# ECONOMICS
## *& Sociology*

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# THE RESEARCH ON THE IMPACT OF THE CHANGES OF COMMODITY PRICE LEVEL IN THE WORLD COMMODITY EXCHANGES ON VARIATION OF GENERAL PRICE LEVEL

**ABSTRACT.** The purpose of the paper is to investigate the influence of changes of commodity price level in the world commodity exchanges on variation of general price level index in Lithuania. Object of the research is commodity price level in the world commodity exchanges. The methodology applied is following: study of the recent scientific literature, collection and analysis of statistical data, correlation regression analysis. The conclusion can be made that variation of general price level in Lithuania depends on changes of commodity prices in world commodity exchanges, mostly from the prices of aluminium, cocoa, coal and oil. Regression function made with analysed commodities is adequate to real situation and chosen variables X explain the 64% of inflation variability and 36% are explained by other factors. The results show that the determinate regression function could be practically used to forecast the dependence of inflation rate on the particular factors.

## Introduction

For many years modern economies is facing significant problem of overall increasing general price level. During which the value of monetary unit falls and decreases its purchasing power – so called inflation appears. Inflation affects not only the area of prices, but directly and indirectly it touches the various areas of economic and social life, causing many negative consequences for country's economic development.

Commodity prices are volatile as well as most of commodity exchanges are volatile and dynamic. It affects the domain of specific fields, such as agricultural economics. For many financial institutions worldwide commodity trading has become an important mean to gain profit. Commodities nowadays are an important component of many investors' portfolios.

One of the most influential factors affecting inflation rate is the price of production costs, from which mainly depends the final price of goods and services in a market. Therefore

the price changes of the most important commodities in the world's commodity exchange markets influence the price of local producers or imported production. This paper analyses the influence of price changes of commodities to general price level in Lithuania. The aim of the research is to analyze the variation of general price level in Lithuania and changes the prices of commodities in the world's commodity exchange markets, identify the influence of the price changes of commodities on variations of general price level as inflation's parameter. In order to achieve the aim correlation regression analysis was used. It allows to set the relation and establish the connection between price changes of commodities and general price level.

## 1. Inflation and factors conditioning it

Relative prices changes, income and assets are repartitioned among the different people and groups, indexes of national production and employment depart form the average during the inflation period. In such situation some are winners, some are losers. But these factors have an influence on the whole economy. The costs of inflation depend not only on its rate, but also on the expectation factor. When inflation is expected people may prepare better, and impact will be less painful (Snieška, 2006). It is important to notice that increase of prices of one product or several groups of products is not evaluated as inflation. Scientific and technological development and demand fluctuations allow the prices to increase and decrease. At the other hand change of prices of particular groups of products can be named as increase of price level. That is why the inflation and the change of price level are adequate terms when it comes to the growth of general price level. Some economists emphasize that the inflation is not onetime, but long term change of price level.

Inflation and tax system operate similarly – they take somebody's asset and give it to others meaning the re-distribution of assets and income. If possible to forecast the rate of inflation and to readjust the prices and wages in accordance with it no problems will arise. High inflation can destabilize or even destroy countries economy (Snieška, 2006). Significant economic, social and political problems arise when it is difficult to forecast price level change. It's connected with the distribution of assets and income among different subjects in the economy. This re-distribution is spontaneous and touches despite the age and financial position. Therefore it is sometimes emphasized that inflation (deflation) has no social consciousness (Snieška, 2006; Gerdesmeier, 2009). But usually the inflation and deflation has the influence on the poorest groups of society, as they have limited possibilities to protect themselves. So, the price stability helps to maintain the cohesion of the society (Gerdesmeier, 2009). Conferment and maintenance of deflation or high inflation according to Duisenberg (Ghoshray, 2014) is equal to maintenance of offence against the society.

The definition of inflation is not very profound. Nausėda (1994) defined that the concept of inflation reflects rising prices in the national economy. Inflation is understood as a decrease of the purchasing power of monetary unit, which can be measured as the price level index. According to Malliaris (2006) inflation is broadly defined as the process of continuously rising prices. Since there are several ways to measure the rate of price increases therefore there are also different measures of inflation. Currently, the most commonly used monthly measure of inflation is the percentage change in the consumer price index (hereinafter – CPI) and the most common quarterly measure is the percentage change in the gross domestic product implicit price deflator

The price level index is the index characterizing the state of price during the particular period, in particular place. The price level can be individual, average or general. The individual price level indicates instantaneous price of the product, the average level shows the average price of product, group of products, in particular territory, submarket, of group of consumers. The general price level measures the total price of "shopping basket". This basket

contains a broad range of products which are typically consumed by a representative household (Miečinskienė & Ževžikova, 2008). A price index is a numerical measure designed to help to compare how the prices of "shopping basket" differ between time periods or geographical locations. Inflation is an increase in the general level of prices or a rise in the prices of a "shopping basket".

There are many factors influencing price level changes. Governmental regulations and control of prices one of them. The governmental intervention is different in various countries, but some directions of typical regulation can be marked. One of them is price fixing (Pranulis *et al.*, 1999). The influence of government on prices should be systemic and balanced, because prices allow the market to adjust supply and demand. The state intervention into the pricing breaks the market prices system formation. The regulation determines some economic outcomes that negatively influence business companies, citizens and the whole economy (Simanavičienė, 2002). The changes in commodity prices, as one of the most important inputs in a production, affect the price of final goods.

## 2. Interaction between commodity prices and inflation

The role of commodity prices as precursors of inflation has been addressed extensively in the literature, with varying results. A long list of studies has shown that changes in the Commodity Research Bureau index and other commodity price indexes led aggregate inflation in the 1970s and the first part of the 1980s. At the same time, studies by Garner (1995) and Bloomberg and Harris (1995) find that some commodity prices have not been reliable leading indicators of inflation since about the mid-1980s (Furlong & Ingenit, 1996).

Commodity prices are argued to be leading indicators of inflation through two basic channels. One is that they respond more quickly to general economic shocks, such as an increase in demand. The second is that some changes in commodity prices reflect idiosyncratic shocks, such as a flood that decimates the supply of certain agricultural products, which are subsequently passed through to over all prices. Depending on the type of the shock, the observed link between commodity prices and inflation would be expected to be different. Moreover, changes over time in the mix of shocks in the economy could affect the stability of a bivariate link between commodity prices and inflation (Furlong & Ingenit, 1996).

