# Assessing the Causality Relationship between the Geopolitical Risk Index and the Agricultural Commodity Markets.

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*Due to the ongoing Russo – Ukrainian war, this dissertation is dedicated to all Ukrainians for their courage in defending their freedom and their motherland.*

# Abstract

**Purpose:** Geopolitics plays a key role in today's complex and globalised world. During the last two decades, the world witnessed various geopolitical events, which have led to an increase in geopolitical risk. Consequently, in recent years, there has been renewed interest in both geopolitics and geopolitical risk. In fact, Caldara and Iacoviello's (2018) seminal work spawned several other works on the topic by clearly defining the notion of geopolitical risk and introducing an index to account for both geopolitical threats and acts.

Since the 1970s, the globalisation phenomenon has played a major role in the commodity market. Simultaneously, this phenomenon amplified the scarcity problem, leading to a war on resources, which eventually resulted in increased geopolitical risk. A growing body of literature suggests that geopolitical risk has implications on the commodity market, especially the crude oil industry and the precious metals industry. However, the implications of geopolitical risk on the agricultural industry have received little attention. Therefore, this study investigates the Granger causality between the Geopolitical Risk (GPR) sub-indices to examine the implications of geopolitical risk on 10 agricultural commodities categorised as either softs or grains.

**Research design and the methodological approach:** A quantitative methodological approach was adopted to investigate the Granger causality effects of geopolitical risk on the agricultural future commodity prices. For the purpose of this study, diagnostic tests were conducted to ensure that the data were stationary. In addition, other tests were conducted to ensure that the optimal lag length was selected and to limit the issue of serial correlation in the data. The author computed the Granger causality test to determine the causality relationship between the daily GPR sub-indices and the future prices of 10 essential agricultural commodities for the period from 31st March 2000 to 31st March 2022.

**Findings:** The study identifies that the Threat and Act GPR sub-indices Granger-cause the commodity prices of both wheat and oats. Moreover, these findings can also be related to the ongoing Russo–Ukrainian war, which has definitely impacted agricultural commodity prices since both nations are major agricultural producers. The empirical results also outline how the GPR Threat sub-index Granger causes the soybean oil, coffee, wheat, and oats future prices. On the other hand, the GPR Act sub-index Granger causes the oats future price only.

**Research implications:** It is evidently clear from the empirical findings that the GPR sub-indices impact the agricultural commodity market. Moreover, such findings highlight the predictive power of the GPR sub-indices in relation to changes in future commodity prices, as these contain information that can shed light on the course prices are likely to take following a particular geopolitical event.

**Originality/value:** These empirical results represent a step further towards understanding better the implications of geopolitical risk in the agricultural commodity market. This study should be of value to various economic actors, such as policymakers and national governments, who wish to understand and determine the effects of geopolitical risk and how it may impact national policies. Furthermore, this study can provide an opportunity for businesses and traders to implement risk management in order to limit the effects of geopolitical risk.

**Keywords:** ***Geopolitical Risk, Geopolitical Acts & Threats, Granger Causality, Uncertainty, Agricultural Commodities***

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# List of Abbreviations

**ADF –** Augmented Dickey Fuller

**AIC** - Akaike Information Criterion

**EPU** – Economic Policy Uncertainty

**EU** – European Union

**FPE** - Final Prediction Error

**GPR** – Geopolitical Risk

**GPRD** – Geopolitical Risk Daily Index

**HQ -** Hannan – Quinn information criterion

**ISO** - International Standard Organisation

**LM** - Lagrange Multiplier

**LR** – Likelihood Ratio

**SC** - Schwarz Information Criterion

**US –** United States

**UK –** United Kingdom

**USSR -** Union of Soviet Socialist Republics

**VAR –** Vector Autoregression

**WEF** - World Economic Forum

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# Chapter 1 – Introduction

## 1.1 Introduction

Over the years, non-financial events, such as the large-scale terrorist attacks of 11th September 2001, the rise of the Arab Spring, the annexation of Crimea from Ukraine, and the implications of Brexit, have left their mark on the globalised world. A common contributory factor to these events is the concept of geopolitics, and the world is constantly in a state of great disequilibrium concerning both the global economy and geopolitics (Bouoiyour et al., 2019). Indeed, Cowen and Smith (2009) acknowledge that "the language of geopolitics is everywhere" (p. 1). In times of an increase in geopolitical tension, uncertainty tends to prevail, which has serious repercussions on the economy and the financial markets. As a result, geopolitics has become an everyday concern for senior decision makers, especially when undertaking investment decisions, while ordinary citizens catch a glimpse of it in the press (Lee, 2020).

Jorion (2009) states that risk can be classified into three categories, namely known knowns, known unknowns, and unknown unknowns, which correspond to different levels of uncertainty. Geopolitical risk[1] can be categorised as a known unknown due to the rapid power shifts and the increase in uncertainty (Debs and Monteiro, 2014). On the other hand, Malmgren (2015) notes that geopolitical risk can be associated with both unknowns, but generally, this risk tends to be ignored completely as it is non-quantifiable and measuring it effectively can be a rather challenging task (p. 21). Even though investors are knowledgeable of geopolitical risk and try their best to manage it effectively, they are unaware of when it could occur, as geopolitical events generally come by surprise. Over the years, the concept of rare disaster risk has received notable attention (Barro, 2006; Gabaix, 2009; Berkman et al., 2011). In essence, rare disaster risk refers to a low probability event with a high economic impact (Pyo, 2021). Nguyen Huu (2021) acknowledges that geopolitical risk is one of the main risk factors of rare disaster risk apart from other risks, such as financial, natural, and technological risks.

[1] Throughout this dissertation, the author uses two important terms which are geopolitical risk and the GPR index. For the sake of consistency and clarity, the author will not abbreviate the term geopolitical risk, in order to distinguish it from the abbreviated term introduced by Caldara and Iacoviello (2018, 2021) the GPR index.

