

**Czech University of Life Sciences Prague**

**Faculty of Economics and Management**

**Department of Economics**



**Diploma Thesis**

**Foreign Trade of Thailand – Case study of rice export**

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et Ph.D.**

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# CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

## DIPLOMA THESIS ASSIGNMENT

Bc. Barbora Mandrysz

Economics and Management

Thesis title

**Foreign Trade of Thailand – Case study of rice export**

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### Objectives of thesis

The main aim of the thesis is to conduct analysis of foreign trade of Thailand with the focus on rice export. Partial objectives are to analyze trade balance of Thailand, to identify determinants influencing Thai rice export and to test which factor has a significant impact on Thai rice export.

### Methodology

The literature review of the diploma thesis is processed on a basis of available books and scientific articles connected with foreign trade. The analytical part of the thesis is based on the construction of one-equation econometric model, through which is processed the quantitative analysis of Thai rice export. There are used statistical techniques and tests elaborated in Gretl software and MS Excel to achieve set objectives.

**The proposed extent of the thesis**

60-70 pages

**Keywords**

Thailand, rice, export, foreign trade, econometric model

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Benes V., Maitah M., Smutka L., and Tanner L (2009): Essentials of International Trade. Czech University of Life Sciences Prague, ISBN 978-80-213-1859-5;  
Bjornkov C., and Ventus (2005) Basic International Economics. ApS, ISBN 87-7681-014-3;  
Korotkova T. L. International Economics. – Finances and Statistics, 2011. – 192 p. – ISBN: 978-5-279-03501-4

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### **Declaration**

I declare that I have worked on my diploma thesis titled "Foreign Trade of Thailand – Case study of rice export" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague on 21.03.2018

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Barbora Mandrysz

### **Acknowledgement**

I would like to thank Assoc. Prof. Ing. Mansoor Maitah, Ph.D. et Ph.D., my family and all other persons, for their advice, patience and support during my work on this thesis.

# **Zahraniční obchod Thajska – případová studie vývozu rýže**

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## **Foreign Trade of Thailand – Case study of rice export**

### **Souhrn**

Diplomová práce je zaměřena na zahraniční obchod Thajska, konkrétně na vývoz rýže v letech 1986 – 2016. Hlavním cílem práce je provést analýzu zahraničního obchodu Thajska se zaměřením na vývoz rýže. Práce je rozdělena na teoretickou a praktickou část. Teoretická část se zprvu zabývá světovou produkcí a spotřebou rýže. Dále popisuje důležitost rýže pro světovou ekonomiku, hlavní vývozce a dovozce rýže, determinanty vývozu rýže a mezinárodní organizace na světovém trhu rýží. Dále popisuje ekonometrickou analýzu a její metody. Praktická část se zpočátku zabývá obchodní bilancí Thajska, Thajskou produkcí, vývozem rýže a analýzou vybraných determinant. Toto je následováno analýzou Thajského vývozu rýže v období 1986 – 2016. V rámci analýzy je zde sestaven jednorovnicový ekonometrický model na Thajský vývoz rýže, pomocí kterého je posuzováno, které faktory významně ovlivňují Thajský vývoz rýže. Dále je provedeno ekonomické, statistické a ekonometrické ověřování modelu. Následně jsou zde vypočítány pružnosti proměnných a odvozeny prognózy všech proměnných pro rok 2017, 2018 a 2019.

### **Summary**

The diploma thesis is focused on foreign trade of Thailand, particularly on rice export in the period of 1986 – 2016. The main aim of the thesis is to conduct analysis of foreign trade of Thailand with the intention of rice export. The thesis is divided into theoretical and practical part. The theoretical part firstly deals with a world production and consumption of rice. Furthermore, it describes the significance of rice to the world economy, major rice exporters and importers, determinants of rice export and international organizations in the world rice market. In addition, it describes an econometric analysis and its methods. The practical part initially deals with trade balance of Thailand, Thailand's rice production, export and analysis of chosen determinants. This is followed by an analysis of Thai rice export in the period from 1986 to 2016.

Within the frame of analysis, there is constructed one-equation econometric model for Thai rice export, through which it is determined which factors significantly influence Thai rice export. Moreover, there is processed economic, statistical and econometric verification of the model. Subsequently, there are calculated elasticities of variables and derived prognoses of all the variables for the year 2017, 2018 and 2019.

**Klíčová slova:** Thajsko, rýže, vývoz, zahraniční obchod, ekonometrický model

**Keywords:** Thailand, rice, export, foreign trade, econometric model

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## **Introduction**

Rice is one of the most significant food crops worldwide, cultivated for centuries and consumed by nearly half of the world's population. Natural conditions are important aspects of rice cultivation. Rice plays an important role in developing countries, which are gaining still more significance in the global economy. Processing, production, transportation and trade with this commodity nourish millions of people around the world. Rice is economically and socially sensitive crop that is subject of a specific trade policy in many countries and whose purpose is to ensure prices that would bring fair profits to farmers and would be acceptable to consumers in order to avoid social unrest. The volume of international trade with this commodity has an increasing trend and thus is necessary to pay attention to the development of the world rice market.

In the first part of the thesis there is described the world production and consumption of rice, the significance of rice to the world economy, major exporting and importing countries and determinants of rice export. Moreover, there are described significant international organizations and standards which, to a certain extent, influences the world rice market. In addition, there is described econometric analysis and steps of an econometric model.

The practical part of the thesis examines trade balance of Thailand, its rice production, export and analysis of chosen determinants. Furthermore, there is processed an analysis of Thai rice export from the year 1986 to 2016 through an econometric model. The model is sequentially verified from the economic, statistical and econometric point of view. In addition, there are computed elasticities of variables to determine which of the exogenous variables influences the endogenous variable the most and there are derived prognoses of the variables for the years 2017-2019.

## **Objectives and Methodology**

### **Objectives**

The main objective of the diploma thesis is to conduct analysis of foreign trade of Thailand with the intention of rice export during the period 1986 – 2016. Partial aims are to analyze trade balance of Thailand, to identify determinants influencing the export of rice from Thailand and to test which of the determinants has an important impact on Thai rice export.

## **Methodology**

The literature review of the thesis is processed on a basis of available scientific articles and books with a focus on the foreign trade of rice, econometrics and statistics. The analytical part of the thesis firstly deals with the trend analysis of selected determinants of rice export within the period from 1986 to 2016. This is followed by an econometric analysis in which the main instrument is an econometric model. The model is constructed through the transformation of economic theory into economic-mathematical model. There is performed one-equation econometric model, a linear regression model. In the first part of the econometric analysis, there is constructed economic model corresponding to the relevant economic theory, which is subsequently transformed into econometric model. The following step is the collection of data and its verification and the estimation of the formulated model.

The data are obtained from the International Rice Research Institute, Food and Agriculture Organization of the United Nations (FAO), FAOSTAT, Thai Rice Exporters Association, the U.S. Department of Agriculture (USDA) and World Bank. The individual parameters of the model are estimated through the method of Ordinary Least Square. After the estimation, there are performed economic, statistic and econometric verification of the one-equation econometric model.

The econometric analysis is concluded by the application of the model, which consists of calculation of elasticities and prognoses for the year 2017, 2018 and 2019. The analytical part of the thesis is conducted using statistical tests and techniques elaborated in Gretl software and MS Excel.

# 1. Literature Review

This part of the thesis deals with a world rice production and consumption and importance of rice to the economy. In addition, there is described world rice market, major exporting and importing countries, determinants of rice export, trade policies of selected states, development of price of rice and international organizations associated with rice. The literature review is elaborated on a basis of available literature and articles.

## 1.1. World production and consumption of rice

Rice is the most widely grown crop for a direct consumption. From the human nutrition point of view, it belongs among significant cereals as it is considered as a staple food for nearly 60% of the world's population. (Kopáčová, 2007) Regarding world production, in 2016, rice represented the third highest produced agricultural commodity.<sup>1</sup> Due to a wide variety of climatic conditions across the globe, the largest concentration of rice is grown in Asian, African and South American countries.

Rice is cultivated in more than 100 countries all around the world on the territory of approximately 165 million hectares.<sup>2</sup> Contrary of the early period when the rice was grown only in Asia, nowadays it is cultivated in all continents except Antarctica. (Smith, 2002)

Since 2010, the world rice production has annually exceeded 700 million tonnes. As it can be seen in Figure 1, the production of rice increases evenly with the exception of the year 2002 and 2009. Only in the last decade the total rice production has increased by roughly 22% and in 2014 the world production accounted for a little over 741 million tonnes.<sup>3</sup>

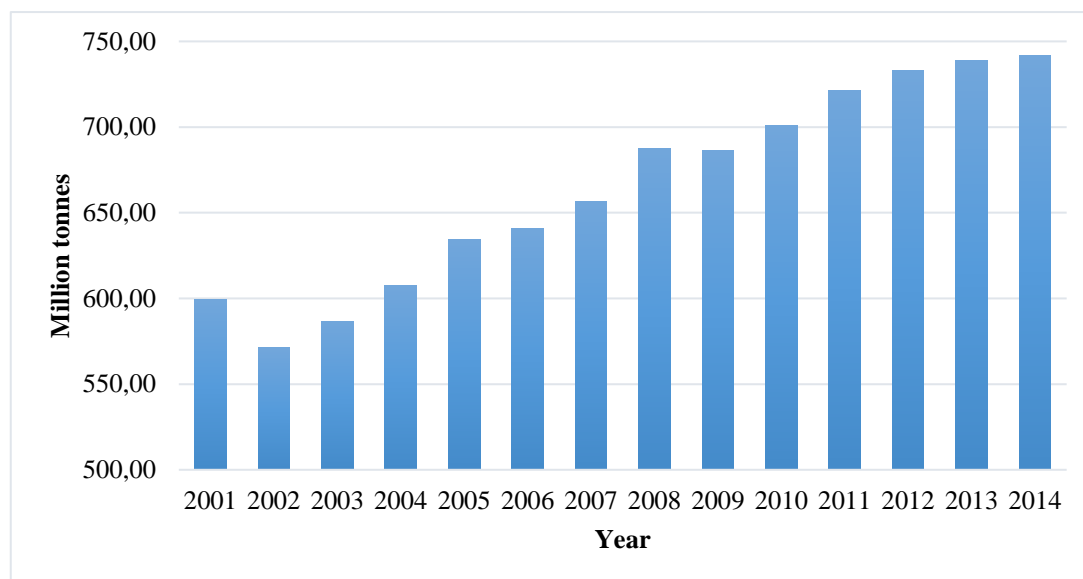
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<sup>1</sup> statista.com, (2017). *Worldwide production of grain in 2016/17, by type (in million metric tons)* [online] Available at: <https://www.statista.com/statistics/263977/world-grain-production-by-type/> [Accessed 21 Sep. 2017]

<sup>2</sup> fao.org, (2017). *Rice market monitor*, July 2017, Volume XX, Issue No.2 [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf) [Accessed 29 Sep. 2017]

<sup>3</sup> fao.org, (2017). *Crops* [online] Available at: <http://www.fao.org/faostat/en/#data/QC/visualize> [Accessed 29 Sep. 2017]

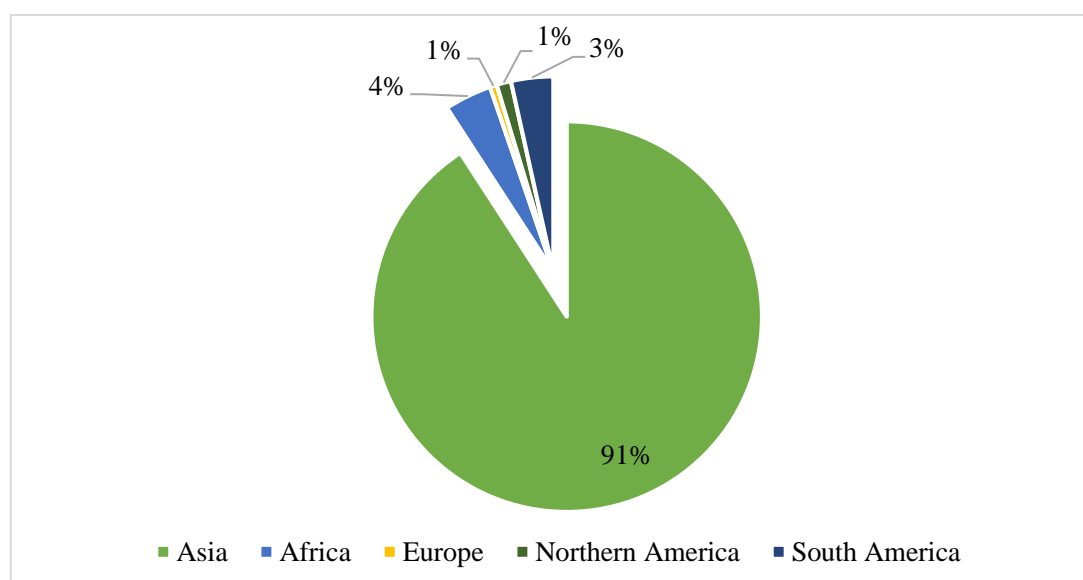
**Figure 1: World rice production from 2001 to 2014**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations (2017)

Most of rice producing countries are developing countries. As it was already mentioned, among main production areas belong Asia, Africa and Southern America. The following Figure 2 shows that in 2015, over 90% of rice was produced in Asian countries, second place occupied Africa and the third South America.

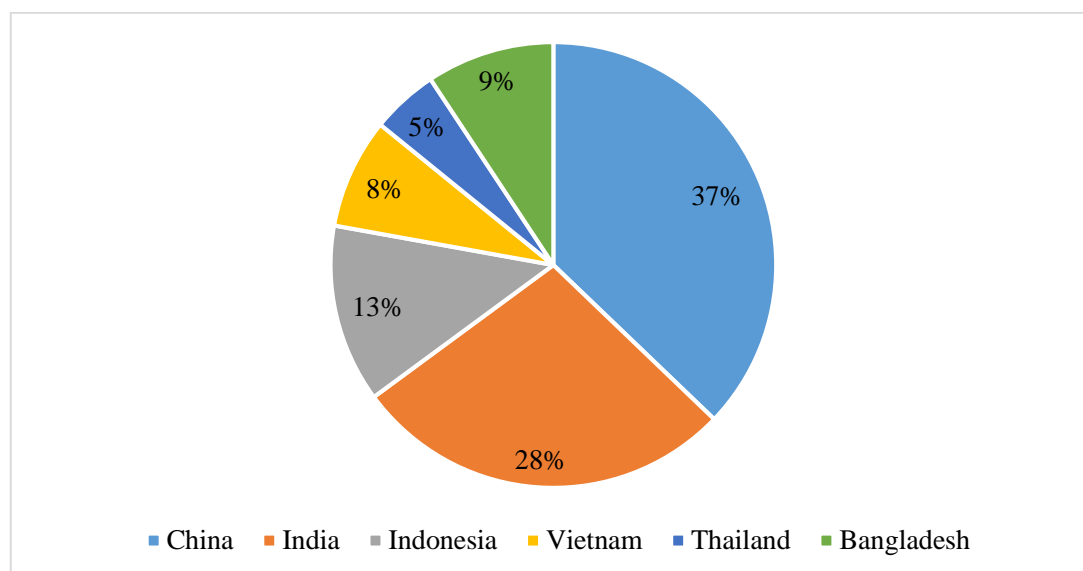
**Figure 2: Share of major producers by continent in 2015**



**Source:** Own elaboration based on Food and Agriculture Organization of the United Nations, Rice Market Monitor (2017)

Due to monsoon rains, which cause a high humidity and a lot of rainfalls, the cultivation conditions in Asia are the most favorable compared to other cultivation areas. The dominant position of Asia in the rice production clearly illustrates also Figure 3. In 2015, all 6 most producing countries were from Asia.