Ghoshray *et al.* (2014) in their work pointed out that given the fact that many developing countries are dependent on commodity prices as their main source of income, the issue of trends in commodity prices in relation to manufactures has been of great interest in the trade and development economics literature and a strand of theoretical research argues that commodity prices should be stationary, due to the biological nature of production, storage and arbitrage. The price movements of commodities as well were analysed by Dudzinski (2010).

Cashin *et al.* (2002) analysed empirical evidence that has generated several stylized facts about real commodity prices: they are often dominated by long periods of doldrums punctuated by sharp upward spikes (Deaton & Laroque, 1992); they have a tendency to trend down in the long run (Grilli & Yang, 1988); shocks to commodity prices tend to persist for several years at a time (Cashin *et al.*, 1999); and unrelated commodity prices move together (Pindyck & Rotemberg, 1990). Several of these stylized facts have been summarized by Deaton (1999).

Commodity prices have recently re-surfaced in discussions of the inflationary outlook for western economies. The popular view seems to be that changes in commodity prices are a consequence of developments occurring solely in the relevant commodity market. Prompted perhaps by the recognition that recent experiences of steep commodity price increases have occurred alongside, or in the wake of, a relatively "easy" stance of monetary policy in

advanced industrial economies, there has, however, been a resurgent interest in the argument that monetary conditions account for changes in commodity prices (Browne & Cronin, 2010).

Furlong & Ingenito (1996) examine the empirical relationship between changes in commodity prices and inflation. Their results indicate that there is a link between inflation and commodity prices, but this link has changed considerably over time. Specifically, commodity prices were statistically robust leading indicators of inflation during the 1970s and early 1980s but they have been poor stand-alone indicators of inflation since the early 1980s. Awokuse & Yang (2003) also examine the usefulness of the behaviour of commodity prices in formulating monetary policy and conclude that commodity prices signal the future direction of the economy. Mahdavi & Zhou (1997) distinguish between commodity prices and gold prices as leading indicators of inflation (Malliaris, 2006).

The most direct link often cited is that between inflation and commodity prices. More specifically, commodity price increases can lead to periods of inflation, the latter reflected in changes in the producer and CPI. For manufactures and processors, higher commodity prices lead to lower corporate profits, higher unemployment and result in less consumer spending. In an overheated economy, increased futures trading activity on the part of speculators can amplify already rising commodity prices (Kyrtsou & Labys, 2006).

Another commonly cited relationship is that between commodity price increases and inflation. Inflation can be caused by consumer's, producer's and investor's expectations of the future. "In an overheated economy, increased futures trading activity on the part of speculators can amplify already rising commodity prices" (Kyrtsou & Labys, 2006). In this case, if speculators expect demand for a good to rise, the price for that good will amplifies the increase in demand, thus leading to higher consumer prices. In the precious metals industry, for example, if there is an increase in commodity production due to speculation such that production exceeds commodity demand, there will be a surplus causing exports to rise and imports to fall (Kyrtsou & Labys, 2006).

Akram (2009) found that real commodity prices increase in response to interest rate shocks that lower interest rates. Moreover, commodity prices specifically oil prices and prices of industrial raw materials tend to display overshooting behaviour in response to such interest rate shocks, while food prices and metal prices tend to respond gradually.

The commodity price–inflation connection is important for at least two reasons. First, commodities are frequently touted as inflation hedges, which can be used to motivate commodity investments. For example, Gorton & Rouwenhorst (2006) argue that an index of commodity futures is linked with consumer price inflation, implying that commodity investments protect real purchasing power of market participants, while Bloomberg & Harris (1995) and Verheyen (2010) do not support a positive relation. Secondly, if commodity prices precede general inflation in the economy they can be utilized by monetary authorities in policy decisions. This argument is motivated by the understanding that commodity prices are determined in efficient auction markets and should quickly reflect all available supply and demand shocks in the economy. Furthermore, commodities tend to be important inputs in production and thus, increases in their costs could precede inflationary pressures, see Garner (1989) and Marquis & Cunningham (1990) among others (Ciner, 2011).

## 3. The analysis of dynamics of commodity prices and inflation

Commodities are inputs in the production of other goods or services. In this paper the products grown on earth: grains; products extracted from the earth: minerals, oil, natural gas are characterized as commodity. All of these products are at the first stage of the consumption process, and without additional processing cannot usefully be used right away.

As the quantity of commodity areas and resources in the world is different, for their trade the global markets for raw materials – world commodity exchanges are formed. Commodity exchanges are located in all continents (excluding Antarctica), and the largest are based in the United States. One of the most popular commodity exchanges are: New York Mercantile Exchange, London Metal Exchange, Australian Securities Exchange, Tokyo Commodity Exchange and Dalian Commodity Exchange in China.

In this paper to analyse the changes of general price level the period of the year 2000-2013 was chosen. As it was mention before commodity prices in global commodity exchanges are constantly changing. For example, from January 2007 to July 2008, the price of oil per barrel has risen more than twice (see Index, 2014l), what caused not only the increase of costs for usage of the transport, agricultural machinery, but in general making significant impact on the global economy.

Twelve types of commodity are chosen to analyse in this paper: nutritional raw materials – cocoa, coffee, sugar, corn; energy raw materials – oil, natural gas, and coal; metal raw material – copper and aluminum; material raw materials: cotton and wool.

