2988.

Hickman, B., Huntigton, H.G., Sweenez, J.L. (1987), The Macroeconomic Impacts of Energy Shocks. Amsterdam: Elsevier Science Publishers, B.V., North-Holand.

IEA. (2014), Medium-Term Coal Market Report 2014. p132. Available from: http://www.iea.org/publications/freepublications/publication/MTCMR2014.pdf.

IMF. (2015), Primary Comodity Prices. Available from: https://www.imf.org/external/np/res/commod/index.aspx.

Jamborová, E., Pavelka, Ľ. (2013), Riadenie Rizík v Medzinárodnom Obchode. Bratislava: Ekonóm.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. In Journal of Energy and Development, 3(2), 401-403.

Lescaroux, F., Migon, V. (2009), Measuring the effects of oil prices on China´s economy: A factor-argumented vector autoregressive approach. Pacific Economic Rewiev, 14(3), 410-425.

Lukáčik, M., Pekár, J. (2006), Kointegračná analáza v ekonometrii. Available from: http://www.fhi.sk/files/katedry/kove/veda-vyskum/prace/2006/Lukacik-Pekar2006.pdf.

Obadi, S.M., Korček, M. (2014), Energetická bezpečnosť Európskej únie so zameraním na ropu a zemný plyn: Teoretické pohľady a empirické dôkazy. VEDA, VYDAVATEĽSTVO SAV. Bratislava 2014.

Pierce, J.L., Enzler, J.J. (1974), The effects of external inflationary shocks. Brookings Papers on Economic Activity 1, 13-61.

Rasche, H., Tatom, J. (1977), Energy Resources and Potential GNP, Review. St. Louis: Federal Reserve Bank. p10-24.

Skeer, J., Wang, Y. (2007), China on the move: Oil move: Oil price explosion? Energy Policy, 35, 678-91.

The World Bank. (2015). Available from: http://www.Step=12&id=4&CNO=2>.

US Labor Department. (2015). Available from: http://www.bls.gov/ppi/ppifaq.htm#7.

WEF. (2015), Global Competitiveness Report 2015-2016. Available from: http://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf.

Wolde-Rufael, Y. (2004), Disaggregated industrial energy consumption and GDP: The case of Shanghai, 1952-1999. Energy Economics, 26, 69-75.

Workie, M.T., et al. (2006), Globálna konkurencieschopnosť a energetická a demografická Kríza. Vol. 1. Bratislava: EÚ SAV.

Yuan, J.H., Zhao, C.H., Yu, S.K., Hu, Z.G. (2007), Electricity consumption and economic growth in China: Cointegration and co-feature analysis. Energy Economics, 29, 1179-1191.

Zábojník, S. (2010). Čína a Jej Ekonomický Rast – Dôsledky pre Medzinárodný Energetický trh (Vplyvy a Konzekvencie na Hospodársku Stratégiu SR). Bratislava: Ekonomická Univerzita. Dizertačná Práca.

Annex

Annex 1: Regression analysis between GCI and *REER*

Dependent variable: GCI				
Method: Least squares				
Sample: 2007-2015				
Included observations: 9				
Variable	**Coefficient**	**SE**	**t-statistic**	**P**
C	3.947002	0.252747	15.61644	0.0000
REER	0.007363	0.002289	3.216815	0.0147
R^2	0.596493	Mean dependent variable	4.754444	
Adjusted R^2	0.538849	SD dependent variable	0.130778	
SE of regression	0.088809	Akaike information criterion	−1.811537	
Sum squared resid	0.055209	Schwarz criterion	−1.767709	
Log likelihood	10.15192	Hannan-Quinn criterion	−1.906117	
F-statistic	10.34790	Durbin-Watson statistic	1.093199	
P (F-statistic)	0.014718			

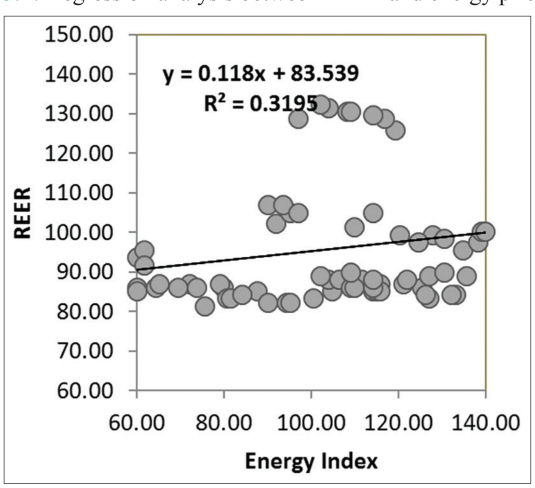
Source: Author's calculations based on data from WEF and MMF, 2015. SE: Standard error, GCI: Global competitiveness index, SD: Standard deviation