**Figure 3: Share of major producers by country in 2015**



**Source:** Own elaboration based on Food and Agriculture Organization of the United Nations, Rice Market Monitor (2017)

The Figure 3 above shows that in 2015, the largest producers of rice were China and India, which together accounted for more than 50% of world stocks and are even nowadays considered as the most significant countries in the rice market. Although China was the largest producer with the total amount of 209.8 million tonne, its export was very small.<sup>4</sup> India was the second largest producer and consumer of rice and was considered as a main supplier of low quality rice, mainly exported into Indonesia, South Africa, Philippines and Nigeria. Its other major trading partners included the European Union, Saudi Arabia, Iran and the United Arab Emirates, which are mainly interested in Indian basmati rice.<sup>5</sup> In 2011, the removal of trade barriers strengthened the Indian export.

<sup>4</sup> fao.org (2017). Rice market monitor, July 2017, Volume XX, Issue No.2 [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf) [Accessed 29 Sep. 2017]

<sup>5</sup> Wailes, E.J. (2003). Rice: Global Trade, Protectionist Policies, and the Impact of Trade Liberalization. [online] Available at: <http://siteresources.worldbank.org/INTPROSPECTS/Resources/GATChapter10.pdf> [Accessed 15 Oct. 2017]

The 3<sup>rd</sup> biggest producer and consumer of rice, Indonesia, has ideal cultivation conditions too and focuses on the production of low quality rice. For its large amount of imports, Indonesia is also a significant world importer. Similar situation is in case of Bangladesh, which was placed on the 4<sup>th</sup> place of the world production and consumption. In the ranking of top six rice producing countries, Vietnam took the 5<sup>th</sup> place. Even though Vietnam accounted for only less than 10% in the world rice production in 2015, it was the third largest rice exporter, mainly due to lower prices in comparison with competing export countries. Vietnam produces long grain rice, both low and high quality. Its significant export destinations are Indonesia, Malaysia, Cuba and several African countries.<sup>6</sup> Until 2012, Thailand was the largest exporting country despite fact that in 2015, it occupied the 6<sup>th</sup> place in the world's largest producers and accounted for less than 10% in world production as well. Thailand was able to maintain its high position despite the unfavorable climate conditions at the end of 2011, when the country was hit by tropical rainfalls and floods, which had negative impacts on agricultural production.<sup>7</sup>

The primary aim of many producing countries is to achieve self-sufficiency, and thus satisfy the domestic demand and provide enough rice stocks for its inhabitants. (Aksoy, Beghin, 2005) In many countries where the rice is cultivated, it is also consumed. This can be observed in the following Table 1 where are compared top exporters, importers, producers and consumers of rice.

**Table 1: Leading countries of world rice exports, imports, production and consumption in 2015**

<b>Rank</b>	<b>Exports</b>	<b>Imports</b>	<b>Production</b>	<b>Consumption</b>
<b>1.</b>	India	China	China	China
<b>2.</b>	Thailand	Nigeria	India	India
<b>3.</b>	Vietnam	Bangladesh	Indonesia	Indonesia
<b>4.</b>	Pakistan	European Union	Bangladesh	Bangladesh

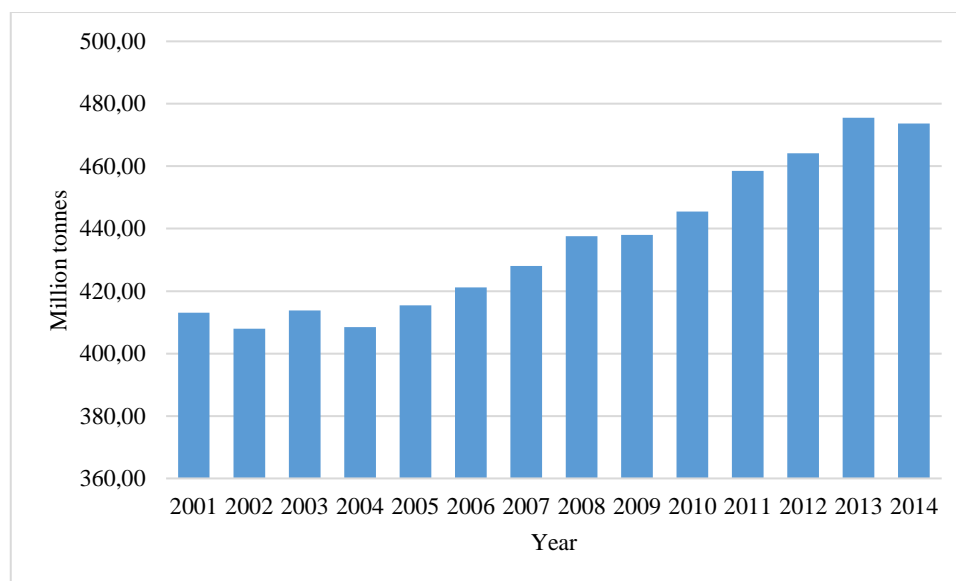
Source: Own elaboration based on the U.S. Department of Agriculture (USDA) (2017)

<sup>6</sup> Wailes, E.J. (2003). Rice: Global Trade, Protectionist Policies, and the Impact of Trade Liberalization. [online] Available at: <http://siteresources.worldbank.org/INTPROSPECTS/Resources/GATChapter10.pdf> [Accessed 15 Oct. 2017]

<sup>7</sup> Fao.org (2012). Rice market monitor, July 2012, Volume XV, Issue No.3 [online] Available at: <http://www.fao.org/docrep/016/ap288e/ap288e.pdf> [Accessed 15 Oct. 2017]

In 2013, the world consumption of rice reached amount of 475.5 million tonnes and as Figure 4 indicates, there is increasing trend except the year 2014 when there was a slight decrease.<sup>8</sup> Related with a high consumption in producing countries, the territorial structure of producing and exporting countries is different. The volume of tradable quantity of rice is small compared to the produced amount.

**Figure 4: Development of world rice consumption from 2001 to 2014**



Source: Own elaboration based on the U.S. Department of Agriculture (USDA) (2017)

For the past years, the average annual consumption of rice per capita has been around 56 kg. However, in some Asian countries, the average consumption per person has been nearly 200 kg per year.<sup>9</sup>

## 1.2. Importance of rice to the world economy

As previously mentioned, rice is a staple for more than 3.5 billion people. It plays a strategic role in many countries, where it does not represent only important source of food and raw materials, but it also creates a large number of jobs. Millions of people are involved in rice chains, whether it is the cultivation, processing or trading.

<sup>8</sup> apps.fas.usda.gov, (2017). *Rice: World Markets and Trade*, [online] Available at: <https://apps.fas.usda.gov/psdonline/circulars/grain-rice.pdf> [Accessed 27 Nov. 2017]

<sup>9</sup> Fao.org (2017). *Rice International Commodity Profile*, [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Documents/Rice\\_Profile\\_Dec-06.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Documents/Rice_Profile_Dec-06.pdf) [Accessed 30 Nov. 2017]



Rice is therefore not negligible source of income for the population.<sup>10</sup> Rice is mostly cultivated in developing countries, in which it represents the most important crop for millions of farmers. Since the consumption of rice in the producing countries is very high, world exports account for only about 5-6% of the produced rice. Despite the low level of export of this commodity, it represents a high importance to the global economy.

Rice also helps to maintain a stable social situation in individual countries. With a shortage of world rice stocks, there is an increasing number of people at risk of poverty. Even in the political field, rice plays a significant role and it is the subject of different trade policies, whose aim is to ensure sufficient income for farmers and affordable prices to consumers. Another important goal of trade policy is to ensure a sufficient supply of rice for its population, thus ensure the food self-sufficiency. There are used subsidies, tariffs, laws and rules which control agricultural businesses and influence international food trade.<sup>11</sup> In addition, a necessary factor is also multifunctionality of agriculture. The cultivation of rice is tied to site conditions, such as climate, soil or topography. At the same time, it creates the cultural landscape of the given country and is the recipient of non-commercial activities such as landscape care. (Smutka, 2010) Some countries even cultivate its culture on rice. Its growing, consumption and sale are indivisible part of the everyday life of millions of people. For instance, in Asia, different parts of the plant are used during religious and festive occasions and in many Western countries rice is prepared for national dishes. (Smith, Dilday 2002)

### **1.3. World rice market**

This chapter concerns the basic quantities of the international trade with rice. It is focused on the most significant exporting and importing countries. Related with international trade there is also analyzed the development of rice prices and its influence on the world rice market.

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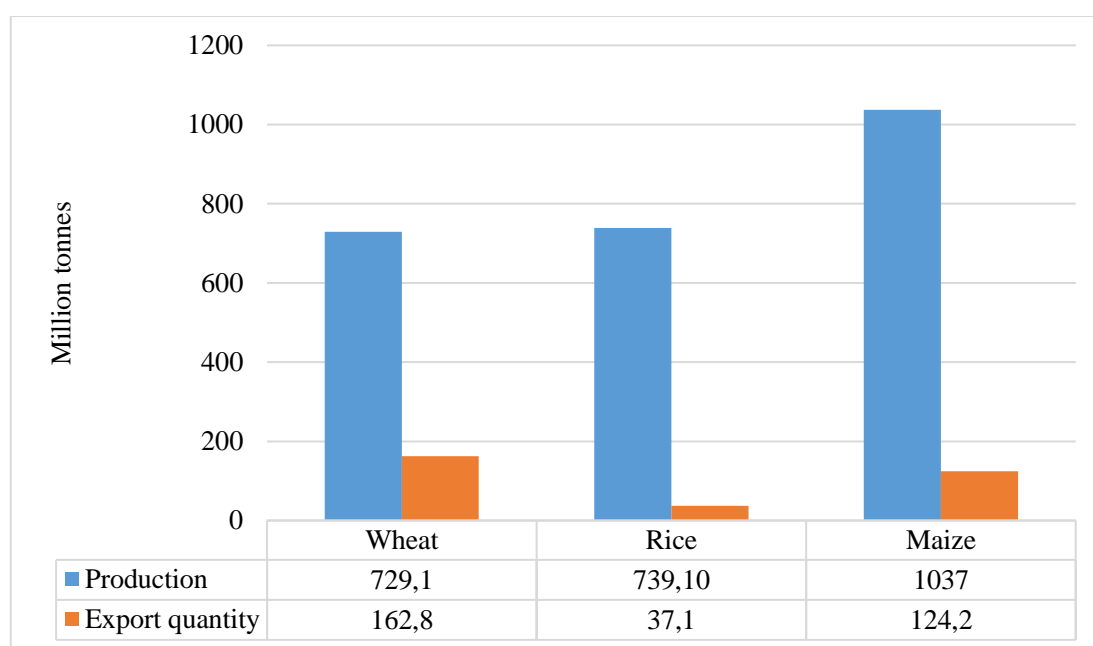
<sup>10</sup> Books.irri.org, (2017). *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, [online] Available at: [http://books.irri.org/9789712202582\\_content.pdf](http://books.irri.org/9789712202582_content.pdf) [Accessed 30 Nov. 2017]

<sup>11</sup> Large.stanford.edu, (2017). *Rice is life: scientific perspectives for the 21<sup>st</sup> century*. [online] Available at: <http://large.stanford.edu/courses/2016/ph240/mccall1/docs/toriyama.pdf> [Accessed 30 Nov. 2017]

### 1.3.1. Rice trade

Since some of the producing countries are at the same time consumers of rice, the volume of rice exchanged internationally is low compared to the volume of produced rice. In 2015, net exports accounted for roughly 44.9 million tonnes and the total world production was over 739 million tonnes.<sup>12</sup> In comparison with other grains such as maize or wheat, the proportion of traded volume of wheat and corn is much larger. Figure 5 illustrates that in 2013, the world wheat and corn exports were more than three times higher than rice exports.

**Figure 5: World production and export of selected cereals in 2013**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

As previously mentioned, the purpose of countries to have a small volume of rice traded is to achieve the greatest possible self-sufficiency and to build up stocks to satisfy domestic demand. Rice is mostly traded on commodity exchanges, where the trade is carried on according to established rules. These rules ensure a reliable environment for realization of trading operations, supervision of business practices and security of ongoing operations. (Jílek, 2002)

<sup>12</sup> Fao.org (2017). Rice market monitor, July 2017, Volume XX, Issue No.2 [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Images/RMM/RMM-Jul17.pdf) [Accessed 29 Sep. 2017]

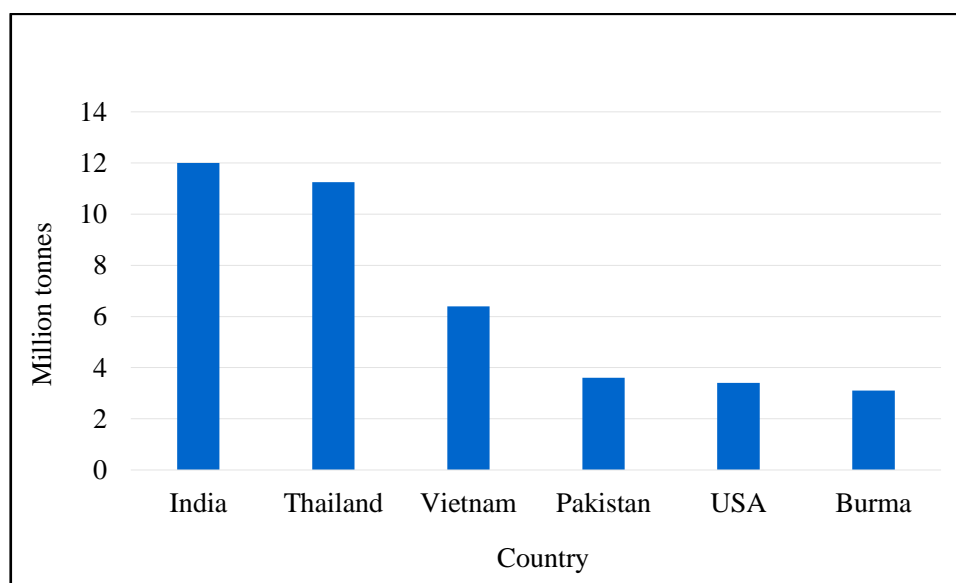
Rice trade is mostly mediated through commodity futures contracts, which are agreements to purchase or sell a predetermined quantity of a commodity for a certain price and date in the future.<sup>13</sup> International rice trade is mainly carried out through large international trading companies, which also frequently trade with other agricultural commodities. Some of the trading companies also undertake rice storage, processing and transportation. Brokers represent a key person in facilitating trade since they identify a suitable purchasers or retailers for the required quality and type of rice.<sup>14</sup>

### 1.3.2. Major exporters and importers of rice

#### Exporters

Asian countries belong among major suppliers of rice. In 2016, India was the world's largest exporter with amount of over 10 million tonnes. The Figure 6 reflects top exporting countries in 2016.