Cocoa is the main composite element of chocolate and the price (see *Figure 1*) of cocoa is mainly affected by the global demand for chocolate as well as by the supply of these products.
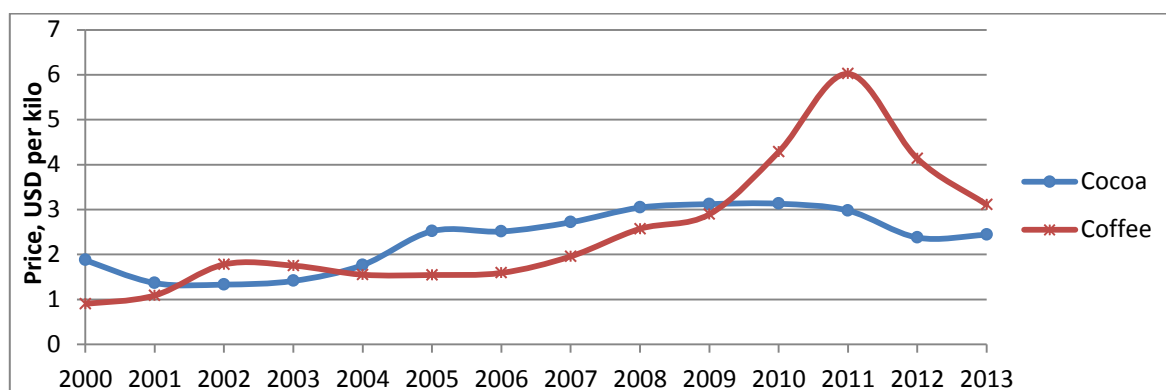


Figure 1. The dynamics of cocoa and coffee prices in the period 2000-2013
*Source:* compiled from Index (2014a); Index (2014b).

In terms of increasing chocolate consumption, the price of cocoa for the period 2002-2009 increased by 200%. Current period shows slow increase in cocoa prices after sharp decrease in 2012. The price of cocoa decreased around 30% during 2012 and reached price level as was in 2005. Cocoa prices are influenced by oil and gasoline prices because a lot of fuel is used to irrigate their plantations, harvest, process and transport. Consequently, oil and gasoline prices fall in late 2008 – early 2009 reduced the prices of cocoa (Meat, 2014).

Coffee prices have fallen sharply from 6 USD per kilo in 2011 till 4,1 USD per kilo in 2012 as a result of increased production (see *Figure 1*). Yahoo (2014a) cited International Coffee Organization that coffee prices continue to fall as a result of increased supply. Coffee demand in producing nations grew by 3,3% while demand in emerging markets fell by 2% (ICO, 2014). If the trend of the coffee and cocoa prices remain, presumable that in the in the coming years, the price of coffee will become lower as the price of cocoa again, what was observed in a period of 2004-2009.

Sugar is one of the oldest and most popular raw materials on the global market. Sugar trade mostly in London and New York exchanges. 2006/2007 sugar prices fall from 38 to 21 cents/kg – at that time the highest price of sugar of the last 25 years, what helped to increase the sugar plantations and supply, causing the influence of prices decrease (Money, 2006).

From 2007 to 2011 the price of sugar increased 3 times (see *Figure 2*). Bloomberg (2014) forecasts that the global sugar surplus will fall 70% next season as consumption rises "quite strongly" and production begins to decline after three years of lower prices. World sugar supply will exceed demand by 1,6 million metric tons in the 2014-2015 season. That compares with a surplus of 5,5 million tons in 2013-2014 (Bloomberg, 2014).
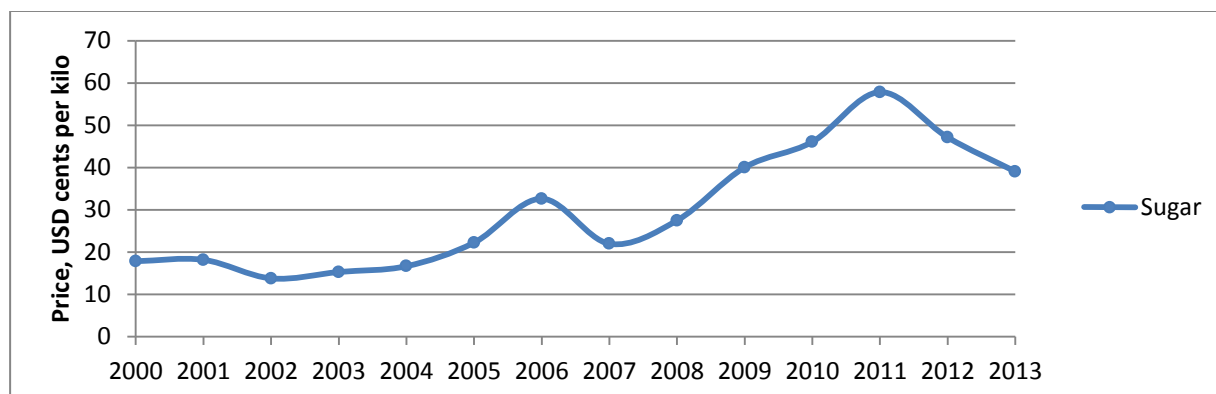


Figure 2. The dynamics of sugar prices in the period 2000-2013
*Source:* compiled from Index (2014c).

Prices of corn (see *Figure 3*) have evolved along with the whole grain market. At about the same time that ethanol production was ramping up in the United States, so did food prices around the world. With government support in the form of tax credits and grants boosting demand, and oil prices on the rise, acreage that might have been allocated for food was sowed with corn slated for ethanol (Chemically, 2008). In 2011 corn prices climbed into record territory. Corn prices fall on expectations for strong crop in 2012/2013. So the situation was presented by ABCnews (2014) „Corn prices settling lower for the fourth day as expectations build for a plentiful harvest. Corn dropped 7 cents, nearly 2%, to settle at 4.58 USD for a bushel, its lowest settlement price since Feb. 27, according to FactSet".



Figure 3. The dynamics of corn prices in the period 2000-2013
*Source:* compiled from Index (2014e).

Cotton and wool price dynamics till the year of 2007 showed much greater discrepancy than corn prices (see *Figure 4*).
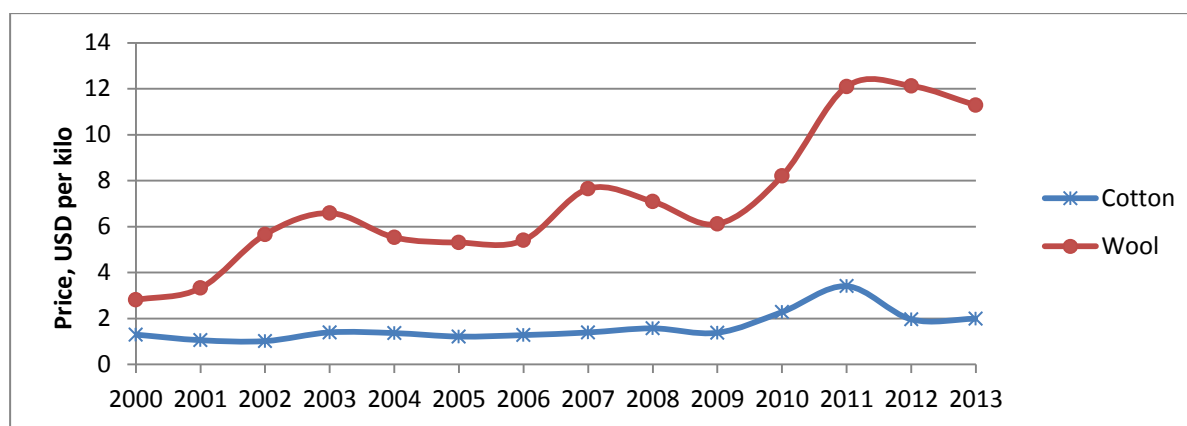
Figure 4. The dynamics of cotton and wool prices in the period 2000-2013
*Source:* compiled from Index (2014f); Index (2014g).