The recent rise in geopolitics has heightened the need for understanding better how geography, politics, international relations, and the economy interact together. Although the concept of risk has long been introduced, it is only recently that the notion of geopolitical risk has gained such momentum. Fägersten (2015) acknowledges that geopolitical risk has become more complex due to the lack of sovereign control as well as the power of the respective state. Sarpong (2021) indeed emphasises how in recent years, geopolitical actors have increased considerably and are influencing the geopolitical domain. However, the most influential factors affecting the increasing complexity of geopolitical risk include power relationships and rivalry, especially when considering physical space—the territory of a particular nation which encompasses various components like energy resources, raw materials, and trade routes (Howell and Sundberg, 2015; Lee, 2018). As a matter of fact, power struggle issues have been ongoing since time immemorial; however, nowadays, due to the globalisation phenomenon, it is increasingly evident that nations are competing for power and aspiring to take control over physical territories and resources (Sarpong, 2021). This was certainly made evident in the case of United States (US) President Trump through his proposal to build a wall bordering the US and Mexico; furthermore, his famous catchphrase "Make America Great Again" symbolises the aspirations of the US as a super-powerful nation (Lee, 2020). As a result, geopolitical tensions are generating divergence in advanced economies, whilst emerging economies remain vulnerable to a decrease in capital inflows and higher volatility in their stock markets (Hoque and Zaidi, 2020; Gosh, 2021).

## 1.2 Background Information

This section provides further insights to the reader on the salient features of geopolitics and how it evolved over time, taking into consideration the importance of the globalisation phenomenon, which paved the way for further economic growth and development. Additionally, power mutuality also plays a crucial role in a globalised and interconnected world. A shift in state power might bring about geopolitical tensions between nations, and as a result, various events might materialise. This was certainly reflected in the recent geopolitical tension caused by a trade spat between the US and Turkey (Mansour-Ichrakieh and Zeaiter, 2019). The relationship between the two countries started deteriorating when President Barack Obama

assumed office in 2009; however, it significantly worsened when President Donald Trump was elected in 2016 (Matera, 2020). The main reason for this tension was the US sanctions on Iran due to its nuclear programme. Due to the fact that Iran is Turkey's main trading partner, Turkey resisted complying with the US sanctions on Iran, thus triggering serious economic implications (Matera, 2020). Geopolitical tensions between the US and Turkey escalated in July 2018, leading to a currency crisis where the Turkish Lira depreciated by 35% within a period of seven weeks, which also impacted the financial markets (Mansour-Ichrakieh and Zeaiter, 2019). In view of such geopolitical tensions, investors must assess any shifts in power that might affect their investment portfolios.

### 1.2.1 The Rise of the Globalisation Phenomenon

Sarpong (2021) refers to how past European explorers had the desire to explore new territories in their search for valuable natural resources. In the late 20th century, and even now in the 21st century, such expeditions are, in fact, being undertaken by corporate entities to secure resources (Sarpong, 2021). Since the 1970s, the globalisation phenomenon has played a crucial role worldwide as countries integrated and progressed culturally, politically, and socio-economically (Sezer and Çavusoglu, 2018). Undoubtedly, globalisation is a prominent subject matter in both economics and the international business field, and Levitt's (1983) pioneering work entitled *The Globalisation of Markets* remains crucial to our wider understanding of why the globalisation phenomenon is still relevant nowadays. Indeed, in his work, Levitt coins the term "globalisation" and highlights how the various technological advances have led to the internationalisation of corporate entities as well as the homogenisation of consumption habits (Levitt, 1983, as cited by Palan et al., 2020, p. 1859; Lecler, 2019). According to Sezer and Çavusoglu (2018), "globalisation means that the world shrinks and the planet becomes a globe as a whole" (p. 351). This phenomenon brought about significant changes as the world became more interconnected, which led to more opportunities also at a domestic level (Das, 2010). The circulation of both trade and capital increased significantly, as globalisation led to a favourable economic environment due to a decrease in transaction costs and the widespread introduction of communication technologies (Sezer and Çavusoglu, 2018). Das (2010) notes, however, that

although globalisation ensured a period of economic growth across the world for at least three decades, the 2008 global financial crisis was a major turning point because globalisation has gone into a reversal.

Various nations across the globe began competing against each other so that multinational enterprises would set up and establish their operations in specific locations, such as South-East Asia. In the meantime, Western economies, such as the US and Europe, were automatically excluded (Pajunen, 2008). As a matter of fact, Asian countries benefitted widely from these foreign inflows since various labour-intensive industries situated in Europe and the US were transferred to numerous Asian nations, and the latter experienced the "flying geese" phenomenon. This term, which was coined by the Japanese economist Akamatsu (1962, as cited in Ruan and Zhang, 2014), refers to when less developed economies catch up with the industrialisation phenomenon (p. 1). Over time, these economies diversify their industries accordingly, leading to sustained economic growth (Ruan and Zhang, 2014). Japan also played a fundamental role in shifting its labour-intensive industries to East Asian economies (Camarero et al., 2021). China and India were among the front runners to exploit the benefits of globalisation, while Vietnam followed suit (Das, 2010). Similarly, Latin American countries experienced a substantial increase in foreign investment related to the extraction of natural resources, regardless of their vulnerability to both below ground risks due to geological factors and above ground risks like weak institutions, political instability, and expropriations (Alvarado et al., 2017). On the other hand, while African economies did experience significant growth in foreign inflows, when compared with both Asia and Latin America, Africa still lags behind due to the nature of the extractive industries (Solomon and Ruiz, 2012). Indeed, during the last decade, African economies have been experiencing the capital flight phenomenon, whereby foreign investments outflow from the respective countries due to political and economic instability (Ndikumana and Sarr, 2019). In general, political conditions are not easily observable, especially for foreign investors, given that all private information is held by the host government, thus causing greater uncertainty. Consequently, foreign investors opt to invest in other nations (Bak, 2016).

Globalisation brought about decentralisation; whereby central government responsibilities are devolved to a number of political actors in the process of local economic development. Such political actors include local governments, non-governmental organisations, and international investors. As a result of globalisation and

financial integration, countries are now more economically and also geopolitically dependent on each other (Mansour-Ichrakieh and Zeaiter, 2019). Although globalisation fostered various opportunities across different economic sectors, critics argue that such opportunities brought about risks on the agenda, such as the risk of inequality, which leads to poverty (Burgoon, 2012); the increase in environmental risk and climate change (Karlsson, 2017); and the rise of populist ideas that tend to favour anti-globalisation policies, which pose a significant threat to globalisation per se (Steenbergen and Siczek, 2017). In fact, one particular risk that hinders the globalisation phenomenon is the disruption emanating from the political environment (political risk) (Sezer and Çavusoglu, 2018). Due to the dynamics of globalisation, such political risk is also applicable at an international level and arises due to geopolitics (better known as geopolitical risk), which have intensified in recent years (Suárez-de Vivero and Rodríguez Mateos, 2017).