**Figure 6: Top 6 rice exporting countries in 2016**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

<sup>13</sup> Investopedia, (2017). *Commodity Futures Contracts*. [online] Available at: <https://www.investopedia.com/terms/c/commodityfuturescontract.asp> [Accessed 2 Dec. 2017]

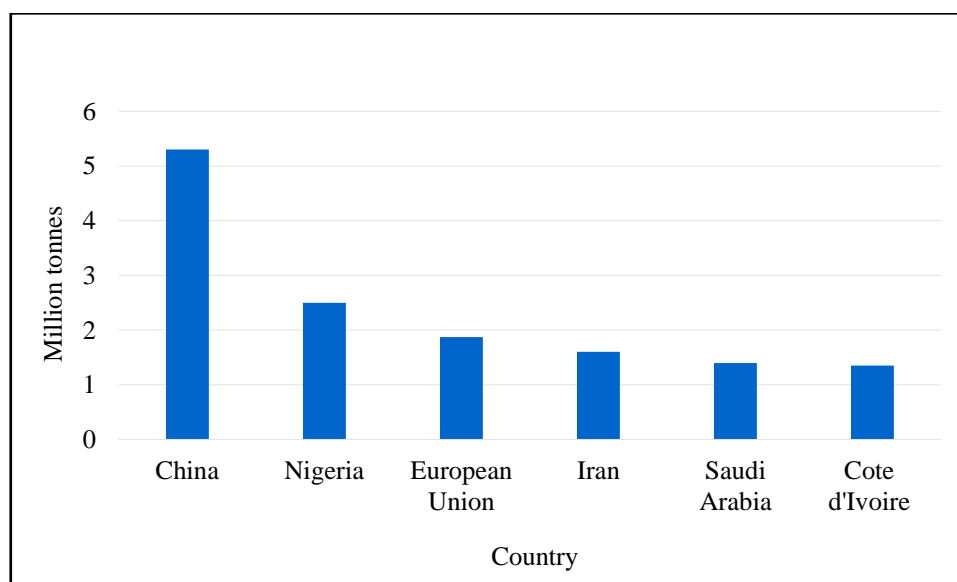
<sup>14</sup> Fao.org (2017). *Rice International Commodity Profile*. [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Documents/Rice\\_Profile\\_Dec-06.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Documents/Rice_Profile_Dec-06.pdf) [Accessed 30 Nov. 2017]

Thailand was the second and Vietnam the third largest source of supplies. Outside of Asia, the United States belong among leading rice exporting countries. Since the large amount of rice exports originates in a relatively low number of countries, it makes rice trade sensitive to changes in government policies in these key countries. For instance, between 2001 – 2004, India resorted to export subsidies, which led to a significant trade expansion but at the same time to low world rice quotations. On the other hand, Vietnam repeatedly imposed restrictions on exports with aim to avert shortages on the local market.<sup>15</sup>

### Importers

In 2016, China was the world’s largest rice importer. China was also the biggest producer and consumer of rice. Major rice importing countries are illustrated in Figure 7.

**Figure 7: Top 6 rice importing countries in 2016**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

In 2016, China allowed rice import from the United States and South Korea to satisfy the country’s growing demand for rice. During the past few years, Thailand, Pakistan and Vietnam have been among other main countries supplying China.<sup>16</sup>

<sup>15</sup> Fao.org (2017). *Rice International Commodity Profile*. [online] Available at: [http://www.fao.org/fileadmin/templates/est/COMM\\_MARKETS\\_MONITORING/Rice/Documents/Rice\\_Profile\\_Dec-06.pdf](http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Documents/Rice_Profile_Dec-06.pdf) [Accessed 30 Nov. 2017]

<sup>16</sup> Globaltimes.cn (2016). *China opens domestic rice market to more importers to satisfy growing demand*. [online] Available at: <http://www.globaltimes.cn/content/969040.shtml> [Accessed 30 Nov. 2017]

Nigeria occupied the second place with the total quantity of approximately 2.5 million tonnes in 2016. The third largest importing country was European Union. The majority of rice is cultivated in Spain, Italy, Greece and Portugal. However, there are other rice producing countries such as Hungary, France or Bulgaria.<sup>17</sup> Other main importers included Iran, Saudi Arabia and Côte d'Ivoire.

### **1.3.3. Determinants of rice export**

There were conducted several analyses on determinants of rice export. According to research performed by Bilal and Rizvi (2013), among factors influencing rice export belong exchange rate, GDP of exporting and importing country, export price, production, domestic consumption, domestic price and international price.

An exchange rate is the price of one currency expressed in another currency. The exchange rate ensures connectivity of domestic economy with the rest of the world, since it enables to compare domestic economic aspects such as price, wage or income with foreigners. (Neumann *et al.*, 2008) A currency appreciation occurs when there is an increase in the value of one currency in terms of another. As a result of currency appreciation, exports become more expensive, the demand for exports is reduced and thus the country loses its competitiveness. A depreciation of currency means fall in the value of a currency in terms of another currency. The currency depreciation might improve a nation's trade deficit since exports are cheaper and it also improves the export competitiveness of the country. (Neumann *et al.*, 2008) Previous empirical studies performed by Kumar *et al.* (2008) and Haleem *et al.* (2005) revealed a significant and positive impact of exchange rate on exports.

Export price represents another determinant influencing export. An increase in export price makes exports more expensive in the world market. According to research processed by Bilal and Rizvi (2013), there is a negative relationship between export price and export. However, a different study performed by Kumar *et al.* (2008) founded a positive effect of export price on export. The rice export is also influenced by the GDP of exporting and importing country. A higher level of production can lead to export expansion. In an open economy, surpluses create foreign reserves by exporting production. In importing countries, the larger domestic markets can absorb higher amount of imports.

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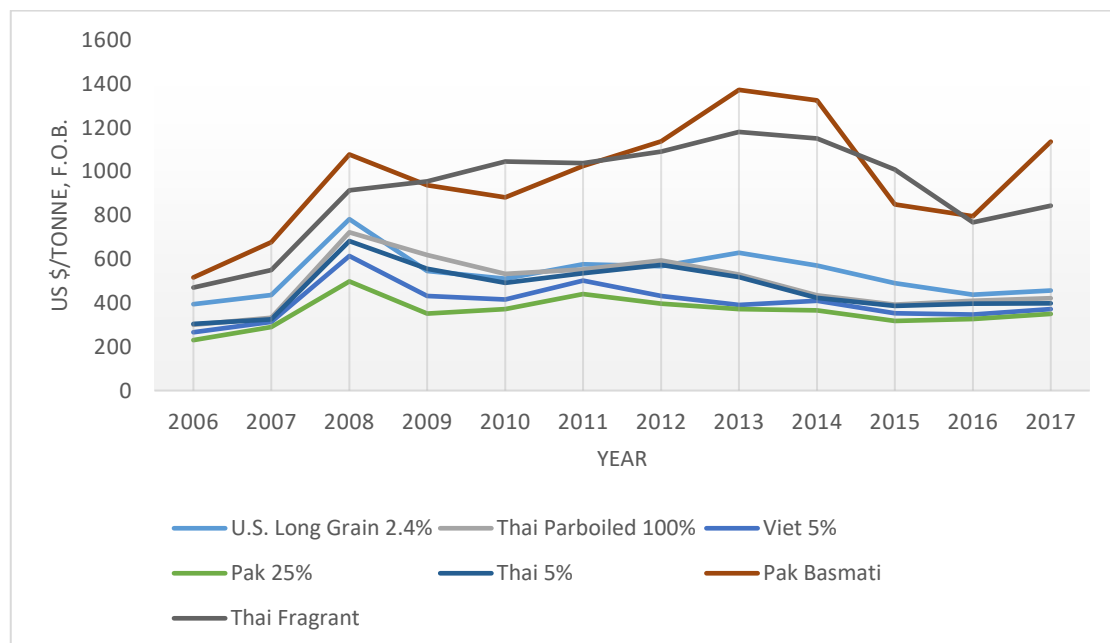
<sup>17</sup> Ricepedia.org (2017). *Europe*. [online] Available at: <http://ricepedia.org/rice-around-the-world/europe> [Accessed 30 Nov. 2017]

Empirical work performed by Shane, Roe, and Somwaru (2008) showed a positive influence of GDP on export. Production is another factor influencing export. If there is an increase in domestic production, there are more of surpluses available for exports, which causes increase in total value of export. Bilal and Rizvi (2013) revealed the positive relationship between domestic production and export. Domestic consumption has impact on export as well. If there is an increase in domestic consumption, there are less of surpluses available for export, resulting in decrease of total exports. Research of Abolagba *et al.* (2010) concluded that there is a negative relationship between domestic consumption and exports.

### 1.3.4. Development of price of rice

In the world rice market there are varieties of submarkets, whose prices are determined according to quality, country origin, stages of process and different types. There are thousands of varieties of cultivated rice. Figure 8 shows export price development of chosen types of rice during the past 12 years.

**Figure 8: Export prices of chosen rice types, 2006 – 2017**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

Price fluctuations are an integral part of the international market since the analyzed agricultural commodity is extremely sensitive to growing conditions and temperature fluctuations.

The Figure 8 shows that there was a sharp increase of prices in 2008, when prices increased by nearly 50%. This period is referred as the rice crisis. The prices of Basmati rice hit the record level of over \$1000 USD per tonne. The situation caused a panic which influenced the whole sector. The rice importing countries were afraid of a shortage of rice and thus increased the demand for rice. On the other hand, rice producing and exporting countries put restrictions on exports to ensure enough stocks for domestic consumption.<sup>18</sup> The general panic was in case of all agricultural products, but rice is considered as a very vulnerable due to its significance as a large source of calories for human consumption.<sup>19</sup> There were several factors connected with the rice crisis. A weak US dollar, increasing oil prices and tariffs contributed to higher soybean and maize prices. There was also decrease in wheat production due to unpleasant weather conditions, which resulted in higher wheat prices. These price increases contributed to policy decisions of important rice trading countries and led to a more rapid and larger price increase on the world rice market.<sup>20</sup> After the year 2008, the rice prices decreased, however, remained on a higher level compare to previous years.

#### **1.3.4.1. Trade policies of selected countries**

An important aspect of international rice market is a high degree of protection. In most countries, both exporting and importing, the state plays an important role and, to a large extent, influences its form. This chapter describes trade policies of chosen countries.

##### **India**

Main policy objectives of Indian agriculture are to provide sufficient nutrition for rapidly growing population and self-sufficiency in grains. There is no specific emphasis on rice, they seek to achieve its goals in case of all grains. Another aim is to ensure food price stability and thus the import regulation represents the important part of protection of domestic market. There are several state organizations dealing with rice trade.

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<sup>18</sup> Legacy.blisty.cz (2017). *Ani banky, ani nemovitosti, ale rýže je problem.* [online] Available at: <https://legacy.blisty.cz/art/40056.html> [Accessed 30 Nov. 2017]

<sup>19</sup> Hir.harvard.edu (2017). *The Rice Crisis of 2008.* [online] Available at: <http://hir.harvard.edu/article/?a=13124> [Accessed 30 Nov. 2017]

<sup>20</sup> Fao.org (2017). *The Rice Crisis. Markets, Policies and Food Security.* [online] Available at: <http://www.fao.org/3/a-an794e.pdf> [Accessed 30 Nov. 2017]

The first one is the Indian Public Distribution System (PDS), which controls the price of rice, ensures price stability and distribution within domestic market. The second organization is The Food Corporation of India (FCI), which conducts purchases of rice from farmers. The FCI also stores and subsequently distributes rice domestically.<sup>21</sup> In 2008, when there was a sharp increase in world rice prices, the Indian government increased the export price to discourage exports and eventually completely banned the export of rice. Exports can be restricted in order to ensure food security of the country. However, in case of India, there were no restrictions on the export of Basmati rice.<sup>22</sup>

Another important state corporation in India is Project and Equipment Corporation (PEC), which purchases rice at pre-set preferential prices and can regulate the amount of inventory in the country. It also supports its own farmers. The Government assists farmers through various programs to support agriculture and rural development. These include insurance against price fluctuations in the agricultural market, natural disaster insurance and commodity lending. In recent years, production of man-made fertilizers has increased in India and mechanization is being introduced in agricultural work. An important task for the government in following years will be to ensure large scale irrigation and water saving treatment. These steps should lead to the creation of modern agriculture as a competitive sector.<sup>23</sup>

## **Vietnam**

The primary policy goal of Vietnam is to achieve food security for its population and at the same time to increase foreign exchange earnings through encouraging export of agricultural products.<sup>24</sup> Important roles in the Vietnam's rice industry play the Vietnam Food Association (VFA), the Ministry of Agriculture and Rural Development (MARD) and the Ministry of Industry and Trade (MOIT). Moreover, there are two enterprises dealing with rice marketing: Vinafood 1 (the Northern Food Corporation) located in Hanoi and Vinafood 2 (the Southern Food Corporation) situated in Ho Chi Minh City.

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<sup>21</sup> Curis.ku.dk (2017). *Vietnam in the international rice market*. [online] Available at: [https://curis.ku.dk/ws/files/127937814/FOI\\_Rapport\\_132.pdf](https://curis.ku.dk/ws/files/127937814/FOI_Rapport_132.pdf) [Accessed 30 Nov. 2017]

<sup>22</sup> News.bbc.co.uk (2017). *India introduces rice export ban*. [online] Available at: [http://news.bbc.co.uk/2/hi/south\\_asia/7323713.stm](http://news.bbc.co.uk/2/hi/south_asia/7323713.stm) [Accessed 30 Nov. 2017]

<sup>23</sup> Fao.org (2017). *The Rice Crisis. Markets, Policies and Food Security*. [online] Available at: <http://www.fao.org/3/a-an794e.pdf> [Accessed 30 Nov. 2017]

<sup>24</sup> Curis.ku.dk (2017). *Vietnam in the international rice market*. [online] Available at: [https://curis.ku.dk/ws/files/127937814/FOI\\_Rapport\\_132.pdf](https://curis.ku.dk/ws/files/127937814/FOI_Rapport_132.pdf) [Accessed 30 Nov. 2017]



The VFA is an organization of companies engaging in processing, producing and trading of agricultural products. The task of MARD and MOIT is to monitor operations of rice industry and to conduct forecasts on supply, demand and prices.<sup>25</sup> Even though Vietnam is the 3<sup>rd</sup> largest exporter of rice, it also belongs among rice importers, because there is a significant demand for better-quality rice which is not cultivated in Vietnam. The Government attempts to put restrictions on imports of high-quality rice to support domestic farmers in cultivation of this type of rice. Vietnam sets up special areas intended to production of quality rice. In addition, Vietnam places emphasis on improving conditions of processing and storing. State provides advantageous loans with low loans to its farmers.