The growth of cotton prices in a period of 2002-2003 was mainly influenced by China's active behaviour in the market, which is the largest cotton producer in the world. Since China has been increasing amounts of imported cotton, the legitimate concern to other market participants that global cotton stocks running low has raised, resulting the rise of the raw materials prices (Rural, 2010). Since 2009 till 2011 the cotton prices were increases constantly. Demand for U.S. cotton is picking up, adding to concerns about the availability of supplies of the fiber. The U.S. exports more cotton than any other country in the world. Its biggest customers are in Asia, where mills spin the U.S. fiber into thread and yarn to make textiles (The Wall, 2010). The price of cotton was dropped by 42% in 2012 (see *Figure 4*). This was driven by traders' worries that slower economic growth can reduce consumers' demand for clothes and other goods made from the fiber (Yahoo, 2014b). Cotton futures prices stated to increase in 2013 (see *Figure 4*) on concerns about the size and quality of the crops in the world's top three producers. In the Wall Street Journal (2013) was explained as following. The U.S. has been suffering from similarly adverse weather. The U.S. Department of Agriculture in 2013 is projecting the smallest U.S. cotton crop since the 2009-2010 season, so any additional demand for exports could squeeze prices higher (The Wall, 2013).

Wool price fluctuations were more notable as of cotton (see *Figure 4*). From the beginning of the year 2000 first quarter, when the price of kilogram of wool was 2.8 USD, over the decade the price of wool has increased up to 8.2 USD, that is 195%. In 2007 strong interest from China, Europe and India has contributed to the rise; with the Eastern Market Indicator finishing at 915 cents per kilogram clean (ABC, 2007). In the wake of the slow-down in the global economy, escalating costs and a stronger currency, wool prices dropped sharply at the opening sale of the 2008/09 season, and Cape Wools' Merino indicator closed down 9.6% on the closing sale of the previous season at R55.51/kg (clean) (Wool, 2008). But in 2009 with lower volumes of wool coming forward, buyers had to be very active to fulfil orders for export and scouring and continued strong demand from Chinese buyers kept the price of fine crossbred fleece and shears trending up (Wool, 2010). In a period 2010/2012 prices reached new highs at the wool sale and slow downturn of wool prices we can see in 2013.

The price of aluminum is directly related to transport and construction industry, demand of cars, trucks as well as growing demand of residential and business areas. After hitting a high of 2.6 USD per kilo in 2008, aluminum prices have dropped over 40% from their peak (see *Figure 5*).
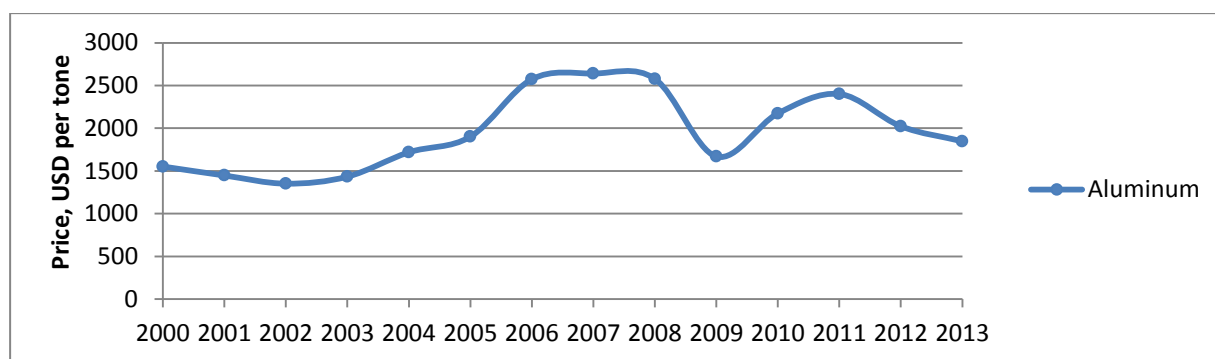
Figure 5. The dynamics of aluminum prices in the period 2000-2013
*Source:* compiled from Index (2014h).

The wave of price fluctuations during the period 2009-2013 with second price peak in 2011 and followed decrease during 2012/2013 can be clearly recognized. Aluminum is an industrial base metal which is almost universally essential in the production of consumer goods. Thus, the global economic downturn is one of the main factors in the price pullback. Demand for aluminum mill products from the transportation, packaging, and construction industries has fallen by a third since the worldwide recession began. Another force that has contributed to the sharp decline in aluminum prices (perhaps even more than sinking demand) is overproduction, which has led to a significant supply/demand imbalance (Koyfman, 2009).