Annex 2: Regression analysis between *REER* and global energy price index

Dependent variable: *REER*				
Method: Least squares				
Sample: 1994M01-2015M07				
Included observations: 259				
Variable	**Coefficient**	**SE**	**t-statistic**	**P**
C	83.53944	1.243031	67.20625	0.0000
Prices	0.118045	0.010746	10.98513	0.0000
R^2	0.319517	Mean dependent variable	95.04598	
Adjusted R^2	0.316869	SD dependent variable	13.03192	
SE of regression	10.77111	Akaike info criterion	7.599304	
Sum squared resid	29816.32	Schwarz criterion	7.626770	
Log likelihood	−982.1099	Hannan-Quinn criterion	7.610347	
F-statistic	120.6730	Durbin-Watson statistic	0.032606	
P (F-statistic)	0.000000			

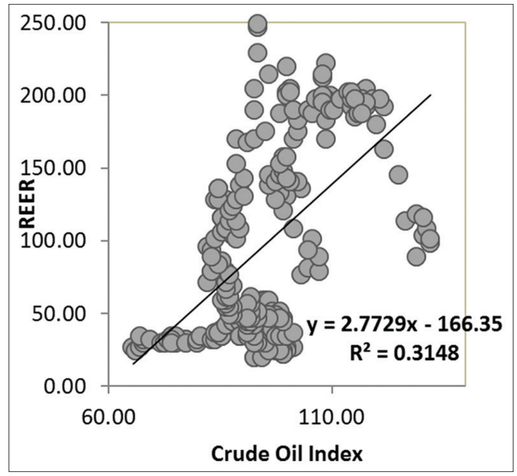
Source: Author's calculations based on data from MMF, 2015. SD: Standard deviation, SE: Standard error

Annex 3.1: Regression analysis between *REER* and energy price index



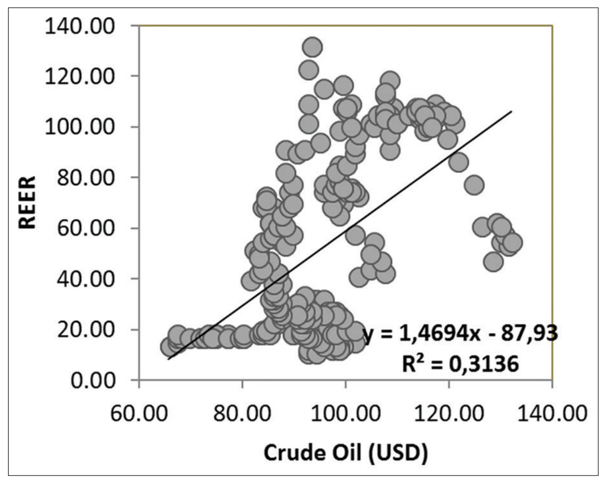
Source: Author's calculations based on data from MMF and FED

Annex 3.2: Regression analysis between *REER* and index of global crude oil prices



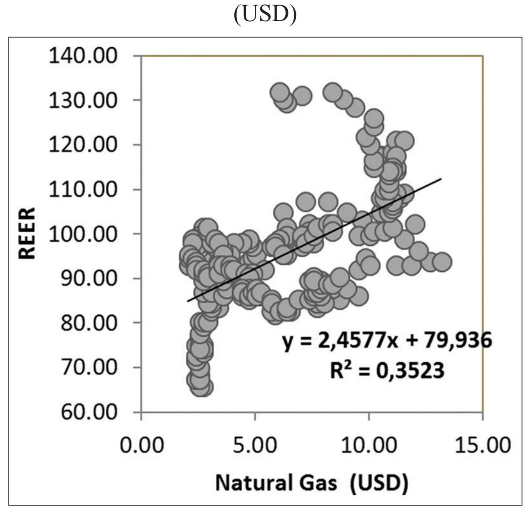
Source: Author's calculations based on data from MMF a FED

Annex 3.3: Regression analysis between *REER* and crude oil prices (USD)



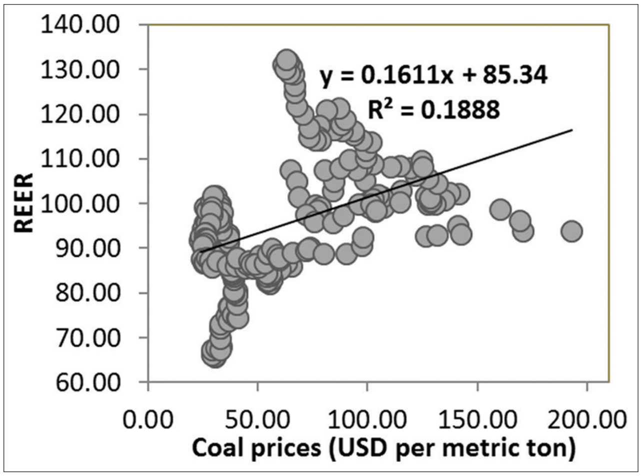
Source: Author's calculations based on data from MMF a FED

Annex 3.4: Regression analysis between *REER* and natural gas prices (USD)