### **European Union**

Rice policy of the EU is unified with the Common Agricultural Policy (CAP) and thus the objectives are coherent. The EU aims are to ensure the availability of supplies, reasonable prices for consumers, a fair living standard for the agricultural community, to stabilize markets, the optimal use of factors of production and to increase agricultural productivity.<sup>26</sup> The EU rice regime includes few components such as system guaranteeing purchases at a predetermined intervention price, import duties gradually being lowered, compensatory payments and export restitutions that enable EU exporters to compete on world markets.<sup>27</sup>

The common market is regulated by rules and integrated instruments such as common prices or quotes, which protects domestic goods. All parts of EU's Common Agricultural Policy are funded by all Member States and the European Agricultural Fund for Rural Development (EAFRD), which provides support for rural development to improve environment and support the competitiveness of agriculture.<sup>28</sup>

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<sup>25</sup> Fao.org (2017). *The Rice Crisis. Markets, Policies and Food Security*. [online] Available at: <http://www.fao.org/3/a-an794e.pdf> [Accessed 30 Nov. 2017]

<sup>26</sup> Europarl.europa.eu (2017). *The Common Agricultural Policy (CAP) and the Treaty*. [online] Available at: [http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU\\_3.2.1.html](http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_3.2.1.html) [Accessed 30 Nov. 2017]

<sup>27</sup> Curis.ku.dk (2017). *Vietnam in the international rice market*. [online] Available at: [https://curis.ku.dk/ws/files/127937814/FOI\\_Rapport\\_132.pdf](https://curis.ku.dk/ws/files/127937814/FOI_Rapport_132.pdf) [Accessed 30 Nov. 2017]

<sup>28</sup> Ec.europa.eu (2017). *European Agricultural Fund for Rural Development (EAFRD)*. [online] Available at: [http://ec.europa.eu/regional\\_policy/en/policy/what/glossary/e/european-agricultural-fund-for-rural-development](http://ec.europa.eu/regional_policy/en/policy/what/glossary/e/european-agricultural-fund-for-rural-development) [Accessed 30 Nov. 2017]

## **Nigeria**

Ensuring food security is the main objective of agricultural policy of Nigeria. The Government authorities attempt to eliminate poverty and hunger by increasing productivity, thereby to reduce the country's dependence on imports. (Stockbridge, 2007) The Government has attempted to regulate the rice market through restriction of exports and imports. The ban on exports should ensure greater domestic supplies. The import ban was applied during the period of extremely successful harvests to assure sales of local farmers. However, these measures were in contradiction with the liberalization of agrarian trade and after the WTO negotiations within the Uruguay Round were eliminated.

In order to protect domestic producers, Nigeria increased import duties. State authorities support farmers through subsidies for seedlings, fuels and fertilizers. Rice is purchased at a predetermined price. Its stocks are subsequently sold to consumers on the domestic market for affordable price. Agricultural sector receives subsidies not only from the Government, but it is also supported by institutions by raising funds and investments into agricultural areas. (Zronik, 2006)

### **1.3.4.2. International organizations in world rice market**

#### **The International Rice Research Institute (IRRI)**

IRRI is an independent, non-profit organization whose aim is to reduce hunger and poverty by improving the health, rice science, welfare of rice consumers and farmers, and by protecting the rice growing environment for future generations. It was founded in 1960 currently with a headquarter in Los Baños, Philippines. The institute has offices in 17 rice producing countries in Africa and Asia with over 1 000 staff. The IRRI develops advanced types of rice, improved technologies and methods which help farmers to manage their farms profitably. In addition, it serves as research and educational institute and assists in implementing strategies for country rice sector.<sup>29</sup>

#### **USA Rice Federation**

Aims of the USA Rice Federation are to ensure health and vitality of the U.S. rice industry. It consists of millers, farmers, users and suppliers.

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<sup>29</sup> Irri.org (2017). *Our organization*. [online] Available at: <http://irri.org/about-us/our-organization> [Accessed 30 Nov. 2017]

In addition, it splits into USA Rice Council, USA Rice Farmers, USA Rice Merchants' Association and USA Rice Millers' Association.<sup>30</sup> The Rice Federation seeks to provide the long-term sustainability and competitiveness of the U.S. rice industry. In addition, the organization serves as the education and research program for the industry.<sup>31</sup>

### **The Africa Rice Center (AfricaRice)**

The rice research organization AfricaRice currently includes 26 countries and seeks to decrease poverty and to ensure food security in Africa through research and development. Moreover, the mission is to increase the productivity and profitability of the African rice sector to ensure the sustainability of the sector. The organization was created in 1971 by 11 African states. Its headquarter is situated in Côte d'Ivoire and its Regional Centers are in Senegal, Nigeria, Liberia, Benin, Tanzania and Madagascar.<sup>32</sup>

## **1.4. Econometric analysis**

According to Hušek (2007), an econometric analysis results from a combination of economic theory, statistics and mathematics with aim to measure, test or verify some economic or social phenomena. One of the goals of econometrics is to give economic theory empirical content, therefore content based on experience. The subject of its research includes following areas:

1. A development of an econometric theory consisting in modification of estimative and testing methods and computational techniques suitable for econometric models and empirical data (Econometric methods)
2. Mathematical and statistical formulation of economic theory through modelling (Econometric modelling)
3. Application of econometric models and methods in individual areas of economic theory (Applied econometrics)

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<sup>30</sup> Usarice.com (2017). *About*. [online] Available at: <https://www.usarice.com/about/who-we-are> [Accessed 30 Nov. 2017]

<sup>31</sup> Usarice.com (2017). *The Rice Foundation*. [online] Available at: <https://www.usarice.com/about/rice-foundation> [Accessed 30 Nov. 2017]

<sup>32</sup> Africarice.org (2017). *Africa Rice Center*. [online] Available at: <http://www.africarice.org/warda/aboutus.asp> [Accessed 30 Nov. 2017]

## 1.5. Econometric model

Depending on the purpose of research, econometric models can consist of one or more equations. There exist single-equation models, multiple-equation models or simultaneous-equation models.

The construction of econometric model consists of the following steps:

1. Creation of economic model
2. Creation of econometric model
3. Obtaining data and its verification
4. Estimation of the parameters of the econometric model
5. Verification of the model
6. Application of the econometric model or its rejection (Gujarati, 2003)

### 1.5.1. Creation of economic model

An economic model is derived from an economic theory and it is a simplification of economic reality. Economic models, i.e. relationships between economic variables, can be expressed algebraically, verbally or graphically. (Čechura, 2014)

When formulating the economic model, it is necessary:

- a. To define the subject of the research – in the model expressed as endogenous variable
- b. To select appropriate exogenous variables
- c. To establish a functional form of the model (Tvrdoň, 2015)

In addition, the economic model must fulfill specification assumptions, namely the inclusion of relevant variables into the model, non-inclusion of irrelevant variables, the selection of appropriate functional form of the model, and the assumption that there is no simultaneous relationship between the endogenous and the exogenous variable or between the exogenous variables. The defined economic model is used to confront economic theory with reality. (Čechura, 2014)

The economic model can be mathematically expressed as following:

$$y = f(x_1, x_2, x_3, x_4) + u \quad (1)$$

where:

y ... endogenous/explained/dependent variable

$x_{1-4}$  ... exogenous/explanatory/independent variables

u ... random component

### 1.5.2. Creation of econometric model

Unlike the economic model, the econometric model is specified by the functional form and includes parameters together with a stochastic component.

The econometric model can be mathematically expressed as following:

$$\beta_{11}y_{1t} = \gamma_{11}x_{1t} + \gamma_{12}x_{2t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + u_{1t} \quad (2)$$

where:

$\beta$  ... parameter of endogenous variable

$\gamma$  ... parameter of exogenous variable

$y_t$  ... endogenous variable at time  $t$

$x_{1t-4t}$  ... exogenous variables at time  $t$

$u_t$  ... random/stochastic component

In the formulation of the econometric model there are important following steps:

#### 1. Selection of mathematical form of the model

The mathematical form of the econometric model can take these forms:

**Single-equation model** contains only one endogenous variable depending on one or more exogenous variables and a random component.

**Multiple-equation model** includes two or more endogenous variables, in which each equation can be examined as a single-equation model.

**Simultaneous-equation model** consists of a system of equations, where endogenous variables can appear in the model on both sides, they can be in role of endogenous variables as well as of explanatory variables. (Hušek, 2007)

#### 2. Determination and classification of all variables included in the model

The model can include following types of variables:

**Endogenous variables** are explained by the model, thus the values are generated by the model. The endogenous variables are generally expressed by  $y$ .

**Exogenous variables** explain endogenous variables and are generally denoted by  $x$ . The values originate outside of the model.

**Random/Stochastic variable** includes influences of all other variables on endogenous variable but are not included in the model. This variable is denoted by  $u$ .

In addition, there are **predeterminant variables**, which include lagged endogenous, lagged exogenous and exogenous variables. (Čechura, 2014)

If the model consists of variables which do not change over time, this model is called a static model. Since the most of economic variables evolve over time, it is necessary to include the time factor into the model, by which means the model becomes a dynamic model. According to Čechura (2014), besides the inclusion of time factor, the model can be also dynamized by expression of variables in gradual differences, inclusion of lagged variables and inclusion by so called dummy variable. A dummy variable is an artificial variable that takes the value of 0 (absence of some effect) and 1 (presence of some effect). (Gujarati, 2003)

### **3. Presumption of signs and expected values of estimated parameters of the model**

The signs of parameters are determined primarily on the basis of economic theory. Based on that, it can be decided that the sign of the specific parameter can be only positive or negative. Similarly, it is possible to determine in which interval the expected values of the estimated parameters will occur. (Hušek, 2007)

#### **1.5.3. Obtaining data and its verification**

To have a high-quality econometric analysis, it is necessary to collect representative statistical data. At this stage, data collecting, sorting and verification determines whether the data have the required properties for estimation of parameters of the model. If the data do not meet statistical requirements, it is necessary to reformulate the equations and its variables or to modify the original variables by different procedures. (Tvrdoň, 2015)

Prior to statistical data processing, it is necessary to summarize and to check collected data. It is an assessment of whether the data correspond to its level of possible bounds, in which they can occur. In addition, there should be conducted research for errors that can be either deliberate, thus causing deliberate distortion of data, or unintentional errors resulting from negligence or data transcription. (Hošková, 2014) Among basic statistical characteristics belong measures of location and measures of variation.

## Measures of location

**The arithmetic mean** can be computed from separate values of the variable (non-weighted form) or from a distribution table (weighted-form). The mean is very sensitive to extreme values which significantly differ and can distort the statistical set.

**Median** is a middle value when the original values are sorted into a variation range.

**Mode** is a value with the highest frequency.

**Quartiles** divide the arranged values into 4 equal parts:

- *First quartile* separates the bottom 25% of the arranged values from the top 75%.
- *Second quartile (median)* separates the bottom 50% of the arranged values from the top 50%.
- *Third quartile* separates the bottom 75% of the arranged values from the top 25%.
- *Interquartile range* measures the spread in the middle 50% of the data, it is the difference between the third and first quartile. (Hošková, 2014)

## Measures of variation

**Range  $R$**  is a difference between the largest and the smallest observation.

$$R = x_{max} - x_{min} \quad (3)$$

**Variance  $s^2$**  is a sum of squared differences among each observation and the sample mean divided by the sample size  $n$ .

$$s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n} \quad (4)$$

**Standard deviation  $s$**  is the square root of the variance.

$$s = \sqrt{s^2} \quad (5)$$

### 1.5.4. Estimation of parameters of the econometric model

One of the most common method used for estimation is the Ordinary Least Square method (OLS) which is more in detail described in the chapter Ordinary Least Square method.

### 1.5.5. Verification of the model

The model is verified from the economic, statistical and econometrical point of view.

**Economic verification** assesses the direction and intensity of the exogenous variables on the endogenous variable. Therefore, it consists in verification of accuracy of the signs and the size of calculated values of the estimated parameters.

**Statistical verification** determines the statistical significance of the estimated parameters and of the whole econometric model. In the framework of statistical verification, there are included:

#### The R<sup>2</sup> measure of goodness of fit

The coefficient of determination R<sup>2</sup> measures how well is the variation of endogenous variable explained by the variation of explanatory variables, in other words, from how many % are the changes of the endogenous variable explained by the exogenous variables. (Hušek, 2007).

The R<sup>2</sup> is given by the formula:

$$R^2 = 1 - \frac{s_u^2}{s_y^2} \quad (6)$$

Where:

$s_y^2$  ... variance of the endogenous variable given by the formula:

$$s_y^2 = \frac{\sum_{t=1}^n (y_t - \bar{y})^2}{n} \quad (7)$$

$s_u^2$  ... the residual variance given by the formula:

$$s_u^2 = \frac{\sum_{t=1}^n (y_t - \hat{y}_t)^2}{n} \quad (8)$$

$y_t$  ... real values of endogenous variable

$\hat{y}_t$  ... theoretical values of endogenous variable

$\bar{y}$  ... an average of real values of endogenous variable

$n$  ... a length of time series



### Statistical significance of estimated parameters

The t-test is used to test the significance of estimated parameters. The procedure of testing consists of:

Calculation of matrix:

$$(X^T - X)^{-1} \quad (9)$$

Calculation of cor. residual variance:

$$\overline{s_u^2} = \frac{\sum_{t=1}^n (y_t - \hat{y}_t)^2}{n - p} \quad (10)$$

Calculation of variance of estimated parameters:

$$s_{ii} = \overline{s_u^2} (X^T - X)^{-1} \quad (11)$$

Calculation of standard error of estimated parameters:

$$s_{bi} = \sqrt{s_{ii}} \quad (12)$$

Calculation of test criterion

$$t - value = \frac{|y_{it}|}{s_{bi}} \quad (13)$$

**Comparison of calculated t-values with a table value** on a chosen significance level. If  $t > t_\alpha$ , the null hypothesis is rejected, which means that the exogenous variable is significant. If  $t < t_\alpha$ , the null hypotheses cannot be rejected, thus the exogenous variable is not statistically significant. (Čechura, 2014)

**Econometric verification** consists in verification of assumptions necessary for a successful application of concrete econometric techniques and tests. The econometric verification is in detail described in the chapter Assumptions of a linear regression model.

### 1.5.6. Application of econometric model or its rejection

The last step of the econometric analysis is the application of the model, eventually its rejection. In case of rejection, it is necessary to return to the first step of the whole econometric procedure. If the created econometric model is of high quality, it can be further used in areas such as simulations, prognoses or structural analyses.