The prices for copper were changing similar as the prices of aluminum, however as a larger amplitude. In a period 2000-2008 the price of copper increased more than 3 times – from 1814 USD till 6963 USD per tonne (see *Figure 6*). It is most closely related to the overall economic development. Copper is needed by expanding the urban public transport infrastructure, electric power plants, as well as manufacturing facilities, residential and business buildings. At the end of 2008 the price of copper has fall. Declining global economic growth was one negative macroeconomic influence governing future price direction (Reuters, 2008). From 2009 the price for copper rose on more signs that China's economy is regaining strength. China is the world's biggest buyer of the industrial metal, so traders tend to buy copper contracts on signs the country's economy is growing. Concerns over China's economy have been the main reason copper prices have slumped 7% in 2013 (ABC, 2014) (see *Figure 6*).
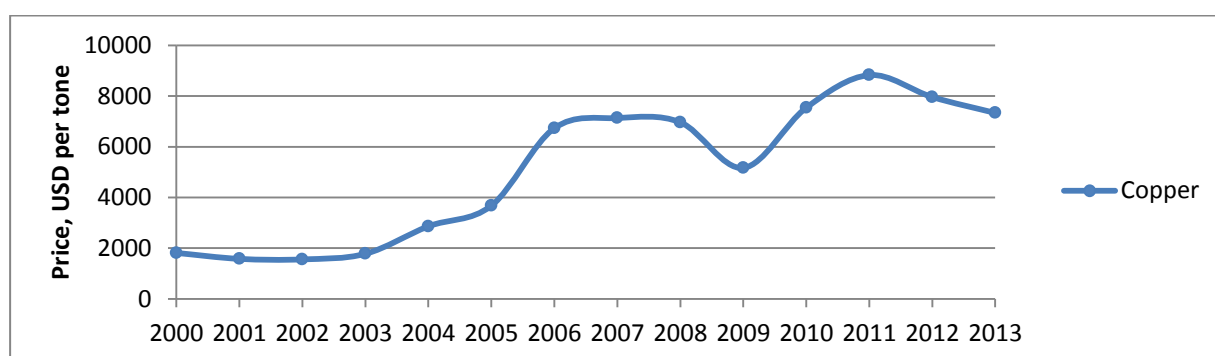


Figure 6. The dynamics of copper prices in the period 2000-2013
*Source:* compiled from Index (2014i).

Natural gas is one of the most important energy commodities the last decade has witnessed significant price hikes (see *Figure 7*). Natural gas prices are mainly driven

by supply and demand fundamentals, but natural gas prices may also be linked to the price of crude oil and/or petroleum products. Natural gas is one of the most unpredictable and the most difficult to forecast commodity, the price could double or drop in half in just a few months (Why, 2010). Looking at the price dynamics of all the commodities' analysing in this research, only the price of natural gas in 2013 was lower than it was in 2000.
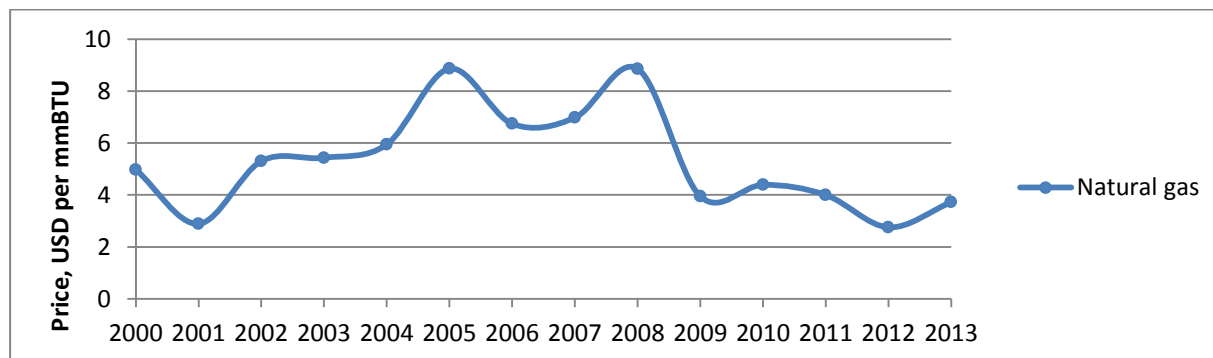


Figure 7. The dynamics of natural gas prices in the period 2000-2013
*Source:* compiled from Index (2014j).

Coal prices during the period of 2000-2007 have doubled (see *Figure 8*). The highest growth rate is captured in 2007/2008, when coal prices during one and a half years increased by more than two times. In 2009 the overall fall in prices of energy commodities occurred particularly in coal market, where starting 2008 the third quarter to 2009 to the first quarter, the price of coal has fallen from 136 dollars to 77 USD per ton (see *Figure 8*). Thermal coal prices are likely to fall in 2014 as mining output increases in an already oversupplied market while demand in emerging markets drops. Prices of coal, the top fuel used to generate electricity in the world, have halved from a peak in 2011 and are down almost 70% from their all-time highs in 2008 (Reuters, 2014).
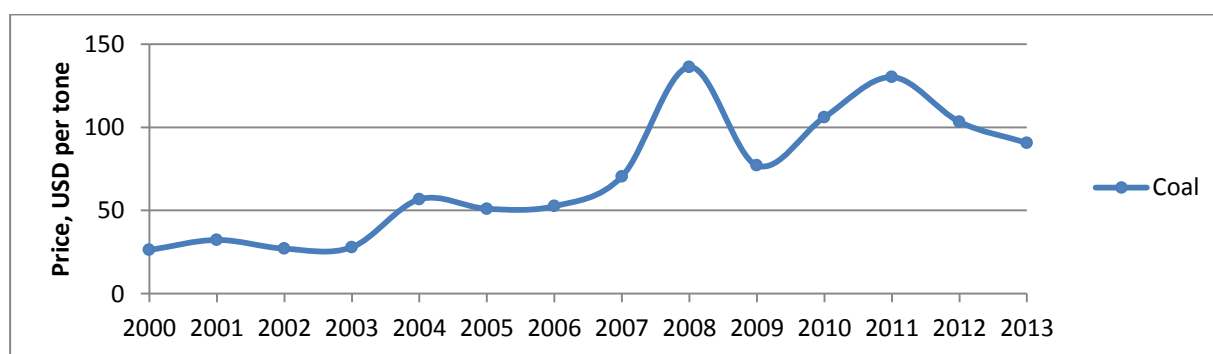


Figure 8. The dynamics of coal prices in the period 2000-2013
*Source:* compiled from Index (2014k).