### 1.2.2 A Historical Background on Geopolitics

Geopolitics seems to be a straightforward concept. Geopolitical analysis starts with a map; however, it ends up leading to severe and complex issues (Granieri, 2019). The historical roots of geopolitics date back over a century when Rudolf Kjellén coined the term geopolitics, which refers to the "formation process of nation states through conflicts over territory and resources" (Lee, 2018, p. 1899). Geopolitics deals with space-specific components, such as raw materials, commodities, trade routes, and territory, which are impacted by geopolitical events, such as war, terrorism, and conflicts (Lee, 2018). Very often, geopolitics is associated with negative consequences that hinder cooperation among states and ultimately impede trade and investment decisions within a business context (Lee, 2018; Nitoiu, 2020).

At the end of the 19th century, various politico-military thinkers, such as Alfred Thayer Mahan, Sir Halford Mackinder, Friedrich Ratzel, and Karl Haushofer, made significant contributions towards the development of geopolitics as a school of thought (Howell and Sundberg, 2015). The US naval officer Alfred Thayer Mahan

heavily contributed to the development of geopolitics in relation to the maritime field. In his seminal work entitled *The Influence of Sea Power upon History,* Alfred Thayer Mahan argues that global power emanates from both naval power and maritime geographical related factors, such as, for instance, the nation's geographical position (Thayer Mahan, 1980, as cited in Klinke, 2021, p.357). Additionally, in 1901, Alfred Thayer Mahan coined the term "Middle East" with reference to the geographical boundaries surrounding the Gulf states, and it became widely acceptable in a geopolitical context (Hughes and Heley, 2015). Another major contributor to the geopolitical school of thought is Sir Halford Mackinder, who is considered to be one of the most influential theorists and the founding father of geopolitics and geostrategy (Hughes and Heley, 2015). In his various seminal works, Mackinder addresses numerous issues related to global politics in relation to history and its geographical setting, which are still highly relevant today due to the current global struggles (Sempra, 2015). Moreover, Sir Halford Mackinder (1919, as cited in Klinke, 2021) is renowned for the "heartland" concept, which implies that whoever rules Eastern Europe will eventually rule the world (p. 357).

Other politico-military thinkers were mainly concerned with understanding better the relationship between socio-politics and biogeography (Barua, 2018). Friedrich Ratzel's main contribution is not directly related to geopolitics; however, his work deals with nationalism and the expansion of imperialism within a geopolitical context (Halas, 2014). Nevertheless, after his death, Ratzel's work was mentioned in other seminal works, including Rudolf Kjellén's *Geopolitik* (1899), which deals with the importance of the state (Haggman, 1998; Klinke, 2021). Indeed, Ratzel's main contribution is the "*Lebensraum*" concept, which literally means living space. This concept focuses on how human beings struggle for survival and have to adapt to the conditions of their respective habitat (Chiantera-Stutte, 2018; Klinke and Bassin, 2018). Further to his contribution, Ratzel had strongly advocated the idea that Germany should colonise Africa as a new living space (Klinke and Bassin, 2018). Meanwhile, General Major Karl Haushofer is considered to be a controversial figure who was highly influenced by both the Anglo-American theorists Alfred Thayer Mahan and Sir Halford Mackinder, as well as Friedrich Ratzel. His main contributions were, in fact, influenced by Mackinder's heartland theory; however, he chose to focus on the Russo-Germanic alliance (Mackinder 1919, as cited in Klinke, 2021, p. 357). Following Ratzel's death, General Major Haushofer established the Institute of

Geopolitics (*Institut für Geopolitik*), which proved instrumental for Hitler's Nazi Party ideologies, especially since it introduced the *Lebensraum* concept, encouraging the Nazi Party to conquer Eastern Europe (Klinke, 2021). Indeed, the *Lebensraum* concept was put into practice when Germany invaded Poland, which led to the beginning of World War II (Murphy, 2014; Klinke 2021). These major yet controversial contributions were written during the late 19th and early 20th centuries, which included some of the darkest moments in history, such as World War II and the Vietnam War (Howell and Sundberg, 2015). Since then, geopolitics has developed as a school of thought of its own; however, such insightful contributions still remain also relevant in the 21st century (Sempa, 2015).

Geopolitics has evolved since then; over time, it has become a critical component within an international context. Granieri (2019) highlights that any geopolitical event is rooted in historical terms, influenced by the local culture, and embedded in the reality of geography. For instance, the tensions between the United States and the ex-Soviet Union, which went on over a long period of time, eventually led to a Cold War culture that has dramatically shaped today's geopolitical arena. Although the Cold War era was a long struggle for the US, it emerged victorious by the end of 1991 and subsequently, the Soviet Union was dissolved. As a result, most ex-Soviet communist countries experienced significant changes, such as regime changes, and parliamentary democracy was introduced (Lee, 2020).

Since the aftermath of the Cold War, the world has witnessed a number of geopolitical events, which include military confrontations and large-scale terrorist attacks, the impact of which has been intensifying in nature since 9/11. Ramiah et al., (2019) state that from 2001 to 2017, around 20 terrorist attacks had been carried out in major cities around the world, with serious repercussions on the financial markets. During the last decade, we have witnessed intense geopolitical tensions, which led to the Arab Spring and the Russo-Ukrainian conflict, which recently developed into a full – scale war between these neighbouring nations. The Arab Spring started off in Tunisia, with the main aim being to end the autocratic leadership of nations like Egypt and Libya, eventually spreading into Bahrain and Syria (Lee, 2020). However, the Arab Spring for both Libya and Syria ended up in an intense interstate war, especially the Syrian war, which is considered

an international proxy war (Lee, 2020). On the other hand, the recent Ukraine–Russia conflict emanated from the divide between pro-Russian and anti-Russian supporters and Russia's ambitions to heavily influence ex-Soviet Union countries. This conflict was the result of the three important factors outlined by Granieri (2019), namely historical roots, culture, and the dynamics of geographies.