One of the main aims of econometric modelling is forecast/prediction of values of endogenous variables outside the period of observation. An econometric prognosis is a quantitative probability estimate of a future value of a particular economic variable using past and present a priori information, represented by economic theory, statistical data and estimated econometric model. In forecasting, there is distinguished a point forecast, which estimates one future value of the predicted variable for a given period and an interval forecast, representing the equivalent of the confidence interval of the estimate. (Gujarati, 2003)

In addition, there is an ex-post and an ex-ante forecast. The ex-ante forecast uses only the value of economic variables that is available at a given period of time whereas the ex-post forecast uses the information extending beyond the time period at which the prognosis is performed. One of the commonly used model in forecasting is Autoregressive Integrated Moving Average (ARIMA) model, which is used for prognosis of the future values of time series as a function of its past values only, thus without the use of other exogenous variables. (Hušek, 2007)

Besides prognoses, there are commonly used the elasticity coefficients in the part of application of the model. Elasticity is a relative expression (%) of the effect of the exogenous variable on the endogenous variable. (Čechura, 2014)

The formula for derivation of coefficient of elasticity is following:

$$E = \frac{\partial y}{\partial x_i} \frac{x_i}{\hat{y}} \quad (14)$$

## 1.6. Linear regression model

Linear regression model (LRM) describes the relationship between the dependent and one or more independent variables and is the most often used model in the econometric analysis. (Hušek, 2007)

### 1.6.1. Assumptions of a linear regression model

To achieve required properties of the estimated parameters, the linear regression model must fulfill specific assumptions. It is therefore necessary to achieve a model that is best, unbiased and consistent. According to Čechura (2014), the essential presumptions include:

#### a. Specific assumptions

- Non-omitting the relevant exogenous variables
- Removal of insignificant exogenous variables
- Selection of correct functional form of the model
- Stable estimated parameters, time invariance
- Lack of simultaneous relationships among variables

#### b. Assumptions of a random component

- The random component  $u_t$  should have a zero average (approaching to zero)
- Homoskedasticity of the model (homogeneity), rejection of heteroskedasticity
- Absence of autocorrelation of residuals
- The lack of perfect multicollinearity
- The normal distribution of random component

**Heteroskedasticity** is an undesirable phenomenon, it is a lack of variance consistency of random errors and thus of residuals. Heteroskedasticity occurs when there are large changes in values of exogenous variables, especially if a significant variable is omitted. The Breush-Pagan test or the White test is used to test the occurrence of heteroscedasticity in the model. The heteroskedasticity can be removed by model transformation. (Marček, 2008)

**Autocorrelation** of residuals is a serial dependence of random residuals, which means that there should be no residual dependence in the model in one time series. The reasons of autocorrelation can be the omission of a relevant variable into a model, insufficiently specified dynamics of the model, incorrect functional form of the model. To test autocorrelation, the Durbin-Watson test (DW test) can be used. Autocorrelation can be reduced or eventually removed by the different model specification or by different analytical form of the model. (Marček, 2008)

**Multicollinearity** expresses the dependency of one or more exogenous variables on other exogenous variables. High multicollinearity occurs if the paired correlation coefficient reaches the value of 0.8 and higher. Perfect multicollinearity occurs when the paired correlation coefficient is equal to 1. If there is a perfect multicollinearity in the model, it is not possible to estimate such model. There are several possibilities how to reduce multicollinearity such as by data transformation, inclusion of a dummy variable or elimination of the variable causing a high multicollinearity. However, a certain degree of multicollinearity is always present in the model. The high multicollinearity can be determined by correlation matrix. (Čechura, 2014)

The correlation matrix is a square matrix, symmetrical according to the main diagonal and contains the paired correlation coefficients of individual exogenous variables, given by the formula:

$$X'^T X' \quad (15)$$

Where  $X'$  is a matrix of normalized vectors that can be quantified by:

$$X'_{it} = \frac{x_{it} - \bar{x}_i}{\sqrt{n}\sigma_{xi}} \quad (16)$$

$\bar{x}_i$  ... the average value of exogenous variable

$x_{it}$  ... the value of exogenous variable in time t

$\sigma_{xi}$  ... standard deviation

n ... number of observations

**Normality of residuals** is another assumption of the linear regression model. The random component should have a normal distribution with a zero mean. The Jarque-Bera test is commonly used to test the normality of residuals. (Hušek, 2007)

### 1.6.2. Ordinary Least Square method

If all of the above-mentioned assumptions are met, it is possible to continue with the estimation of parameters in the linear regression model by the Ordinary Least Square method (OLS). The purpose of the OLS is to find parameters, which minimize the sum of squared errors of theoretical values of endogenous variable from its real values. The estimated parameters of the linear regression model are best, unbiased and consistent. (Čechura, 2014)

The formula is following:

$$\min \sum_{t=1}^n (y_t - \hat{y}_t)^2 \quad (17)$$

The estimation function minimizing the sum of squared residuals is in the form:

$$\gamma = (X^T X)^{-1} X^T y \quad (18)$$

Where:

$\gamma$  ... vector of size (k x 1) of estimated parameters

$X$  ... matrix of size (n x k) of observed values of exogenous variables

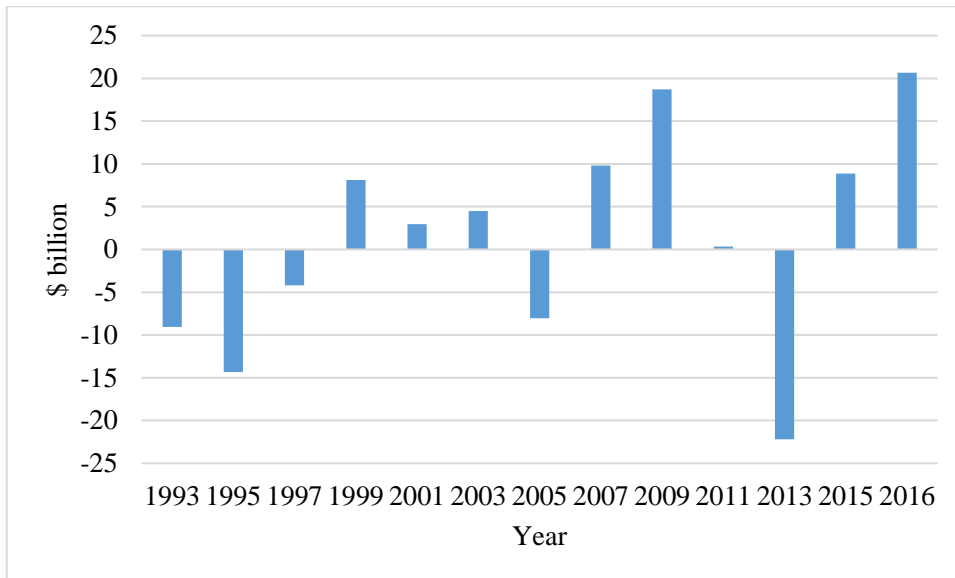
$y$  ... vector of size (n x 1) of observed values of endogenous variable

## 2. Practical part

### 2.1. Trade Balance of Thailand

Trade represents an important part in the economy of Thailand. The Thai economy is export-dependent. Exports of goods and services account for nearly 70% of the Thailand's economic output. Any significant shifts in demand have important implications for the economy. The world's three largest economies represented by the United States, Japan and China account for more than 30% of Thai exports.<sup>33</sup> Figure 9 shows trade balance of Thailand from 1993 to 2016.

**Figure 9: Trade Balance of Thailand, 1993 – 2016**



Source: Own elaboration based on World Bank, exports and imports data (2017)

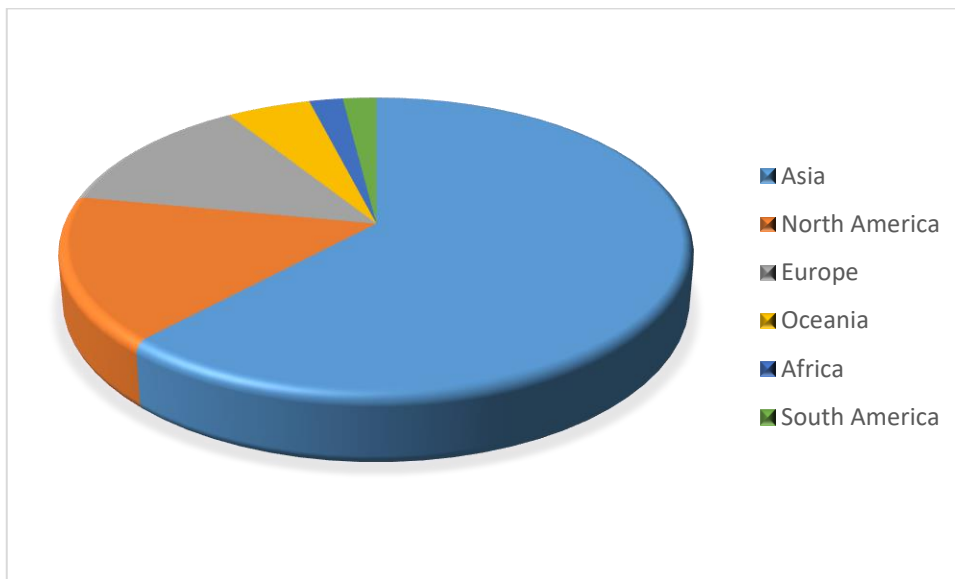
As it can be seen from the figure above, during the first half of 90's, Thailand was running a trade deficit. The following years, Thailand was running a trade surplus except the year 2005, when the economic growth was slowed down primarily due to droughts and tsunami. Also, the increased import of iron and steel, oil and non-monetary gold contributed to a negative balance of over \$8 billion.<sup>34</sup>

<sup>33</sup> Businessinsider.com (2017). *How trade is having an incredible influence on the Thai economy*. [online] Available at: <http://www.businessinsider.com/sc/thai-export-economy-drivers-2016-12> [Accessed 2 Dec. 2017]

<sup>34</sup> Bot.or.th (2017). *Thailand's Economic and Monetary Conditions in 2005* [online] Available at: [https://www.bot.or.th/English/MonetaryPolicy/EconomicConditions/AnnualReport/AnnualReport/AnnualReport\\_2004.pdf](https://www.bot.or.th/English/MonetaryPolicy/EconomicConditions/AnnualReport/AnnualReport/AnnualReport_2004.pdf) [Accessed 2 Dec. 2017]

In 2013, Thailand recorded the largest trade deficit during chosen period. There was a sharp increase in imports of vehicle parts and fuel.<sup>35</sup> In 2016, the value of Thailand's exports was \$215.33 billion, and the value of imported goods was \$194.67 billion, resulting in a positive trade balance of \$20.66 billion.<sup>36</sup> Figure 10 below illustrates the distribution of Thailand exports in 2016.

**Figure 10: Distribution of Thailand's exports in 2016**



Source: Own elaboration based on UN Comtrade Database (2017)

In 2016, Asia accounted for 62% of Thailand's exports, followed by North America with 16% and Europe 13%. Main exports destinations of Thailand were, China, Japan, the USA, Hong Kong and Malaysia. Majority of exports included computers and its related parts, delivery trucks, automobiles and vehicle parts, refined petroleum, rubber and rice.<sup>37</sup>

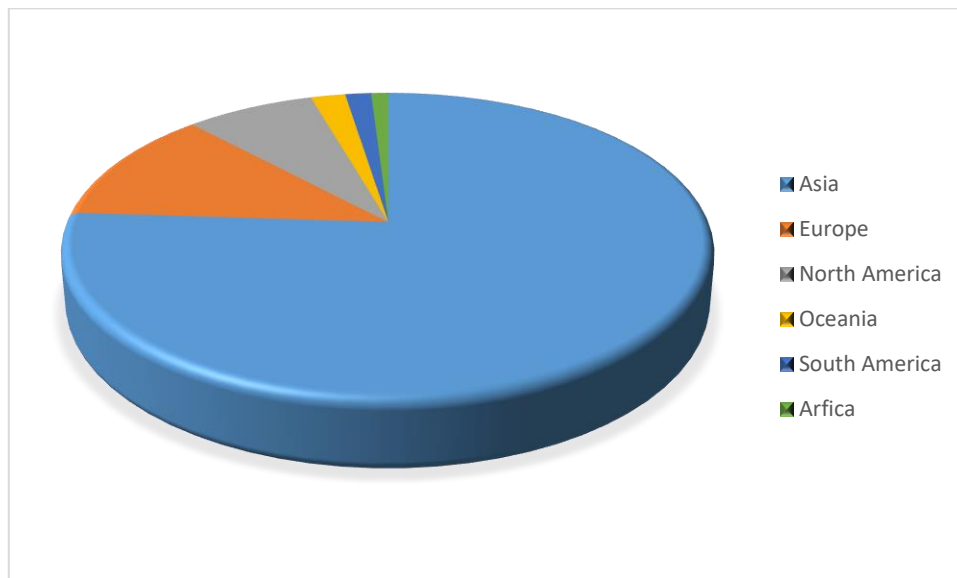
<sup>35</sup> Ft.com (2017). *Thailand posts record trade deficit*. [online] Available at: <https://www.ft.com/content/a1e565cc-0f09-332c-a01b-37574236f38b> [Accessed 2 Dec. 2017]

<sup>36</sup> Thaiwebsites.com (2017). *Thailand: Trade Balance, Exports and Imports (2016)*. [online] Available at: <http://www.thaiwebsites.com/imports-exports.asp> [Accessed 2 Dec. 2017]

<sup>37</sup> Atlas.media.mit.edu (2017). *Thailand*. [online] Available at: <https://atlas.media.mit.edu/en/profile/country/tha/#Exports> [Accessed 2 Dec. 2017]

The following Figure 11 expresses the distribution of Thailand imports in 2016.

**Figure 11: Distribution of Thailand's imports in 2016**



Source: Own elaboration based on UN Comtrade Database (2017)

In 2016, Asia continent represented 76% of Thailand's imports. The second largest origin of Thailand's imports was Europe. Imports were primarily from China, Japan, the United States, Malaysia and Singapore. The crude oil was the largest imported commodity, integrated circuits, gold, vehicle parts and iron.<sup>38</sup>

## 2.2. Thailand's rice production and export

Over the last few decades, rice production in Thailand has played a significant role in Thailand's economic development and therefore it is one of the most important commodities of agricultural sector. The arable land of Thailand had increased from 15.2 million ha in 2005 to 16.8 million ha in 2015.<sup>39</sup> The higher rice prices in the world market encourage farmers to cultivate more rice.

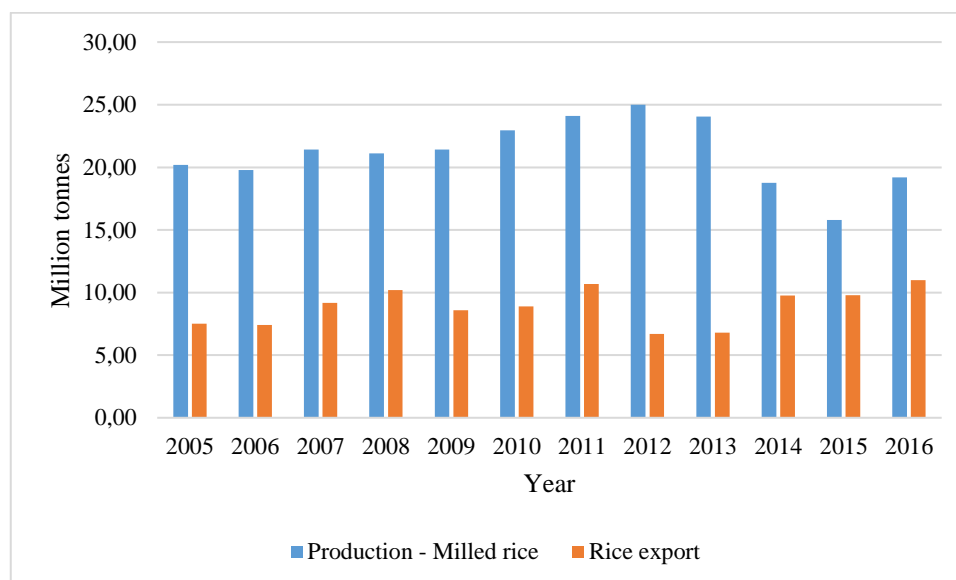
<sup>38</sup> Atlas.media.mit.edu (2017). *Thailand*. [online] Available at: <https://atlas.media.mit.edu/en/profile/country/tha/#Exports> [Accessed 2 Dec. 2017]

<sup>39</sup> Data.worldbank.org (2017). *Arable land (hectares)*. [online] Available at: <https://data.worldbank.org/indicator/AG.LND.ARBL.HA> [Accessed 2 Dec. 2017]



The development of Thailand's rice production and export from 2005 to 2016 expresses Figure 12.