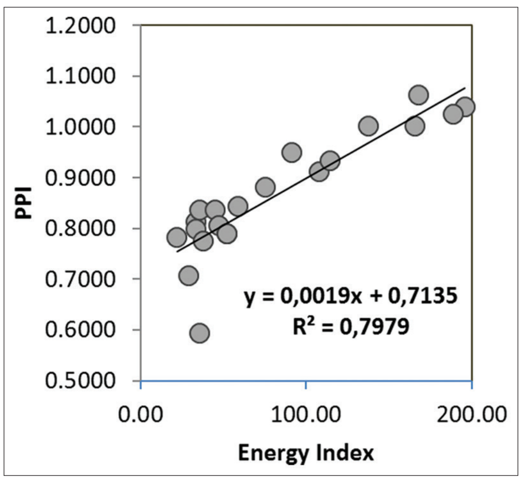
Source: Author's calculations based on data from MMF a FED

Annex 3.5: Regression analysis between *REER* and coal prices (USD)



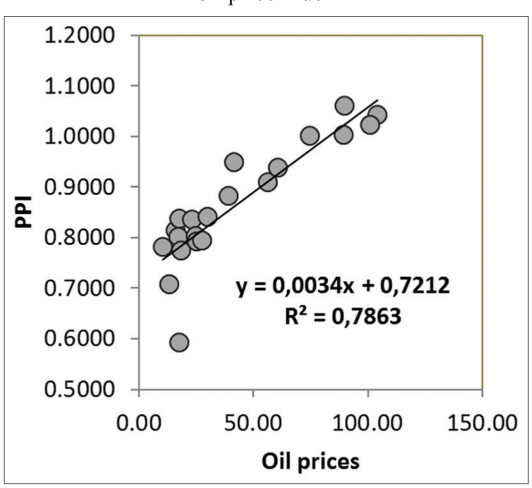
Source: Author's calculations based on data from MMF a FED

Annex 4.1: Regression analysis between producer price index and global energy price index



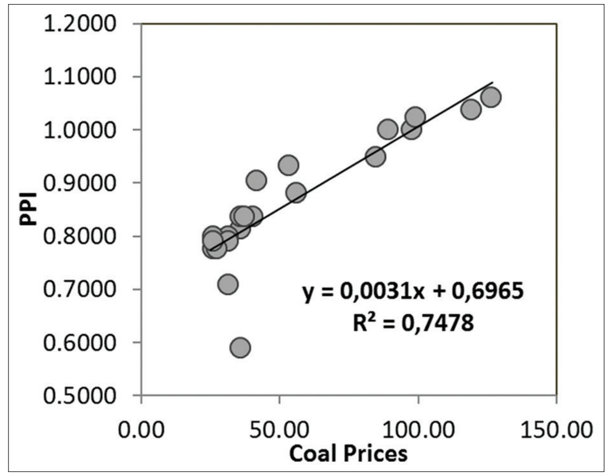
Source: Author's calculations based on data from

Annex 4.2: Regression analysis between producer price index a crude oil price index



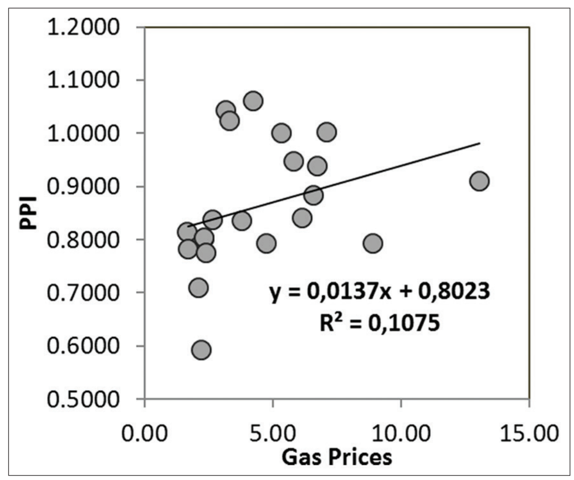
Source: Author's calculations based on data from MMF a Fed

Annex 4.3: Regression analysis between producer price index and natural gas prices



Source: Author's calculations based on data from MMF a Fed

Annex 4.4: Regression analysis between producer price index and coal prices



Source: Author's calculations based on data from MMF a Fed

Annex 5: Analysis of the relationship between crude oil, natural gas and coal prices and PPI

Dependent variable: PPI				
Method: Least squares				
Sample: 1993-2013				
Included observations: 21				
Variable	**Coefficient**	**SE**	**t-statistic**	**P**
C	0.677297	0.032460	20.86577	0.0000
OILPRICES	0.001500	0.001121	1.338000	0.1985
GASPRICES	0.006489	0.005020	1.292459	0.2135
COALPRICES	0.001728	0.001011	1.708828	0.1057
R-squared	0.821079	Mean dependent var		0.865479
Adjusted R^2	0.789505	SD dependent var		0.118888
SE of regression	0.054545	Akaike info criterion		−2.809925
Sum squared resid	0.050578	Schwarz criterion		−2.610969
Log likelihood	33.50422	Hannan-Quinn criteria		−2.766747
F-statistic	26.00466	Durbin-Watson statistic		0.798574
P (F-statistic)	0.000001			

Source: Author's calculations based on data from FRED a MMF, 2015. PPI: Producer price index, SE: Standard error