The most popular and best value energy source, crude oil prices grew steadily until the second quarter of 2008, when oil prices reached a record – 97 USD per barrel (see *Figure 9*).
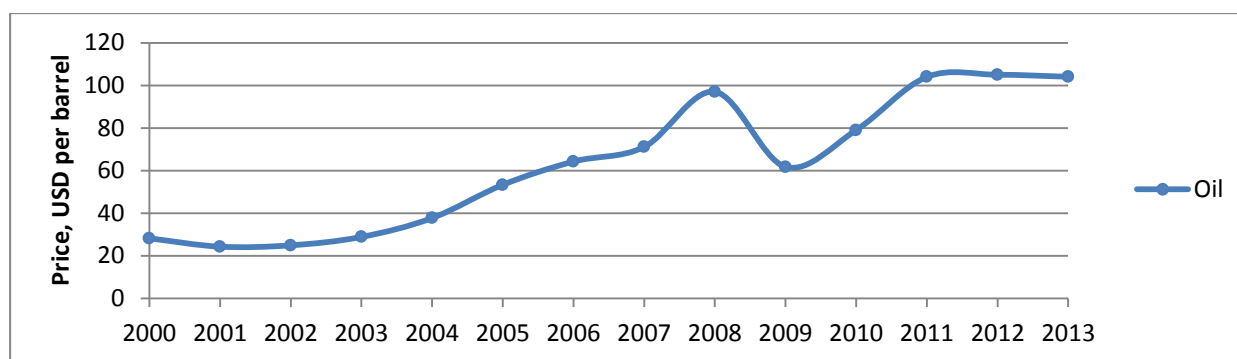
Figure 9. The dynamics of oil prices in the period 2000-2013
*Source:* compiled from Index (2014l).

After record-breaking oil prices the sudden fall has followed. The ongoing economic recession and the decline in demand, the price of oil decreased about 40% up to the first quarter of 2009. Therefore, the oil producers began to reduce the volumes of oil production. In late 2009, as the world economy started to recover and the demand of oil began to rise, the prices of oil recovered pretty fast and within a year had almost doubled, from 61 dollars per barrel in the 2009 to 104 dollars per barrel in the 2011 (see *Figure 9*). Now US oil continued its recent strong run, climbing above 100 USD per barrel (Financial, 2014).

The commodities which were chosen to be analysed in this paper constitute a significant part of total import of goods and services of Lithuania. Part of them fluctuated from 27.8% in 2005 to 68% in 2011. The essential parts of commodities' import are oil and petroleum products, which in 2011 made up more than 50% of the whole Lithuania's import (Lithuanian, 2014; Index, 2014m).

The dynamics of inflation / deflation rate in Lithuania for the period 2000-2013 are presented in *Figure 10*.



Figure 10. Inflation/deflation rate dynamics in Lithuania in the period 2000-2013
*Source:* compiled from Official (2014).

After the 2003 the inflation/deflation rate constantly increased and in the 2008 has reached the highest value around 11% (see *Figure 10*). During a period of 2009/2010 inflation rate decreased and in the 2010 reached 1,3%. With the recovery of the economy, the prices changed correspondent to the situation and in the 2011 the rate of inflation rocket up again. In the period of 2011-2013 the rate of inflation decreased to a record level – slightly over 1%, due to the recession in some EU countries, the EU's fiscal policy and the Lithuanian government policies focused on compliance with the Maastricht criteria for adopting the euro.

Summarizing the analysis of dynamic of commodity prices in a period of 2000-2013, it can be assumed that the prices of commodities are very sensitive to the changes of market conditions. In addition, the prices of mostly all analysed commodities grew from 100% to more than 300% in the period of 2000-2013. It was determined that only the price of natural gas in 2013 was lower than it was in 2000. The significant changes of commodity prices in world commodity exchanges could have an impact for prices changes of final goods and services in Lithuania. The research of the dependence and the results of it are presented in the next chapter.

## 4. The evaluation of Impact of Commodity Prices Changes to General Price Level in Lithuania

As it was mentioned in the beginning, the aim of this paper is to investigate if the influence of changes of commodity price level in the world commodity exchanges makes significant impact on the Lithuanian general price level fluctuations. If the following findings show that the influence is significant, the dependency expression will be found. To identify the influence of changes of commodity price level on general price level a correlation regression analysis will be used. Will be identified the dependence between Y (the rate of inflation in Lithuania) and selected factors:

$X1$ (price of cocoa, USD per kilo);            $X2$ (price of cafe, USD per kilo);
$X3$ (price of sugar, USD cents per kilo);       $X4$ (price of corn, USD per ton );
$X5$ (price of cotton, USD cents per kilo);      $X6$ (price of wool, USD cents per kilo);
$X7$ (price of aluminum, USD per ton);           $X8$ (price of copper, USD per ton);
$X9$ (price of natural gas, USD per mmBTU);      $X10$ (price of coal, USD per ton);
$X11$ (price of oil, USD per barrel).

The quarterly data used for research in period 2000-2013. All calculations were done using Microsoft Excel program. The calculated numerical characteristics of all selected factors are presented in the *Table 1*.

Table 1. Numerical characteristics

|  | *Y* | *X1* | *X2* | *X3* | *X4* | *X5* |
|---|---|---|---|---|---|---|
| Sum | 159.90 | 133.31 | 144.64 | 1700.67 | 9415.41 | 9265.61 |
| Mean | 2.81 | 2.34 | 2.54 | 29.84 | 165.18 | 162.55 |
| Variance | 9.70 | 0.45 | 2.07 | 205.82 | 5823.34 | 4728.23 |
| Standard deviation | 3.11 | 0.67 | 1.44 | 14.35 | 76.31 | 68.76 |
|  | *X6* | *X7* | *X8* | *X9* | *X10* | *X11* |
| Sum | 40755.27 | 110926.53 | 290703.57 | 304.38 | 4032.90 | 3639.11 |
| Mean | 715.00 | 1946.08 | 5100.06 | 5.34 | 70.75 | 63.84 |
| Variance | 88354.07 | 221995.05 | 7545899.38 | 4.56 | 1426.32 | 1008.38 |
| Standard deviation | 297.24 | 471.16 | 2746.98 | 2.14 | 37.77 | 31.76 |

*Source:* compiled by the authors.

From the *Table 1* it is seen that the average of inflation in Lithuania of the previous 14 years is 2.81%, and the standard deviation, that is to say the dispersion of inflation, in period of 2000-2013 is even higher than its mean – 3.11. The standard deviation of all commodity prices was lower than their arithmetic means, what indicates that the fluctuations of commodity prices during the period was lower than the changes of inflation rate in Lithuania.

It should be noted that the minimum dispersion between the analysed factors has the price of cafe (*X*2) which's standard deviation accounts for about one-fourth of the average.