**Figure 12: Thailand's production and export of rice, 2005 – 2016**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

From the Figure 12 there can be observed unstable development of quantity exported. In 2011-2012, the harvest was damaged by the droughts and floods. The natural disasters caused considerable losses in the production of rice. At the end of 2011, Thai Prime Minister Shinawatra initiated rice purchasing from local farmers to support incomes of local farmers and discourage them from exports. Simultaneously with this, there was an increase in export prices.<sup>40</sup>

Since the rice is a food staple for Thai population, the rice consumption generally accounts for more than half of the annual production. The supply side of Thai rice is dependent on rice production. The increase in irregular rainfall pattern causing droughts and flooding in some rice producing areas resulted in decreased total rice production. For many years, Thailand had been the largest exporter of rice. However, in 2012, Thailand lost its position as the world's top rice exporter, falling behind Vietnam and India.

<sup>40</sup> Adb.org (2017). *The Rice Situation in Thailand*. [online] Available at: <https://www.adb.org/sites/default/files/project-document/73082/43430-012-reg-tacr-03.pdf> [Accessed 15 Dec. 2017]

Even though only over 30% of rice production was exported in 2015, Thailand is currently the second largest exporter of rice. Major markets for Thai rice are China, the United States, Benin, the Philippines and Nigeria.<sup>41</sup>

### **2.3. Thailand's rice policies and regulations**

The Thailand's rice market is liberalized, and the Government supports the rice sector. Aside from private rice exporters, the Government is further incorporated in rice export through intergovernmental trading operated by the Department of Foreign Trade. Some of the intergovernmental rice trades are led by the Government, subcontracting to private rice exporters via special auction procedures. The involvement of the Government into rice trade mainly aims to promote and secure Thai rice export.<sup>42</sup> In Thailand, the policies on the regulation of rice standards are the same as for other economically significant crops such as maize or sugarcane.

The Good Agricultural Practices (GAP) sets the standards for agricultural products controlled at the farm level. The GAP is agricultural production standards developed by FAO which aim to ensure quality, safety and the environmental sustainability of agriculture. From the GAP benefits farmers and their families, who can acquire high quality and healthy food to ensure their nourishment and nutrition as well as consumer who can get more safety food quality. In addition, the GAP creates a valued added in its products with aim to access markets in a better way. Thailand had developed Thai GAP standards in 2005 with the goal to improve farmers' competitiveness at the global markets.<sup>43</sup>

There are two kinds of certification: the certification of the production system and the certification of products. The certification of the production system creates standards for the system of agricultural foods and products to meet the protocols such as the Hazard Analysis and Critical Control Points (HACCP) and the Good Manufacturing Practice.

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<sup>41</sup> Oxfordbusinessgroup.com (2017). *Rice remains economically crucial to Thailand*. [online] Available at: <https://oxfordbusinessgroup.com/analysis/price-rice-despite-slowdown-production-grain-remains-powerful-commodity-both-home-and-abroad> [Accessed 2 Dec. 2017]

<sup>42</sup> Adb.org (2017). *The Rice Situation in Thailand*. [online] Available at: <https://www.adb.org/sites/default/files/project-document/73082/43430-012-reg-tacr-03.pdf> [Accessed 15 Dec. 2017]

<sup>43</sup> Ijat-aatsea.com (2017). *An Investigation of Factors Influencing the Implementation of GAP among Fruit Farmers in Rayong Province, Thailand*. [online] Available at: [http://www.ijat-aatsea.com/pdf/v12\\_n7\\_2\\_16\\_DecemberSpecialissue/072--Suneeporn%20%20Suwanmaneepong--S%20%206A.pdf](http://www.ijat-aatsea.com/pdf/v12_n7_2_16_DecemberSpecialissue/072--Suneeporn%20%20Suwanmaneepong--S%20%206A.pdf) [Accessed 15 Dec. 2017]

The certification of products aims to ensure that certified products fulfill safety and qualification standards. Moreover, it evaluates the production process to assure standards are maintained, including protocols the Organic Agriculture and the Code of Conduct. There are also regulations created to control rice trading, including export. The Government limited the quantity of exported rice in the past, because the excessive exports could be the cause of undesired issues for domestic consumers. Therefore, there are export regulations such as Export Tax, the Rice Reserve Enactment, Quota system and the Export License (Rice Trade Act). These regulations affect not only the Thai rice export quantity but also domestic price of rice.

Set of regulations influencing rice production among others consists of the Plants Act (2007) with aim to safeguard farmers from low-quality seeds, the Fertilizer Act (2007) to protect farmers against substandard fertilizers and the Plant Quarantine Act (2008), which controls and protects the spread of pests appearing from exports and imports.<sup>44</sup>

#### **2.4. Analysis of chosen variables**

To conduct an econometric analysis of Thai rice export, there were included following variables:

- Thai rice export value
- Export price of Thai rice
- Exchange rate (Thai Baht/USD)
- Total production of milled rice in Thailand
- GDP per capita in China

All variables are analyzed through time series from the year 1986 to 2016.

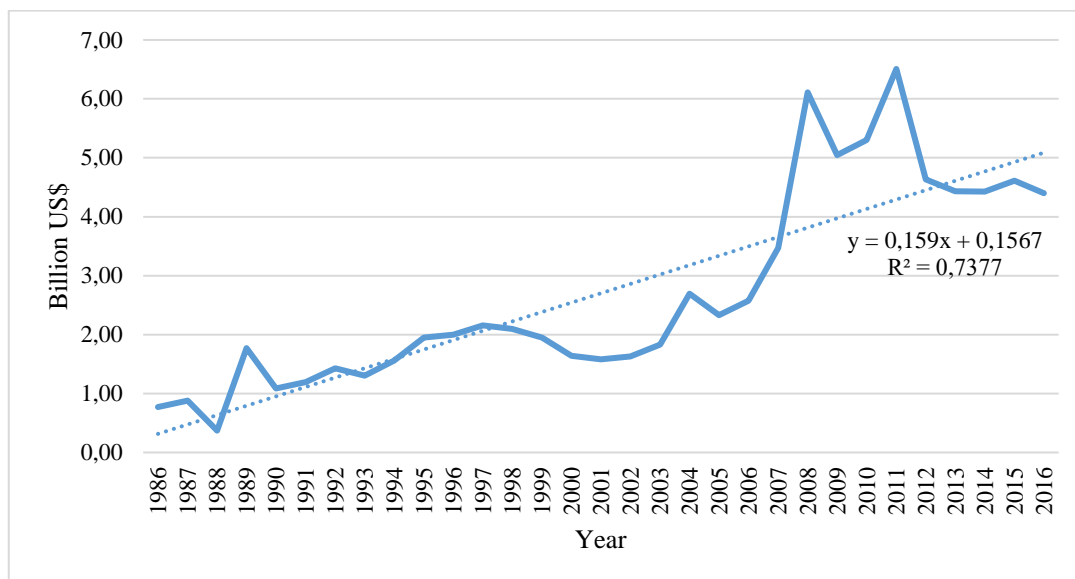
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<sup>44</sup> Adb.org (2017). *The Rice Situation in Thailand*. [online] Available at: <https://www.adb.org/sites/default/files/project-document/73082/43430-012-reg-tacr-03.pdf> [Accessed 15 Dec. 2017]

### 2.4.1. Thai rice export value

The Figure 13 illustrates the development of Thai rice export value during the period of 1986 – 2016.

**Figure 13: Thai rice export value, 1986 – 2016**



Source: Own elaboration based on Food and Agriculture Organization of the United Nations, FAOSTAT and the U.S. Department of Agriculture (USDA) (2017)

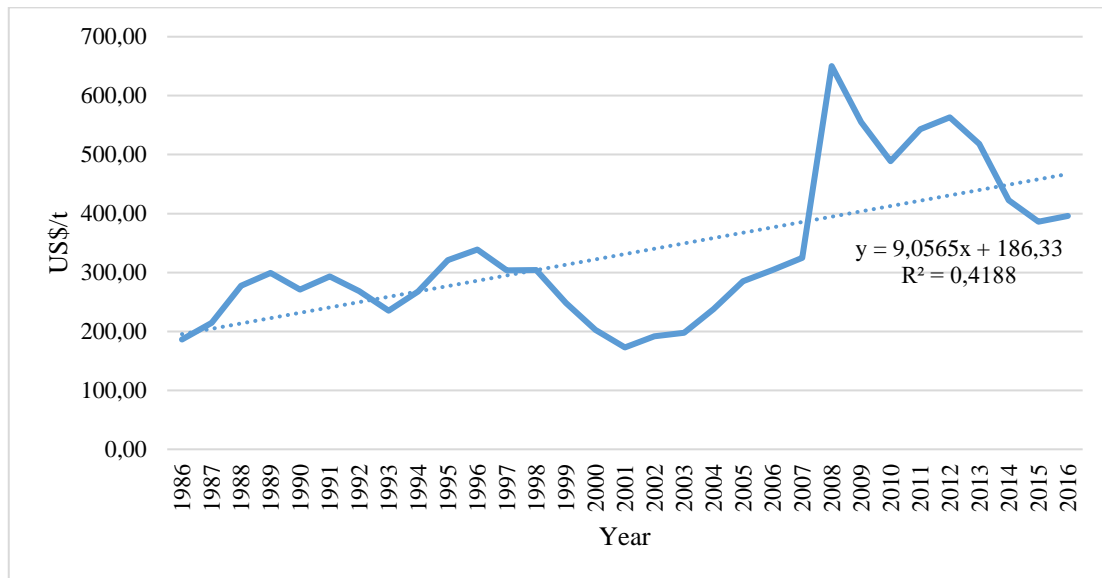
During the selected period, the value of Thai rice export indicates an increasing trend. The average annual value of Thai rice export is \$2.7 billion. In the last decade, the value has significantly increased compared to previous years. In the year 2008 and 2011, the export of rice reached the highest values.

As it was already mentioned, in 2008, there was a sharp increase in rice export prices which caused panic of rice importers who were afraid of even higher prices in the future, and thus increased the purchases. As a result of that, the value of rice export rapidly increased. An increase in export prices occurred in 2011 as well. Based on the linear trend function it can be expected that in following years the value of Thai rice export will increase with reliability of 73.7%.

### 2.4.2. Export price of Thai rice

Another variable included in the model is export price of Thai rice. Export price represents a significant factor influencing the export. The Figure 14 below shows the development of Thai export price of rice from 1986 to 2016.

**Figure 14: Export price of Thai rice, 1986 – 2016**



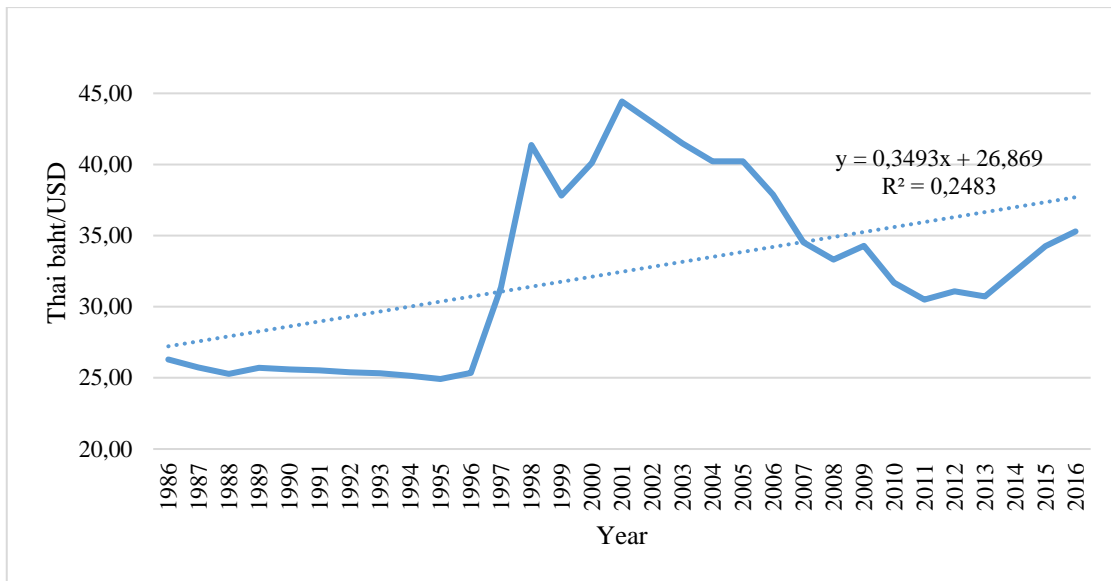
Source: Own elaboration based on the International Rice Research Institute and Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

In the Figure 14 there can be observed the sharp increase in the export price of Thai rice in 2008, when the price nearly doubled and reached the value of \$650.19 per ton. The average annual export price of rice during selected period is 331.2 US\$ per ton. The trend function determines the increasing trend of Thai export price of rice in following years with the 41% of reliability.

### 2.4.3. Exchange rate (Thai baht/USD)

According to economic theory, the exchange rate belongs among determinants of export. The development of exchange rate during the years 1986 – 2016 expresses Figure 15.

**Figure 15: Exchange rate (Thai baht/USD), 1986 – 2016**



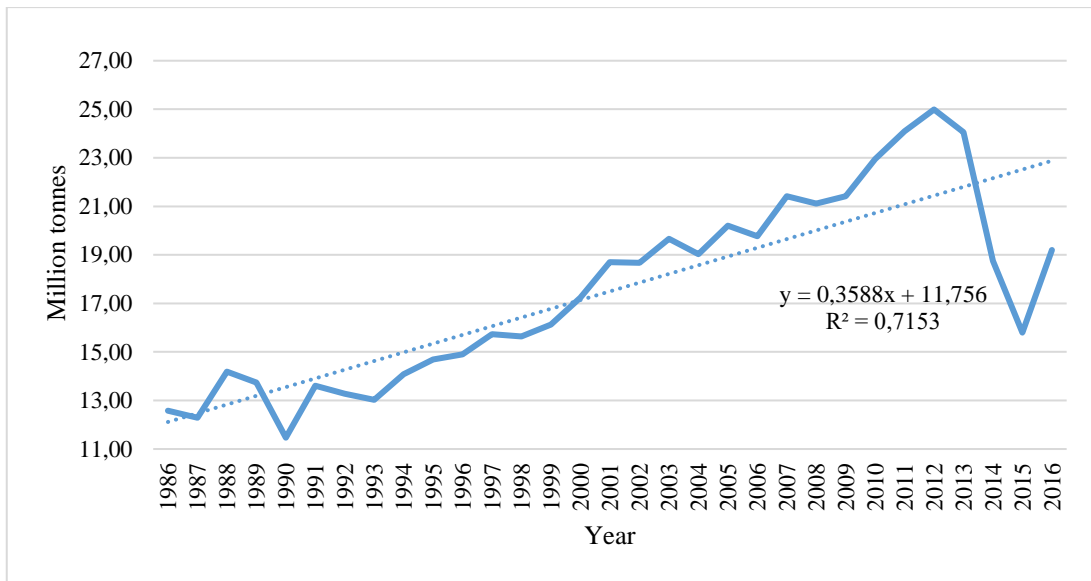
Source: Own elaboration based on Thai Rice Exporters Association, Food and Agriculture Organization of the United Nations, FAOSTAT (2017)

The Figure 15 shows the increasing trend of the Thai baht/USD exchange rate. However, there are slight fluctuations. In 1997, Thailand was hit by the Asian financial crisis. The following year, the Thai baht peaked at 41.36 baht to the US dollar compared to 25.34 baht to the US dollar before the year 1997. Since there are larger variations in values, it can be expected with reliability only of 24% that there will be increase of Thai baht in next years.