Within a geopolitical context, the recent dominance of the Asian region has also grown stronger. Over the years, the Chinese government has undergone numerous economic reforms, and as a result, the People's Republic of China has emerged as another superpower, leaving its communist regime intact (Lee, 2020). Apart from being a major economic powerhouse, the People's Republic of China is also the main investor in various countries, with ambitious plans for the near future, such as the Belt and Road initiative, which was introduced in 2013 by the Chinese President Xi Jinping. In a nutshell, the Belt and Road initiative is comprised of two infrastructure projects influenced by China's historical past, namely the Maritime Silk Road and the Silk Road Economic Belt, with the aim of developing better connections (including port, railway, highway, and pipelines) with other Asian and European countries along both routes (Blanchard and Flint, 2017). These ambitious infrastructural projects will be completed by 2049 and will also be complemented with soft infrastructure, which includes the introduction of free trade agreements that can potentially transform the global geopolitical landscape (Blanchard and Flint, 2017; Jessop and Sum, 2018). Hence, China has become a serious threat to the Western world, especially to the US, a case in point being the recent US–China trade retaliation, which is considered to be an economic version of hegemony struggle (Lee, 2020). Undoubtedly, the world will experience geopolitical tensions in the near future; however, the intensification of such events will depend on two important factors, namely the power struggle and how willing nations are to commit budgets to their defence.

## 1.3 The Importance of Power Struggles and Defence Expenditures

Recently, the scholarly field of critical geopolitics has gained momentum, especially in today's interconnected and globalised world. In essence, critical geopolitics is distinct from international relations as it analyses the relationship between physical space and the exercise of political power (Howell and Sundberg, 2015). This

relationship can be seen, for example, through how the disintegration of the Soviet Union and the globalisation phenomenon proved fundamental for various countries, especially developing nations, which experienced countless economic booms as a result. Subsequently, such economic events can lead to a shift in a nation's power dynamics, endowing it with the ability to either dominate and/or control other territories or valuable natural resources (Khan et al., 2020; Saprong, 2021).

In essence, state power is the ability to effectively affect other countries in multiple ways, such as by setting the political agenda or else, in extreme cases, through military action (Nye, 2004). Wilson (2008) classifies power into three categories, namely hard, soft, and smart power. Hard power refers to the military power of a particular country. Undoubtedly, North Korea fits perfectly within the definition of hard power since Kim Jong-Un invested heavily to strengthen his military power, especially with nuclear missiles, while engaging relatively less at an international level (Lee, 2020). On the other hand, soft power refers to a nation's ability to affect the preferences of others. For instance, in order to achieve both its international and economic goals, Denmark focuses more on soft power; indeed, it effectively implements the "hygge"[2] concept rather than using coercion (Howell and Sundberg, 2015). Meanwhile, the concept of smart power is the hybrid version combining both hard and soft power, which must be mutually reinforcing in order for a nation to advance politically in an effective and efficient manner (Wilson, 2008). For instance, China has effectively implemented the smart power approach as it has deployed its power resources strategically and pursued its doctrine to rise peacefully (Wilson, 2008). Obviously, power differs amongst countries, and generally, countries tend to prioritise their interest, eventually leading to conflicts and tensions (Debs and Monteiro, 2014; Tam and Kim, 2020).

Ever since the 9/11 large-scale terrorist attacks, countries have been seriously concerned about both the internal and external security and subsequently began increasing their defence expenditures. Khan et al., (2020) note that over a period of two decades (1998–2018), defence expenditure has increased tremendously to roughly around 2 trillion US dollars. In particular, emerging countries, such as Turkey, Israel,

[2] The Danish word "hygge" means cosiness.

Saudi Arabia, and India, are investing heavily in their defence equipment, which is being supplied by two superpower nations, namely China and Russia (Khan et al., 2020). Such an increase in defence expenditure is also linked to various ongoing conflicts, such as the Kurdish conflict in Turkey, the Palestine conflict in Israel, the effects of the Arab Spring in Saudi Arabia, and the ongoing tensions with China and Pakistan in India. Moreover, these emerging countries are strategically positioned across the globe, which further enhances both their political and economic dominance in order to exploit natural resources (Khan et al., 2020).

## 1.4 The Implications of Geopolitics on Developing Nations

Developing nations are geographically situated in every part of the world and tend to have distinctive characteristics, such for instance a less developed industrial base when compared to developed nations and a surge in population complemented by a rapid increase in urbanisation despite the prevalent lack of infrastructure (Mogaji et al., 2021). Undoubtedly, developing nations face a paradox; even though they are registering a substantial increase in their gross domestic product, these nations have the lingering problem of registering a lower value in the human development index when compared to developed nations (Lee and Lee, 2020; Resce, 2021). Over the years, developing nations have intensified both their economic and political potentials, leading to further integration with developed nations (Lee and Lee, 2020). It is envisaged that the fastest-growing emerging nations, namely Brazil, Russia, India, China, and South Africa (better known as BRICS), will dominate the global market in the nearby future (Gemechu, 2015). Mayer (2012) notes that commodities are crucial for the economies of developing nations; however, these nations are vulnerable to geopolitical risks, which could suddenly decrease both their international trade and capital flows, leading to increased uncertainty (Carrière-Swallow and Céspdes, 2013; Cheng and Chiu, 2018).

In 2013, Morgan Stanley, an international credit rating agency, coined the term "Fragile Five", which refers to the following nations: Brazil, India, Indonesia, Turkey, and South Africa (Chadwick, 2019).[3] Unver and

[3] Morgan Stanley rated these developing nations in line with six important factors, namely current account balance, forex reserves to external debt ratio, foreign holdings of government bonds, US dollar debt, inflation, and real rate differential.

Bulent (2015) highlight that these economies experience high inflation and a large amount of current account deficits. Although these economies experienced a rapid increase in foreign direct investment, especially post the global financial crisis, an increase in geopolitical tensions would result in a decrease in capital flows, diminishing their growth prospects (Hoque and Zaidi, 2020). Chadwick (2019) mentions that an outflow of capital shifts from these emerging economies was registered in 2015, whilst advanced economies benefitted from such capital flows. In view of this, Morgan Stanley created the "Trouble Ten" category, which includes countries like South Africa; Asian countries, such as Taiwan, Singapore, Russia, Thailand, and South Korea; and Latin American countries, such as Peru, Chile, Colombia, and Brazil (Chadwick, 2019).

## 1.5 The Interplay Between Geopolitics and the Commodity Markets

It is common knowledge that commodities are highly influenced by the law of supply and demand; however, geopolitical factors also play a significant role (Aloui and Hamida, 2021). In recent years, the war on resources has become prevalent in our globalised and interconnected world (Sarpong, 2021). Dalby (2015) acknowledges two valid reasons why such types of wars are taking place, namely due to the scalability of resources and the lack of good governance of a particular nation, thus encouraging the occurrence of such violence. This is certainly true in the case of the Middle East region, which has experienced the so-called resources war over the years, given that this particular region is rich in crude oil. Having access to such a resource can both impact the economies of Middle Eastern countries and cause major shocks to international markets (Dalby, 2015).