*The investigation of mathematical relationship between CPI and commodity prices.* In order to measure the degree to which variable Y (inflation) is linearly related with every *X* (selected factors) correlation analysis is used. The analysis is carried out by two steps: the coefficient of correlation is calculated; its significance is assessed. The calculated coefficients of correlation presented in *Table 2*. The significance of the correlation coefficients is determined from t-statistic. Critical value t ($t_{kr}$ = 2,00) is found using a statistical function TINV, at the level of significance – 0,05 and degrees of freedom – 55 (i.e., 57-2). When $t_{kr}$ < t, then the coefficient of correlation is significant and a stochastic dependence exists. The *t* statistics values are presented in *Table 2*.

Table 2. The coefficients of correlation and t statistics values

| | *X*1 | *X*2 | *X*3 | *X*4 | *X*5 | *X*6 | *X*7 | *X*8 | *X*9 | *X*10 | *X*11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coefficients of correlation | 0.56 | 0.18 | 0.19 | 0.37 | 0.10 | 0.12 | 0.64 | 0.47 | 0.41 | 0.62 | 0.47 |
| Statistics t | 5.01 | 1.33 | 1.42 | 3.00 | 0.73 | 0.88 | 6.11 | 3.96 | 3.31 | 5.81 | 3.94 |
| t critical | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |

*Source:* compiled by the authors.

As it is seen from *Table 2*, some of the coefficients of correlation calculated from selected factors did not show a statistical relationship between them and inflation in Lithuania. This should be said about the relationship between the prices of cafe (*X*2), sugar (*X*3), cotton (*X*5), wool (*X*6) and inflation (*Y*). The impact on inflation in Lithuania during the period had the changes of cocoa (*X*1), aluminum (*X*7), coal (*X*10), copper (*X*8), oil (*X*11) and gas (*X*9) prices. And moderate positive relationship between *Y* and listed *X* is determined.

*The determination of relationship between inflation and individual commodity prices.* After identifying that Y and some selected variables *X* factors are linearly relates, the analytical expression and the form of stochastic relationship using simple liner regression analysis are sought. The general form of the equation of regression line is following:

$$y = a_0 + a_1 x \qquad (1)$$

Using EXCEL statistical functions, the coefficients of regression line can be calculated using the INTERCEPT (coefficient $a_0$) and SLOPE (coefficient $a_1$) functions. Once these factors are found, respectively having one or the other commodity price, the dependence of inflation rate on the particular factor can be predicted. In figures bellow (see *Figure 11*) the results of regression analysis are presented.
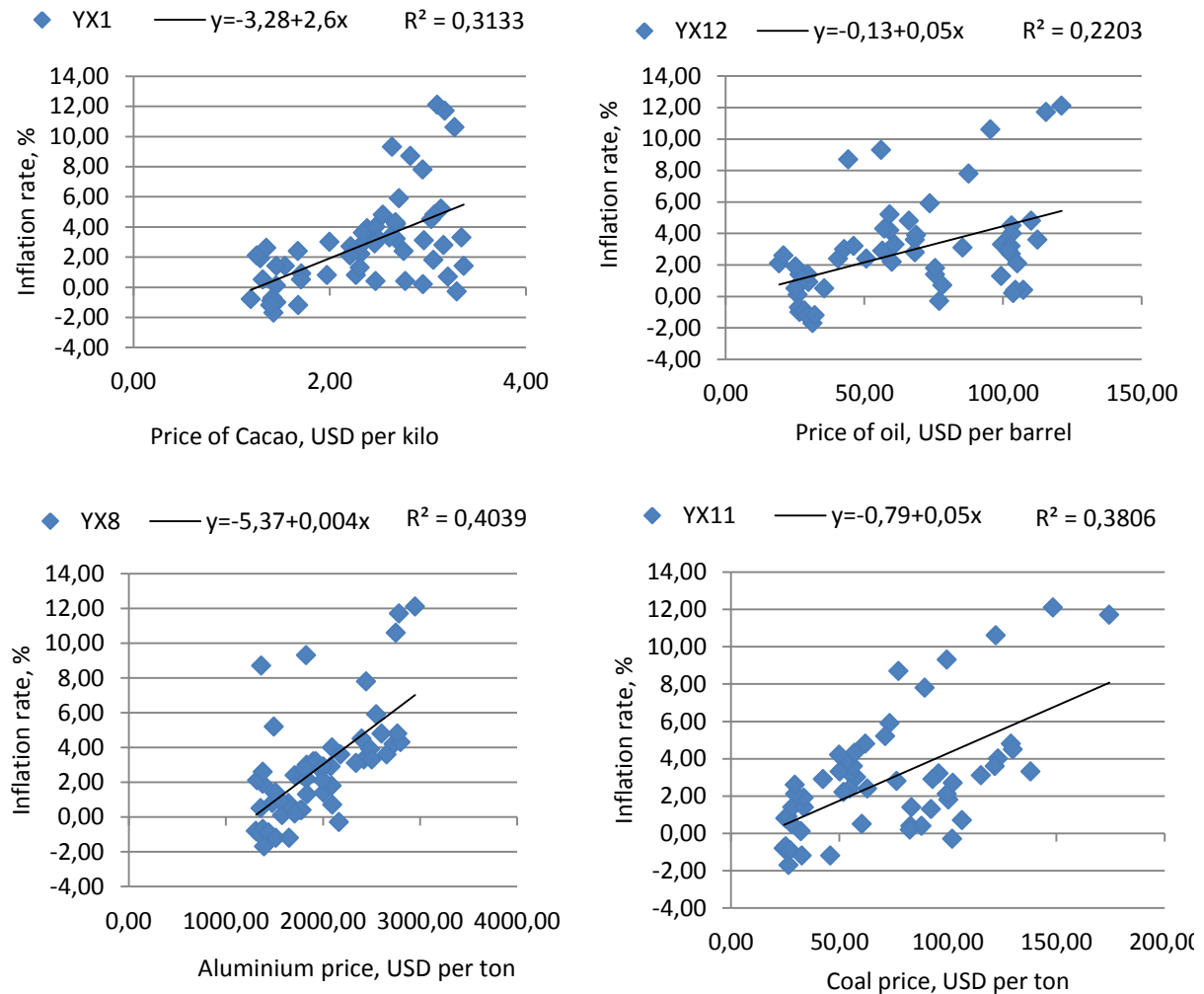
Figure 11. The dependence of inflation rate in Lithuania on prices of cacao, aluminium, coal and oil
*Source:* compiled by the authors.