#### **2.4.4. Production of milled rice in Thailand**

The development of production of rice in Thailand from the period 1986 – 2016 reflects Figure 16.

**Figure 16: Production of milled rice in Thailand, 1986 – 2016**



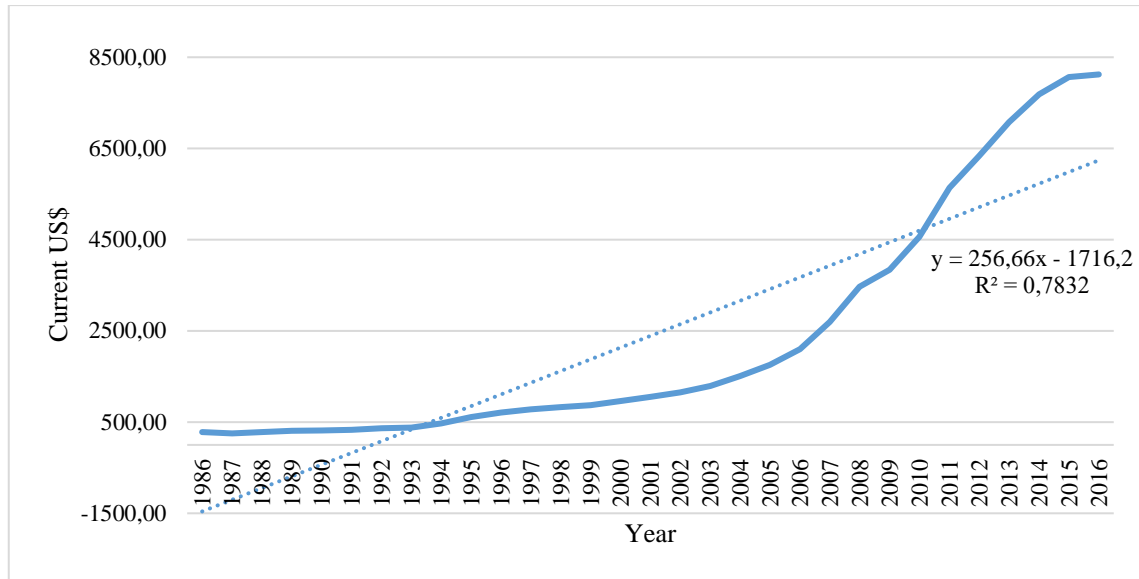
Source: Own elaboration based on the U.S. Department of Agriculture (USDA) (2017)

The Figure 16 indicates the increasing trend of rice production in Thailand. The average annual production of rice in Thailand is over 17.49 million tonnes. In addition, there can be seen a significant decrease of the production from the year 2011, which was caused by the weather changes in Thailand. On a basis of linear trend function, the rice production in Thailand will tend to grow in following years with the 71% of reliability.

#### **2.4.5. GDP per capita in China**

Since China is one of the main markets for Thai rice, its GDP per capita is included into the model as a representative of importing country. Figure 17 on the following page shows the development of GDP per capita in China from 1986 to 2016.

**Figure 17: GDP per capita in China, 1986 – 2016**



Source: Own elaboration based on World Bank (2017)

The Figure 15 shows that GDP per capita in China has from the long-term point of view increasing trend. From 1986 to 2000, there can be observed only a slight annual growth of GDP per capita in China. However, the last decade has indicated a fast-growing trend. With a reliability of 78%, trend function determines the increasing trend of the GDP per capita in China in the following years.

## 2.5. Linear Regression Model

### 2.5.1. Construction of economic model

An economic model of Thai rice export was constructed on a basis of economic theories and it has following formula:

$$y_{1t} = f(x_1, x_2, x_3, x_4, x_5)$$

Where:

$y_{1t}$  ... Thai rice export value (billion US\$)

$x_{1t}$  ... unit vector (constant)

$x_{2t}$  ... Thai export price of rice (US\$/t)

$x_{3t}$  ... Exchange rate (Thai baht/USD)

$x_{4t}$  ... Total production of milled rice in Thailand (million tonnes)

$x_{5t}$  ... GDP per capita in China (current US\$)



The main assumption of the economic model is the dependency of Thai rice export as an endogenous variable on Thai export price of rice, exchange rate, total production of milled rice in Thailand and GDP per capita in China. According to economic theory, there are assumed following relationships among variables:

- If the Thai export price of rice increases, the value of Thai rice export increases.
- If the exchange rate (Thai baht/USD) increases, the value of Thai rice export increases.
- If the total production of milled rice in Thailand increases, the value of Thai rice export increases.
- If the GDP per capita in China increases, the value of Thai rice export increases.

### **2.5.2. Formulation of econometric model**

One-equation econometric model includes 1 endogenous variable  $y_t$  at time  $t$ , 4 exogenous variables  $x_{1t-5t}$  and 1 random component  $u_t$ . The functional form of the one-equation econometric model is linear.

The final one equation econometric model is following:

$$y_{1t} = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \gamma_4 x_{4t} + \gamma_5 x_{5t} + u_{1t}$$

### 2.5.3. Data set

**Table 2: Data set**

<b>Variable</b>	<b>Thai rice export (billion US\$)</b>	<b>Unit Vector</b>	<b>Export price of Thai rice (US\$/t)</b>	<b>Exchange rate (Thai baht/USD)</b>	<b>Total production of milled rice in Thailand (million tonnes)</b>	<b>GDP per capita in China (current US\$)</b>
<b>Year</b>	$y_1$	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$
1986	0.77	1.00	186.25	26.30	12.59	281.93
1987	0.88	1.00	214.61	25.72	12.29	251.81
1988	0.37	1.00	277.47	25.29	14.18	283.53
1989	1.77	1.00	299.16	25.70	13.74	310.88
1990	1.09	1.00	270.85	25.59	11.47	317.89
1991	1.20	1.00	293.28	25.52	13.61	333.14
1992	1.43	1.00	268.22	25.40	13.28	366.46
1993	1.30	1.00	235.41	25.32	13.03	377.39
1994	1.56	1.00	267.59	25.15	14.08	473.49
1995	1.95	1.00	320.96	24.92	14.68	609.66
1996	2.00	1.00	338.88	25.34	14.90	709.41
1997	2.16	1.00	303.51	31.36	15.73	781.74
1998	2.10	1.00	304.16	41.36	15.64	828.58
1999	1.95	1.00	248.42	37.81	16.12	873.29
2000	1.64	1.00	202.40	40.11	17.24	959.37
2001	1.58	1.00	172.84	44.43	18.70	1053.11
2002	1.63	1.00	191.87	42.96	18.67	1148.51
2003	1.83	1.00	197.62	41.48	19.66	1288.64
2004	2.70	1.00	237.67	40.22	19.04	1508.67
2005	2.33	1.00	285.00	40.22	20.20	1753.42
2006	2.58	1.00	304.00	37.88	19.77	2099.23
2007	3.47	1.00	325.00	34.52	21.41	2695.37
2008	6.11	1.00	650.19	33.31	21.11	3471.25
2009	5.05	1.00	554.99	34.29	21.41	3838.43
2010	5.30	1.00	488.91	31.69	22.95	4560.51
2011	6.51	1.00	543.03	30.49	24.10	5633.80
2012	4.63	1.00	562.98	31.08	24.99	6337.88
2013	4.43	1.00	518.00	30.73	24.05	7077.77
2014	4.43	1.00	422.83	32.48	18.75	7683.50
2015	4.61	1.00	386.00	34.25	15.80	8069.21
2016	4.40	1.00	396.17	35.30	19.20	8123.18

Source: Own elaboration based on the International Rice Research Institute and Food and Agriculture Organization of the United Nations, FAOSTAT, Thai Rice Exporters Association, the U.S. Department of Agriculture (USDA) and World Bank (2017)

Correlation matrix is computed to determine the existence of a high multicollinearity in the model. The computed matrix illustrates Table 3.

**Table 3: Correlation matrix**

EXP	PEX	ER	PRO	GDP	
1.0000	0.8953	0.1725	0.7919	0.8310	EXP
	1.0000	-0.1269	0.6574	0.7043	PEX
		1.0000	0.4855	0.1562	ER
			1.0000	0.6566	PRO
				1.0000	GDP

Source: Gretl software

Based on Gretl output, in the model there is no high multicollinearity, none of the paired correlation coefficients is higher than 0.8.

#### 2.5.4. Estimation of parameters using Ordinary Least Square method

Estimation of parameters using the Ordinary Least Square method was elaborated through Gretl software. Table 4 shows computed values of parameters. The complete Gretl output is in Appendix 1.

**Table 4: Estimated parameters using OLS**

Parameters	Value of parameter
$\gamma_1$ – Unit vector	-2.75022
$\gamma_2$ - Export price of Thai rice	0.00865499
$\gamma_3$ - Exchange rate	0.0433332
$\gamma_4$ - Total production of milled rice in Thailand	0.0428953
$\gamma_5$ - GDP per capita in China	0.000178835

Source: Own elaboration based on output from the Gretl software

Based on computed parameters, the final one-equation econometric model is following:

$$y_{1t} = -2.75022 + 0.00865499x_{2t} + 0.0433332x_{3t} + 0.0428953x_{4t} + 0.000178835x_{5t} + u_{1t}$$

## 2.6. Economic verification

Within the frame of economic verification, there is evaluated the direction and intensity of influence of exogenous variables on endogenous variable. With a *ceteris paribus* conditions, it can be assumed:

- If all the exogenous variables equal to 0, the value of Thai rice export is  $-2.75022$  billion US\$ per year.
- If the Thai export price of rice increases by 1 US\$/t, the value of Thai rice export increases by 0.00865499 billion US\$ per year.
- If the exchange rate Thai baht/USD increases by one unit, the value of Thai rice export increases by 0.0433332 billion US\$ per year.
- If the total production of milled rice in Thailand increases by 1 million tonne, the value of Thai rice export increases by 0.0428953 billion US\$ per year.
- If the GDP per capita in China increases by 1 US\$, the value of Thai rice export increases by 0.000178835 billion US\$ per year.

All the above-mentioned assumptions are consistent with the set assumptions.

## 2.7. Statistical verification

In terms of statistical verification, the statistical significance of estimated parameters is analyzed. The value of coefficient of determination  $R^2$  is equal to 0.924586, which means that exogenous variables are explaining endogenous variable by 92%. The value of adjusted  $R^2$  is 0.912984, which means that from 91% the changes in dependent variable are caused by changes in independent variables.

### Statistical significance of estimated parameters

Statistical significance of estimated parameters is determined by t-test. The Gretl output shows p-values of individual parameters, which inform about the significance level, at which a null hypothesis is rejected. The null hypothesis states that the parameter is not statistically significant at a given level of significance. If the p-value is lower than chosen significance level, the null hypothesis is rejected. Calculated p-values from Gretl output are shown in the following Table 5. The complete Gretl output can be found in Appendix 1.

**Table 5: P-values of parameters**

Parameters	P-value
$\gamma_2$ - Export price of Thai rice	<0.00001
$\gamma_3$ - Exchange rate	0.06261
$\gamma_4$ - Total production of milled rice in Thailand	0.38663
$\gamma_5$ - GDP per capita in China	0.00210

Source: Own elaboration based on output from the Gretl software

Based on Table 5, on the significance level  $\alpha = 0.01$ , parameters export price of Thai rice and GDP per capita in China are statistically significant. The parameter exchange rate is statistically significant on the significance level  $\alpha = 0.1$ . The parameter total production of milled rice in Thailand is not statistically significant.

## **2.8. Econometric verification**

Within the scope of econometric verification, there are processed test of autocorrelation, heteroskedasticity and normality in order to verify conditions for application of the econometric model.

### **2.8.1. Autocorrelation**

To test autocorrelation in the model, the Durbin-Watson (DW) test is applied. The value of DW statistic is equal to 1.955014. According to calculated degrees of freedom is lower bound 0.96042 and upper bound 1.51003. The calculated test statistic is in the interval  $\langle d_u; 2 \rangle$  which means statistically not significant positive autocorrelation.

### **2.8.2. Heteroskedasticity**

The White test is used to determine heteroskedasticity. The null hypothesis states that residuals have a constant variance, thus there is homoskedasticity. Based on White test, calculated p-value is 0.0608292. P-value is higher than the significance level  $\alpha = 0.01$  and thus the null hypothesis cannot be rejected on the given significance level. There is homoskedasticity in the model.

### 2.8.3. Normality

To verify normality of residuals, there was used Jarque-Bera (JB) test. The null hypothesis states that residuals have normal distribution. P-value of JB test is 0.04088. Therefore, the null hypothesis cannot be rejected at the significance level 0.01. The residual has normal distribution. The summarization of the econometric verification is displayed in Table 6.

**Table 6: Results of econometric verification**

			$\alpha$	Decision
<b><u>Autocorrelation, the Durbin-Watson test</u></b>				
H <sub>0</sub> : there is no autocorrelation in the model				
H <sub>1</sub> : there is autocorrelation in the model				
<b>Result</b>	1.955	>	0.01	The H <sub>0</sub> cannot be rejected, there is no autocorrelation in the model.
<b><u>Heteroskedasticity, the White test</u></b>				
H <sub>0</sub> : there is no heteroskedasticity in the model				
H <sub>1</sub> : there is heteroskedasticity in the model				
<b>Result</b>	0.060	>	0.01	The H <sub>0</sub> cannot be rejected, there is no heteroskedasticity in the model, but homoskedasticity.
<b><u>Normality</u></b>				
H <sub>0</sub> : there is normal distribution of residuals				
H <sub>1</sub> : there is not normal distribution of residuals				
<b>Result</b>	0.040	>	0.01	The H <sub>0</sub> cannot be rejected, the residuals are normally distributed.

Source: Own elaboration

### 2.9. Application of the model

In the framework of application of the one equation econometric model, there are computed elasticities of individual exogenous variables. In addition, there are derived prognoses of the endogenous variables and all variables for the year 2017, 2018 and 2019.

## Elasticities

The following Table 7 shows data set for the computation of elasticities.

**Table 7: Data set for calculation of elasticities**

Variable	Mean value	Theoretical value	Value of parameter
PEX ( $x_2$ )	331.2300	2.70111	0.00865
ER ( $x_3$ )	32.45900	2.70111	0.04333
PRO ( $x_4$ )	17.49600	2.70111	0.04290
GDP ( $x_5$ )	2390.40000	2.70111	0.00018

Source: Own computation in MS Excel

Calculated elasticities reflects the Table 8.

**Table 8: Calculated elasticities of exogenous variables**

Variable	Result
PEX ( $x_2$ )	1.061339386
ER ( $x_3$ )	0.520731612
PRO ( $x_4$ )	0.277847521
GDP ( $x_5$ )	0.158263638

Source: Own computation in MS Excel

### Interpretation of the individual elasticities is as follows:

- If the Thai export price of rice increases by 1%, the value of Thai rice export increases by 1.06% per year.
- If the exchange rate (Thai baht/USD) increases by 1%, the value of Thai rice export increases by 0.52% per year.
- If the total production of milled rice in Thailand increases by 1%, the value of Thai rice export increases by 0.27% per year.
- If the GDP per capita in China increases by 1%, the value of Thai rice export increases by 0.15% per year.

Based on computed elasticities, the value of Thai rice export is the most influenced by the Thai export price of rice.