Another important factor to consider is scarcity, which has significantly intensified in recent years, and both crude oil and natural gas are under pressure due to the increase in demand and population (Gemechu et al., 2015). As a matter of fact, scarcity has always been a central problem of economic societies, as valuable resources tend to be limited in supply while demand is always on the increase. Brown (2012) believes that the world is in a transition phase from abundance to scarcity (p. 1). For instance, energy commodities have

become less abundant, and other commodities are also following suit (Klare, 2008). The issue of climate change, in particular, has recently amplified the belief that we are moving towards an "age of scarcity"; indeed, nations have become more concerned about food security and the lack of water resources, which also impacts agricultural commodities (Oliveira, 2016, p. 361). Yilanci and Kilci (2021) point out how, recently, the financial markets have begun to influence the commodity markets, and subsequently, investors have started to invest more in a variety of commodities.

Commodities are considered an alternative investment, distinctive from traditional investments like bonds and securities. In fact, financial investors (money managers and index traders) are trading in the commodity markets without necessarily investing in and owning the selected commodity. This is made evident when investors take long positions in different commodity futures, and as such, these positions are closed just in time when the futures contract expires, generally within three months. As a result, this investment strategy can be rolled on for the following contracts, leading to a substantial increase in commodity prices (Mayer, 2012). Another increase in commodity prices was witnessed between 2010 and 2011, especially due to the rise of the Arab Spring. As the two major emerging markets, China and India are highly influencing the rise in commodity prices (Yilanci and Kilci, 2021). Besides, this commodity boom led to a burden, especially on emerging markets, as these are heavily dependent on food and energy imports (Mayer, 2012; Sommerville et al., 2014). Indeed, such commodities are essential, especially the agricultural commodities, because these include the basic food products consumed in such emerging countries and are the currency of at least 2 billion people (Tadesse, 2014).

## 1.6 Problem Statement

Various prominent international organisations, intelligence agencies, and think tanks acknowledge that the topic of geopolitical risk is a key concern in today's globalised world (Suárez-de Vivero and Rodríguez Mateos, 2017). One such international organisation is the World Economic Forum (WEF), which actively monitors five categories of large-scale risks on a global level and publishes a yearly report entitled *Global*

*Risk Report*. Apart from geopolitical risk, the WEF monitors economic risk, environmental risk, societal risk, and technological risk. In their 2021 report, the WEF noted that the world's top geopolitical risks include interstate relations fracture, the proliferation of weapons of mass destruction, and large-scale terrorist attacks, amongst others. Interstate conflicts and the proliferation of weapons of mass destruction were assigned as having a higher likelihood and a higher impact, respectively. However, a slight variation in geopolitical risks was noted from previous reports (2016–2019); the 2021 WEF report also highlighted the failure of national governance and state collapse/crisis, which have intensified in recent years.

Any geopolitical tension between nations might have potential adverse implications, which could, in turn, affect both the macro-economic and financial cycle of a nation (Olasehinde-Williams and Balcilar, 2020). Furthermore, several strands of literature outline how geopolitical risks hinder various sectors, such as tourism (Neacsu et al., 2018; Balli, 2019; Demir et al., 2019; Chiang Lee et al., 2020), banking (Phan et al., 2021), the shipping industry (Kotcharin and Maneenop, 2020), and the stock markets (Balcilar et al., 2018; Bouri et al., 2019; Bouras et al., 2019; Hoque and Zaidi, 2020; Smales, 2021), amongst other economic sectors. Additionally, since various nations are exerting both economic and political power to exploit numerous valuable resources, the commodities industry has gained particular attention within a geopolitical context, especially due to the increase in demand for the consumption of certain commodities as well as the impact of climate change across the sectors within the industry (Kolb, 2011). Recently, the commodities industry has also gained particular attention within a geopolitical context. It is common knowledge that various nations exert both their economic and political power to exploit different natural resources.

Over the years, several academics have conducted studies on the implications of geopolitical risk on commodity markets. Such studies focused on crude oil and the precious metals, which are considered to be the most important commodities in the world (Antonakakis et al., 2017; Abdel-Latif and El-Gamal, 2019; Bouoiyour et al., 2019; Das et al., 2019a; Su et al., 2019; Cuando et al., 2020; Qin et al., 2020). However, there are few studies related to the various types of agricultural commodities in order to assess the importance of food security and the supply of raw materials. Hence, the author believes that there is a clear gap in the literature concerning the subject of agricultural commodity markets within a geopolitical context.

In the following sections, the author explains the significance of this study, provides a detailed explanation of the research objectives, and outlines both the research question and research hypothesis posed.

## 1.7 Research Objectives

In view of the latest geopolitical developments across the world, an empirical analysis was carried out in order to assess how the GPR index affects the agricultural commodity markets. Apart from academic literature, the author also consulted various reports and documentation issued by prominent international organisations, such as the World Bank and the WEF. Through this study, the author aims to:

i) improve the understanding of geopolitical risk and the concept of uncertainty within the context of geopolitics; and

ii) investigate and confirm the Granger causality relationship between the GPR sub-indices and the agricultural future commodities.

### 1.7.1 Research Question and Research Hypothesis

Following the outline of the research objectives, the author now introduces the research question for this study. As stated in the previous section, limited research could be found on the overall relationship between geopolitical risk and agricultural commodities. Consequently, the author raises the following question:

Is there a causal relationship between the GPR sub-indices (GPR threat and GPR act) and the commodity prices when considering agricultural future commodities (grains and softs)?

In order to determine the causal relationship, the following null and alternative hypothesis are outlined as follows:

$H_0$: No causal relation between the GPR – sub index (GPR Act and GPR Threat) and the respective future commodity price.

$H_A$: There is a causal relation between the GPR – sub index (GPR Act and GPR Threat) and the respective future commodity price.

## 1.8 The Significance and Originality of the Study

It is common knowledge that geopolitics presents a plethora of risks. However, it seems that geopolitical risk is given secondary importance or else ignored completely as investors tend to underreact to political news (Malmgren, 2015; Hoque and Zaidi, 2020). In times of global tensions and uncertainty, geopolitical risk becomes the only risk that matters. Caldara and Iacoviello (2018) emphasise that investment decisions are highly influenced by geopolitical risk. Indeed, geopolitical implications have been a current thematic issue both at a policy level as well as in academic discourse (Olasehinde-Williams and Balcilar, 2020). Since geopolitical tensions have intensified across the globe, international businesses need to effectively manage geopolitical risk as well. The monitoring and minimisation of geopolitical risk cannot be achieved without any adequate data being analysed and developed in this field. Moreover, from an academic point of view, only a few studies exist on the causal relationship between geopolitical risk and the commodity markets. The author opines that more research needs to be carried out to highlight the implications of geopolitical risk, and as far as the author is aware, no studies have been conducted on the causal relationship between the GPR sub - indices and agricultural commodity markets.