The adequacy of the regression equations to the real situation is assessed by comparing the dispersing of regression equation's values $y_i$ around the average $\bar{y}$ (regression dispersion) with statistical dispersion of $y_i$ values in relation to the regression line (residual dispersion). If the dispersing of the regression line is significantly lower, it means that the curve reflects statistics fairly well. The ration of dispersions in order to evaluate regression equation of each factor is shown in *Table 3*.

Table 3. Statistical significant F

| Factors | *X*1 | *X*7 | *X*8 | *X*9 | *X*10 | *X*11 |
|---------|------|------|------|------|-------|-------|
| statistics F | 25.10 | 37.27 | 15.71 | 10.95 | 33.80 | 15.54 |

*Source:* compiled by the authors.

The dispersion ratio of all analysed factors, i.e., where statistics F is higher than the critical statistical significance $F_{0,05,1,55}^{kr} = 4.02$ (at a significance level of $\alpha = 0.05$ and degrees of freedom m = 1; n − 2 = 55) are presented in *Table 3*. The conclusion could be made that the

regression equations of all the analysed factors are adequate to the real situation and can be applied in the planning processes or other practical calculations.

*Determination of Relationship Between Inflation and Selected Commodities Prices.* After evaluating the variation of average inflation, by changing one or the other commodity price, it is important to find the general expression of all factors dependent variable. The multiple regression analysis allows to obtain the colligated results for all analysed variables. The general expression of the equation, when the seven chosen factors are included, presented below:

$$y = a_0 + a_1 x_1 + a_7 x_7 + a_8 x_8 + a_9 x_9 + a_{10} x_{10} + a_{11} x_{11} \qquad (2)$$

To measure the reliability of the model, the statistics F with a critical statistical significance should be compared. In our case critical value F=2,687 at a significance level of $\alpha = 0.05$ and degrees of freedom $m = 6; n - 2 = 55$.

*Table 4* shows that the calculated value of the ratio of dispersions is 14.59, which is significantly higher than the critical value F, what means the regression equation is adequate to the real situation and it can be used in the planning process of inflation.

Table 4. Summary output of the regression analysis

| Multiple R | 0,797768 | | Standard | |
|---|---|---|---|---|
| R Square | 0,636434 | | Error | 1,987019 |
| Adjusted R Square | 0,592806 | | Observations | 57 |

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | df | SS | MS | F | Significance F |
| Regression | 6 | 345,5761 | 57,59602 | 14,58775 | 1,54E-09 |
| Residual | 50 | 197,4123 | 3,948246 | | |
| Total | 56 | 542,9884 | | | |

| | Coefficients | Standard Error | t Stat | P-value |
|---|---|---|---|---|
| Intercept | -8,30027 | 1,953353 | -4,24924 | 9,34E-05 |
| X Variable 1 | 0,896931 | 0,76083 | 1,178885 | 0,244024 |
| X Variable 2 | 0,004651 | 0,00162 | 2,870626 | 0,005991 |
| X Variable 3 | -0,00113 | 0,000527 | -2,13811 | 0,037418 |
| X Variable 4 | 0,114245 | 0,200567 | 0,569611 | 0,571492 |
| X Variable 5 | 0,062369 | 0,017646 | 3,534504 | 0,00089 |
| X Variable 6 | 0,010617 | 0,035573 | 0,29845 | 0,766596 |

*Source:* compiled by the authors.

The found linear multiple regression equation looks as follows:

$$y = -8{,}3003 + 0{,}8969 x_1 + 0{,}0047 x_7 - 0{,}0011 x_8 + 0{,}1142\ x_9 + 0{,}0624 x_{10} + 0{,}0106 x_{11} \quad (3)$$

Multiple R value (see *Table 4*) shows how the equation is adequate to regression line. The multiple R is equal 0.798, what shows a strong adequacy of the equation to regression line. R square suggests that the equation explains 64 present of variability and it shows

sufficiency of the reliability of the equation. In the regression line (equation 3) chosen variables X explain the 64% of inflation variability and 36% are explained by other factors.

Taking into account historical results and commodity exchanges experts' forecasts for the future commodity prices, the found linear multiple regression equation, to predict the rate of inflation, could be adapted. However, it is also appropriate to carry out a similar research analysing other factors as well that may be relevant to price changes in Lithuania.

**Conclusions**

Major changes in the general price level, in the case of growth – inflation, are measured by generally considered rate – the consumer price index (CPI). The main reasons of inflation should be mentioned as drivers of changes of aggregated supply or aggregated demand. The increase of commodity prices in world commodity exchanges increases producers' costs of production, what causes the increase of prices of consumer goods, i.e. aggregated supply conditioned inflation.

The analysis of the dynamics of the level of inflation in Lithuania during the last 14 years showed that the highest inflation rate in Lithuania was reached in a year 2008. Short after, the overtaken economic recession, forced to distribute households' costs and to reduce their consumption rates, significantly reduced the rate of inflation. Though responding to the situation in global markets, the next jump of price level, but more temperate, followed. Such dynamics suggests that commodity prices are sensitive to the country, regional and global market conditions.

The research shows that the prices of mostly all analysed commodities grew from 100% to more than 300% in the period of 2000-2013. It was determined that only the price of natural gas in 2013 was lower than it was in 2000.

The conclusion can be made that variation of general price level in Lithuania depends on changes of commodity prices in world commodity. Regression function made with analysed commodities is adequate to real situation and chosen variables X explain the 64% of inflation variability and 36% are explained by other factors.

As the research revealed the inflation rate is correlated with the change of most commodity prices, therefore states especially those with large exported or imported quantities of commodities, should draw the attention to the changes of these commodity prices in world commodity exchanges, before planning the state's anti-inflation politic. Changes of commodity prices in world commodity exchanges usually have a significant impact on the variation of the world's general price level, but on the causes of inflation and the multiplicity features occurring at the same time it is quite difficult to mark out the effect of one or some factors on inflation trends.

The results of the research lead to the conclusion that there is an influence of commodities prices' changes on the general price level in Lithuania. In order to determine the broader adaptability of the obtained results, it would be appropriate to carry out the research selecting other types of commodities and expand the research including other countries.

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