## Prognoses

To derive prognoses of the Thai rice export value for the year 2017, 2018 and 2019, the estimated equation of the linear regression model is used. Firstly, there are processed prognoses for all exogenous variables for chosen years in Gretl using the ARIMA model. The Gretl output is summarized in the Table 9 below.

**Table 9: Calculated prognoses of exogenous variables**

Year/Variable	PEX (x <sub>2</sub> )	ER (x <sub>3</sub> )	PRO (x <sub>4</sub> )	GDP (x <sub>5</sub> )
2017	383.900	35.240	19.855	8115.870
2018	370.850	34.640	19.244	8002.570
2019	361.940	34.420	19.064	7790.435

Source: Own elaboration based on output from the Gretl software

After the computation of prognoses of individual exogenous variables, the prognoses for the endogenous variable is obtained through the substitution of calculated prognoses in the following model:

$$y_{1t} = -2.75022 + 0.00865499x_{2t} + 0.0433332x_{3t} + 0.0428953x_{4t} + 0.000178835x_{5t} + u_{1t}$$

The prognoses of Thai rice export value for the year 2017, 2018 and 2019 are shown in the Table 10.

**Table 10: Calculated prognoses of the endogenous variable**

Year	EXP(y <sub>1</sub> )
2017	4.403
2018	4.217
2019	4.085

Source: Own elaboration based on output from the Gretl software

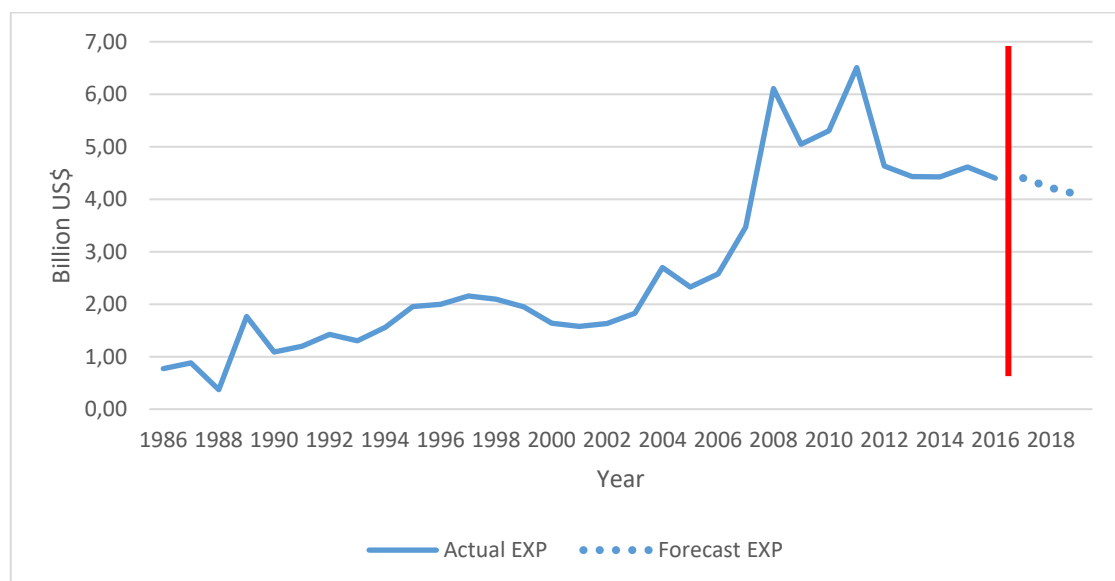
From the table above can be concluded that in the following three years, the value of Thai rice export will have a decreasing trend.



In 2017, the Thai rice export value is estimated to be \$4.403 billion. In 2018, the value of Thai rice export is predicted to be \$4.217 billion. In 2019, the Thai rice export value is estimated to be \$4.085 billion.

The actual values of Thai rice export and calculated prognoses of the Thai rice export value are illustrated in the Figure 18.

**Figure 18: Prognoses of Thai rice export value**



Source: Own elaboration

## Results and Discussion

In the practical part there was firstly analyzed the trade balance from the year 1993 to 2016. Based on comparison of exports with imports, the first half of 90's indicated a trade deficit. From 1999 to 2012, Thailand was running a trade surplus except the year 2005, when the economic growth was slowed down primarily due to droughts and tsunami. Also, the increased import of iron and steel, oil and non-monetary gold resulted in a negative balance of over \$8 billion. In 2013, Thailand recorded the largest trade deficit in the selected period when there occurred a sharp increase in imports of fuel and vehicle parts. In 2016, Asia accounted for 62% of Thailand's exports and majority of exports included automobiles and vehicle parts, computers, refined petroleum, rice and rubber. Major export destinations of Thailand were China, Japan, the United States, Hong Kong and Malaysia. In the same year, approximately 76% of Thailand's imports were from Asian countries.

The largest imported commodity was the crude oil, followed by iron and integrate circuits. Imports were mainly from China, Japan, the USA, Malaysia and Singapore. The second part initially analyzed development trends of Thai rice export and chosen export determinants and subsequently there was constructed a one-equation econometric model. The value of Thai rice export indicated increasing trend with the average value of \$2.7 billion. This trend is estimated to continue in following years with the 73.3% of reliability. All exogenous variables, namely the export price of rice, exchange rate (Thai baht/USD), production of milled rice in Thailand and GDP per capita in China indicated increasing trend as well. However, in case of exchange rate, there is only 24% probability that the Thai baht/USD will increase in next years.

The one-equation model consisted of Thai rice export value as the endogenous variable and the export price of Thai rice, exchange rate, production of milled rice in Thailand and GDP per capita in China as exogenous variables. Firstly, there was computed the correlation matrix to detect a high multicollinearity in the model. The high multicollinearity was not present in the model. Subsequent step was the estimation of individual parameters, after which there was constructed the final one-equation econometric model.

In economic verification, there was assessed the intensity and direction of exogenous variables on the endogenous variable. According to assumptions formulated in the part of the construction of economic model, all calculated values from the final model were in conformity with economic theory. Results showed that increase in Thai export price of rice positively contributes the value of Thai rice export. The empirical estimate is consistent with empirical evidence found in the study performed by Kumar *et al.* (2008). As expected, the effect of exchange rate on the value of Thai rice export is positively significant. This finding is consistent with the results of Haleem *et al.* (2005). The total production of milled rice in Thailand was found to be positively correlated with the value of Thai rice export. This result is in line with Bilal and Rizvi (2013). The GDP per capita in China is positively associated with the value of Thai rice export as well. The result is in conformity with outcomes of Shane, Roe and Somwaru (2008).

In the statistical verification of the model, there was interpreted the result, that the value of Thai rice export is from 92.45% explained by the changes of exogenous variables in the model. The model as a whole was considered as a statistically significant, since the p-value (F) was  $3.32e-14$ , thus lower than a significance level.

Individual parameters were put into a table and computed p-values were compared with significance levels and the results were interpreted. The parameter export price of Thai rice and the GDP per capita were found to be statistically significant at the significance level  $\alpha=0.01$ . The exchange rate was statistically significant at the significance level  $\alpha=0.1$ . The total production of milled rice in Thailand was found to be statistically insignificant, since its computed value was bigger than the level of significance.

Within the frame of econometric verification of the model, there was tested the presence of autocorrelation, heteroskedasticity and normality of residuals. Results from Gretl were compared with set hypotheses. In the model the autocorrelation was not present, there was no heteroskedasticity and the residuals had a normal distribution.

In the application of the model, there were calculated elasticities to detect which of the exogenous variables influences the endogenous variable the most. Results showed that the variable Thai export price of rice has the largest impact on the value of Thai rice export. If the Thai export price of rice increases by 1%, the value of Thai rice export increases by 1.06% per year. In this section there were also performed prognoses of variables for the year 2017, 2018 and 2019. Based on results, it is estimated that the value of Thai rice export will tend to decrease in the next 3 years. In 2017, the value of Thai rice export was estimated to be \$4.403 billion, in 2018 it will be \$4.217 billion and \$4.085 billion in 2019.

## **Conclusion**

Trade plays a significant part in the economy of Thailand. Rice represents one of the most important commodity in the Thailand's agriculture sectors. As a food staple for Thai population, consumption of rice accounts for over half of annual production.

The first goal of the thesis was to perform trade balance of Thailand. The analysis of Thailand's exports and imports revealed that in the last decade more of unstable trade balance. During the years 2007-2012, Thailand was running a positive trade balance. However, in 2013, Thailand recorded the largest trade deficit, imports significantly exceeded exports. There was a sharp increase in imports of vehicle parts and fuel. Since 2015, Thailand has been running trade surplus. In 2016, the value of Thailand's exports reached the value of \$215.33 billion, and the value of imported goods was \$194.67 billion, resulting in a positive trade balance of \$20.66 billion. Major trading partners of Thailand are China, the United States and Japan.

Another aim was to identify determinants influencing Thai rice export and detect which of the factors has the significant impact on Thai rice export. In developing countries, determinants which have impact on Thai rice export are represented by the exchange rate, GDP of exporting and importing country, rice production, export price of rice and domestic consumption. Based on results, the exchange rate, Thai export price of rice and GDP of China were found to be statistically significant. Even though the production of milled rice in Thailand was not statistically significant, it still plays an important role in the development of the value of Thai rice export due to a high vulnerability of Thailand towards extreme weather events. The advantage of Thailand is the long-term demand from China, the world's second largest economy. Since 2012, China raised imports of rice from Thailand and became the largest purchaser of Thai rice, and thus Thailand should develop more agreements with China in order to maintain strong trade links.

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# Appendices

## Appendix 1: OLS

Model 1: OLS, using observations 1986–2016 (T = 31)  
 Dependent variable: y1

	coefficient	std. error	t-ratio	p-value	
const	-2.75022	0.637160	-4.316	0.0002	***
x2	0.00865499	0.00142980	6.053	2.15e-06	***
x3	0.0433332	0.0222743	1.945	0.0626	*
x4	0.0428953	0.0487148	0.8805	0.3866	
x5	0.000178835	5.23438e-05	3.417	0.0021	***
Mean dependent var	2.701122	S.D. dependent var	1.683416		
Sum squared resid	6.411426	S.E. of regression	0.496582		
R-squared	0.924586	Adjusted R-squared	0.912984		
F(4, 26)	79.69121	P-value (F)	3.32e-14		
Log-likelihood	-19.56056	Akaike criterion	49.12112		
Schwarz criterion	56.29106	Hannan-Quinn	51.45834		
rho	0.019434	Durbin-Watson	1.955014		

Excluding the constant, p-value was highest for variable 5 (x4)

Source: Gretl output

## Appendix 2: D-W test

Durbin-Watson statistic = 1.95501  
 p-value = 0.216391

Source: Gretl output

## Appendix 3: Normality test

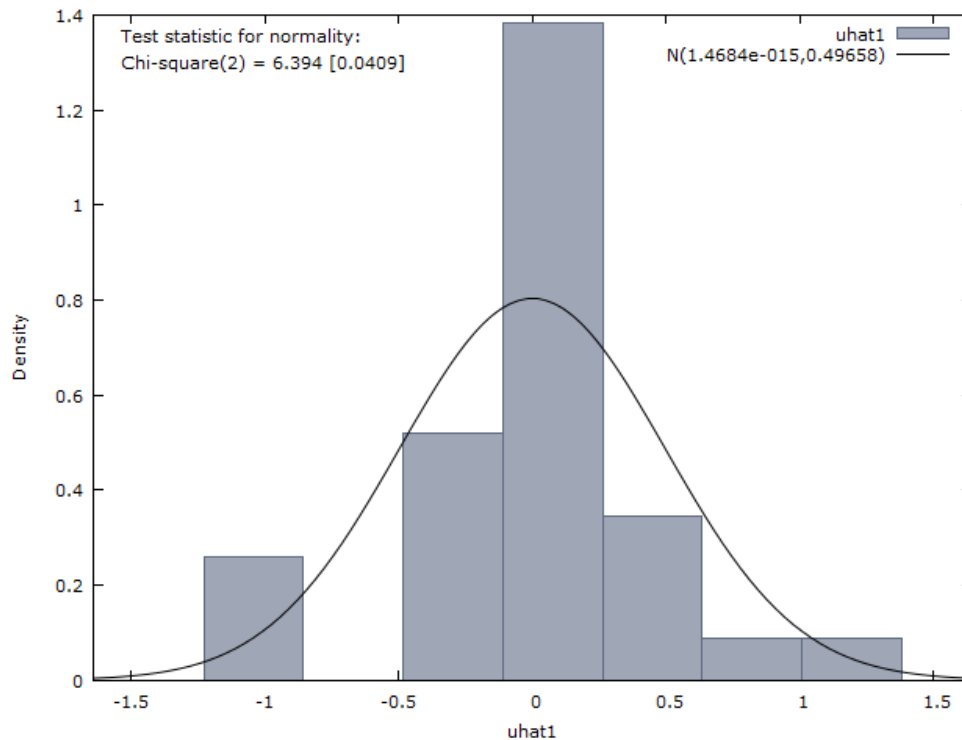
Frequency distribution for uhat1, obs 1-31  
 number of bins = 7, mean = 1.46836e-015, sd = 0.496582

interval	midpt	frequency	rel.	cum.	
< -0.85585	-1.0423	3	9.68%	9.68%	***
-0.85585 - -0.48290	-0.66937	0	0.00%	9.68%	
-0.48290 - -0.10995	-0.29642	6	19.35%	29.03%	*****
-0.10995 - 0.26300	0.076530	16	51.61%	80.65%	*****
0.26300 - 0.63595	0.44948	4	12.90%	93.55%	****
0.63595 - 1.0089	0.82243	1	3.23%	96.77%	*
>= 1.0089	1.1954	1	3.23%	100.00%	*

Test for null hypothesis of normal distribution:  
 Chi-square(2) = 6.394 with p-value 0.04088

Source: Gretl output

## Appendix 4: Normality – graph



Source: Gretl output

## Appendix 5: White test for heteroskedasticity

White's test for heteroskedasticity  
OLS, using observations 1986-2016 (T = 31)  
Dependent variable: uhat<sup>2</sup>

	coefficient	std. error	t-ratio	p-value
const	0.568241	8.43399	0.06738	0.9471
x2	-0.00311280	0.0163326	-0.1906	0.8512
x3	-0.0452243	0.296621	-0.1525	0.8807
x4	0.0231824	0.658453	0.03521	0.9723
x5	-0.000595217	0.00197380	-0.3016	0.7669
sq_x2	-5.87070e-06	1.08398e-05	-0.5416	0.5956
X2_X3	0.000130231	0.000323537	0.4025	0.6926
X2_X4	7.35056e-05	0.00158299	0.04643	0.9635
X2_X5	9.37009e-07	2.99337e-06	0.3130	0.7583
sq_x3	0.00346600	0.00397503	0.8719	0.3961
X3_X4	-0.0156046	0.0186804	-0.8353	0.4158
X3_X5	9.72236e-06	4.19874e-05	0.2316	0.8198
sq_x4	0.0213080	0.0163121	1.306	0.2099
X4_X5	-4.45067e-05	2.78934e-05	-1.596	0.1301
sq_x5	7.17915e-08	9.16706e-08	0.7831	0.4450

Unadjusted R-squared = 0.740831

Test statistic:  $TR^2 = 22.965755$ ,  
with p-value =  $P(\text{Chi-square}(14) > 22.965755) = 0.060829$

Source: Gretl output