This study should prove useful for international businesses as it could help them develop a better understanding of the dynamics of geopolitical risks. As a result, international businesses would be able to undertake effective and informed decisions. Furthermore, this study could also assist professional investors as they can use it as a guide to adequately plan their strategies and diversify their investment portfolios in

view of the increase in geopolitical risk. From an academic point of view, this study may be used for reference by university students and industry professionals both locally and abroad. Overall, this dissertation should offer considerable contributions to the geopolitical risk literature due to its emphasis on how geopolitical risk impacts various commodity markets and the various recommendations it provides on how geopolitical risk can be managed efficiently and efficiently.

## 1.9 The Outline of the Study

This dissertation is divided into five chapters as follows:

This introductory chapter provided a historical background on the rise of the globalisation phenomenon, as well as the origins of and recent developments in geopolitics. A detailed account was provided on how, at an international level, nations are struggling to maintain their power and have subsequently increased their defense expenditure. This chapter also presented the problem statement as well as the objectives of the study. The significance of the study was also discussed, the research question and hypothesis were outlined.

Chapter 2 provides an in-depth analysis of the literature available on geopolitical risk and the importance of the uncertainty concept, which matters in today's dynamic business environment. This chapter discusses the importance of effectively measuring geopolitical risk while also presenting a review of how geopolitical risk affects the commodity markets based on existing empirical research on the subject.

Chapter 3 outlines the methodology that was chosen by the author for the purpose of this study, focusing mainly on the deductive method used to conduct the study in order to answer the research question mentioned in this chapter. The limitations of the research approach used are also described in this chapter.

Chapter 4 presents the empirical results, along with a diagnostic checking of the data. The findings are discussed and compared with the findings from the literature presented in Chapter 2.

Lastly, Chapter 5 concludes this study by highlighting the most significant findings and listing any recommendations that could be put into practice so that international businesses could better manage geopolitical risks. A brief summary of the study is provided, and the dissertation concludes with further recommendations for any future research.

# Chapter 2 – Literature Review

## 2.1 Introduction

It is worth noting that academic interest in geopolitical risk gained importance shortly after the 9/11 large-scale terrorist attacks in the US. During the last decade, the world witnessed numerous geopolitical events, such as the Arab Spring in 2011, the Russo-Ukraine conflict in 2014, and the US–China trade retaliation in 2018, which have caused an increase in geopolitical risk and impacted both the financial and commodity markets. As a result, these recent events have stimulated further academic interest in exploring the dynamics of geopolitical risk. This chapter consists of a review of literature related to geopolitical risk; the concept of uncertainty, which arises due to the presence of risk; and how to effectively measure geopolitical risk, with the aim of expanding on the initial propositions highlighted in the introductory chapter.

## 2.2 What is Geopolitical Risk?

Prior to analysing the notion of geopolitical risk, it is important to understand better the concept of risk. Over the years, a number of definitions of the concept of risk were coined. However, the author notes that the International Standard Organisation (ISO)'s definition of risk is the most widely accepted, which presents risk as the "effect of uncertainty on objectives" (ISO, 2018). On the other hand, political risk is considered to be a broad concept and generally difficult to measure (John and Lawton, 2018; Yilanci and Kilci, 2018). Various academic researchers made considerable progress in defining the concept of political risk (Robock, 1971; Kobrin, 1979; Huang et al., 2015; John and Lawton, 2018). Yilanci and Kilci (2021) associate political risk with any unfavourable changes emanating from the political environment that could bring about instability as well as uncertainty, thus affecting asset prices. In contrast, John and Lawton (2018) provide a comprehensive definition of political risk that accounts for the importance of action or inaction within a political environment, which could regularly or episodically lead to either negative or positive changes. As outlined in the introductory chapter, geopolitical risk has intensified in recent years, mainly due to the globalisation phenomenon, and as a result, nations are facing a power struggle to control both their physical

and space-specific territories (Howell and Sundberg, 2015). In view of this, various advanced and emerging nations have increased their defence expenditure to counteract any geopolitical threats (Khan et al., 2020).

Over the years, academic research made considerable progress in defining the concept of geopolitical risk. Bremmer and Keat (2010) define geopolitical risk as "the risk posed to economic actors and governments by the relative rise and decline of great powers and the impact of conventional wars on state and corporation" (p. 38). Bremmer and Keat (2010) undertook a broad conceptual approach to define the term geopolitical risk, solely focusing on two actors, namely the state and the government. Moreover, Bremmer and Keat (2010) highlight three principal factors, which are duration, bias, and complexity (p. 40). The duration factor concerning geopolitical risk refers to how it takes time for there to be either a rise or decline in state powers. A rise in state power is clearly illustrated in the case of China, which rose to power over the last five decades following the globalisation phenomenon. Such success cannot be attributed solely to hard power but also to soft power, which China employs to introduce global norms to the wider world (Cunningham-Cross, 2012). Besides, China has also proved to be a threat to the Western world due to its continuous growth, even following the 2008 global financial crisis, and how it managed to alter its development in accordance with both global and national imbalances (Dunford and Yeung, 2011). On the other hand, discontinuities as a result of terrorist attacks, violent conflicts, or trade retaliations that are difficult to anticipate or predict could lead to a decline in state power.

Meanwhile, the bias factor can be attributed to experts who are ready to sound the alarm on threats arising from other enemy states and other emerging threats that have recently intensified, such as terrorism and climate change (Bremmer and Keat, 2010). Enemy state threats increase considerably when the citizens of two or more neighbouring states endorse clashing beliefs. This is certainly true in the recent case of Nagorno-Karabakh, a region in Azerbaijan, which is mostly inhabited by ethnic Armenians. Since the disintegration of the Soviet Union, the Nagorno-Karabakh region witnessed numerous national conflicts and violence between Armenians and Azeri, the climax of which was reached with an intense war in 2019 (Radnitz, 2019). Governments, especially authoritarian regimes, are, in fact, considered to be another type of expert contributing to the bias factor; such governments are more likely to alert their own citizens against any

threats, especially from the perceived enemy. Indeed, the leaders of both Russia and Belarus, two well-known authoritarian regimes, acknowledged that such an enemy state rose from two sources, namely the Western world and the opposition leaders in their respective countries. In the meantime, President Vladimir Putin and President Alexander Lukashenko used their authoritarian power and their paternalistic image as stabilising forces to ensure that their citizens do not inspire any geopolitical change while targeting any opposing individuals to discipline or punish them (Kazharski and Makarychev, 2021).

Alongside political issues, the world has witnessed serious environmental concerns, such as global warming and climate change. However, these issues have not been adequately addressed by all the countries across the globe, and in view of this situation, the number of environmental experts has increased significantly over the years (Baiardi and Morani, 2021). During the last decade, the younger generation has taken the initiative to raise awareness of the ongoing environmental issues by organising numerous climate change protests. For instance, Greta Thunberg, a Swedish environmental activist, has been leading various environmental campaigns recently (Baiardi and Morani, 2021). One of her most popular campaigns criticised the ex-US President Donald Trump for pulling out from the 2015 Paris Agreement, which was signed by 197 countries in order to decrease and stabilise their carbon emission by 2050 (Liu et al., 2020; Hayes and O' Neill, 2021; Baiardi and Morana, 2021).

Lastly, geopolitical risks are deemed to be complex in nature as these can generate and mutually reinforce other types of risks. An increase in geopolitical risk can, for instance, increase the likelihood of economic risks as well as the exchange rate risk. This is certainly true in the case of the recent US sanctions against Venezuela and Turkey, two authoritarian regimes ruled by President Nicolás Maduro and President Recep Tayyip Erdogan, respectively. Nowadays, sanctions are becoming increasingly popular as a foreign policy tool; these involve actions by a single, group, or block of actors against one or more countries. The scope of a sanction is to punish the targets and make them obey important norms. Sanctions are issued unilaterally and multilaterally and can also target specific individuals, organisations, and regimes. In 2018, the US sanctioned Venezuela due to violations of human rights and also boycotted the country financially (Duan et al., 2021). Also in 2018, the US issued sanctions to various Turkish diplomats and tariffs on the Turkish economy, which

led to a trade spat between the US and Turkey, leading the latter to deem the US as an enemy state. As a result, this led to a trade war with serious economic implications (Mansour- Ichrakieh and Zeaiter, 2019). These two distinctive geopolitical tensions led to an increase in economic risks, which also affected the stability of the respective currencies of the countries involved. Indeed, these geopolitical events resulted in a severe currency crisis for both the Venezuelan bolívar and the Turkish lira, leading to an international spillover (Arbaa and Varon, 2019; Mansour-Ichrakieh and Zeaiter, 2019; Duan et al., 2021).

In contrast to Bremmer and Keat (2010), Caldara and Iacoviello (2018) narrowly define geopolitical risk as being "associated with wars, terrorist acts, and tensions between states that affect the normal and peaceful course of international relations" (p. 6). Put differently, geopolitical events materialise due to the exertion of state power on other states. Nowadays, countries are exerting their influence on global affairs that impact their geopolitical imprint, thus increasing the chances that such risks materialise (Kyriazis and Economou, 2021). Caldara and Iacoviello's (2018) definition is based on the historical term of geopolitics while also including the implications of terrorism, which has increased significantly following the 9/11 large-scale terrorist attacks. In addition to this, any political tensions that may arise at a national level could create geopolitical instability (Caldara and Iacoviello, 2018). However, a distinction should be made between domestic political events and geopolitical events. For instance, the failed 2016 Turkish coup d'état against the state institutions and President Tayyip Erdogan falls within Caldara and Iacoviello's definition of geopolitical risk as it had spillover implications in the Middle East region. On the other hand, the 2016 referendum in the United Kingdom to leave the European Union (EU) does not fall within the context of geopolitical risk, as the democratic referendum was accepted by the EU member states (Caldara and Iacoviello, 2018). Although various geopolitical events may be evident, there are certain flashpoints that, very often, tend to be ignored. Furthermore, it is not always clear which aspects could lead to predictable surprises (Lee, 2019).

## 2.3 Economic Implications Arising from Geopolitical Risk

As the world became more globalised and interconnected, the relationships between countries have intensified. Yilanci and Kilci (2021) acknowledge that such relationships can be categorised into three: economic, political, and military. An economic relationship ensures that the respective countries benefit from further economic growth. Meanwhile, a political relationship depends on international relations and the exertion of power. On the other hand, the aim behind a military relationship between countries is to ensure peace and security. Whenever these relationships are under threat from an opponent country, both geopolitical risk and uncertainty increase (Yilanci and Kilci, 2021). In view of such global tensions, certain countries are strengthening their military power whilst increasing their defence budget to combat such conflicts (Khan et al. 2020).

Without a doubt, any changes in both the domestic and international political environments severely impact the economy, the markets, as well as the investor sentiment (Aloui and Hamida, 2021). Khan et al., (2020) emphasise that geopolitical risk is unpredictable in nature, and generally, it is difficult to manage it effectively. Furthermore, it is the main determinant that affects investment decisions (Caldara and Iacoviello, 2018). Moreover, Alqahtani and Klein (2021) highlight that geopolitical risk has become a relevant factor and the main source of both uncertainty and risk, impacting both the commodity and energy markets. In response to an increase in geopolitical risk, market traders may redesign their hedging differently in order to reconsider other "safe haven" assets (Alou and Hamida, 2021, p. 468). In addition to this, Baur and Smales (2020) highlight that geopolitical risk is deemed to be a systematic risk that is very often difficult to diversify. Indeed, investors are often unable to diversify away geopolitical risks in cases of sudden increases (Apergis et al., 2018; Alqahtani and Klein, 2021). Another important implication is that geopolitical risk leads to panic selling by investors, which can make or break the financial markets (Alqahtani and Klein, 2021).

Olasehinde-Williams and Balcilar (2020) highlight that such geopolitical risks highly influence the macro-economic perspective and financial cycles, leading to a considerable amount of risk and uncertainty. An

increase in geopolitical risk also results in increased insecurity and political instability, which, in turn, affect private sector investment. Bilgin et al., (2020) conducted an empirical test using both fixed-effect estimation and the least squares dummy variable corrected model in order to analyse the relationship between geopolitical risks and government investment across 18 emerging countries for the period 1985 to 2015. In line with their augmented compensation hypothesis, Bilgin et al., (2020) noted that geopolitical risk is positively related to an increase in government investment due to the repercussions of such geopolitical events; as such, economic actors demand compensation in view of geopolitical risk.

## 2.4 The Relationship Between Uncertainty and Geopolitical Risk

Another important concept related to risk is the notion of uncertainty. One well-known early study related to both risk and uncertainty that is often cited in academic research is that of Frank Knight (1921). Risk is associated with a probability distribution related to an event, while uncertainty is the inability to appropriately forecast the likelihood that an event occurs (Knight, 1921 as cited by Bloom, 2014, p. 154). Bloom (2014) highlights that uncertainty is an amorphous concept because individuals perceive uncertainty about the future differently. Besides, it affects both micro- and macro-economic phenomena, as well as non-economic events that tend to cause uncertainty, such as war and climate change (Bloom, 2014). As the global economy has become more advanced and integrated, the degree of uncertainty in a business context has recently been amplified. Investors are susceptible to uncertainty as it matters to their investment decisions (Bilgin et al., 2020). Rational investors tend to undertake a decision based on either their past experience or their theoretical knowledge (Jackson and Orr, 2019). Uncertainty is always present, however, and investors cannot predict the future (Jackson and Orr, 2019). In certain instances, investors undertake evidently irrational investment decisions pertaining to their portfolio following any unusual events, leading to a flight to quality, where investors sell risky investments (Caballero and Krishnamurthy, 2008).

Following the 2008 global financial crisis, there was a surge in academic interest in how uncertainty overall affects the economy, as well as the financial and commodity markets. Carney (2016) introduced the concept of "uncertainty trinity", which categorises three types of uncertainty, namely economic uncertainty, policy uncertainty, and geopolitical uncertainty (p. 3). By far, economic uncertainty is the most common type of uncertainty; it is associated with the operation economy and both public and private debt (Carney, 2016). Uncertainty is a critical factor both for the economy and the capital markets as it causes ambiguity, and as a result, investors adopt a wait-and-see approach by prolonging their investments until it becomes clear enough for them which investment decisions should be taken (Bloom, 2009; Yilanci and Kilaci, 2021). Government institutions play an important role as these set policies and frameworks within an economy. An increase in policy uncertainty emanates from the absence of such effective policies or the frequent changes of existing policies, leading to macro-economic instabilities (Carney, 2016; Yilanci and Kilci, 2021). In recent years, policy uncertainty has intensified, especially following the global financial crisis and the Eurozone crisis, which subsequently led to changes in both fiscal and monetary policies (Baker et al., 2016). Eventually, policy uncertainty impacts the economic growth of the respective country (Aisen and Veiga, 2013).

Geopolitical uncertainty creates an unfavourable economic prospect on the aforementioned types of uncertainty. Cuando et al., (2020) acknowledge that geopolitical uncertainty highly impacts the state of the economy. As a result, it hinders investors' confidence, especially in developed markets rather than in emerging markets (Hedström et al., 2020). Besides, uncertainty induced by the geopolitical environment has serious implications on international markets. Conversely, from an economic perspective, Bloom (2014) notes that uncertainty is significantly higher in developing countries than in advanced countries, primarily due to their less diverse economy and their focus on different commodities, which tend to be volatile. Overall, both geopolitical risk and uncertainties can result in harmful economic consequences that have negative implications on asset price dynamics (Bouoiyour et al., 2019).

### 2.4.1 Measuring Uncertainty

Uncertainty is a broad concept, and as a result, it can be challenging to measure (Bloom, 2014; Joëts et al., 2017). However, in their recent seminal work, Baker et al., (2016) make a major contribution to the uncertainty literature by constructing a proxy to measure uncertainty, this being the Economic Policy Uncertainty (EPU) index. In their empirical analysis, Baker et al., (2016) employed a text mining framework on terms related to uncertainty, such as monetary policy uncertainty, fiscal policy uncertainty, and government policy uncertainty, to reproduce a quantitative measure based on 10 US newspapers and over 12,000 newspaper articles.[4] The EPU index was first computed for the US on a monthly basis for the sample period from 1985 to 2015. The most notable spike of uncertainty was related to the debt ceiling dispute, which occurred in 2011; it concerned the increased government spending due to the global financial crisis, the 9/11 large-scale terrorist attacks in 2001, and the Lehman Brothers bankruptcy and the subsequent trouble asset relief programme in 2008 (Baker et al., 2016). A historical EPU index dating back to the beginning of the 20th century was also computed, with the most notable spike occurring during the Great Depression period of the 1930s; however, the former historical event registered a spike lower than that of the 2011 debt ceiling crisis.

In their empirical study, Baker et al., (2016) constructed EPU indices for 12 major economies,[5] including both advanced nations, such as the US, Germany, and Japan, as well as emerging nations like Russia, China, and India. This comprehensive study had to be adapted to include different terms related to the uncertainty policy of the respective nation being analysed. Since freedom of press is highly controlled in both the authoritarian regimes of China and Russia, these indices were highly dependent on a single newspaper. However, the Russian EPU index is a good illustration of the importance of uncertainty in authoritarian regimes; based on this index, the most notable spikes throughout the sample period (October 1992–April 2014) appeared due to the First Chechen War in 1995, the Russian financial crisis in 1998, Vladimir Putin's

[4] A selection of the US newspapers consulted from across various states: *USA Today*, *Miami Herald*, *Chicago Tribune*, *The New York Times*, *The Washington Post*, *Los Angeles Times*, *The Boston Globe*, *San Francisco Chronicle*, and *The Wall Street Journal*.
[5] The remaining major economies included: Italy, Spain, United Kingdom,France, Canada and South Korea.

election as prime minister in 1999, the Duma election fraud in 2011, and the annexation of Crimea from Ukraine in 2014 (Baker et al., 2016). Following this empirical study, Baker et al., (2016) constructed a total of 27 EPU indices for various countries across the world. The data generated through these indices are publicly available and constantly being updated.

It must be noted that Baker et al., (2016) made use of a transparent methodology by auditing the term policy of 12,000 newspaper articles covering both the sample period and the historical period in order to address effectively any issues related to accuracy and bias. For the purpose of the audit process, Baker et al., (2016) employed terms related to policy while considering the time period in question. Apart from the audit process, Baker et al., (2016) also compared the EPU index with the volatility index, whereby the latter takes into consideration the implied volatility of the US S&P 500 index. It was noted that the EPU index and the volatility index are both correlated; however, these indices vary accordingly over time, depending on the event in question. This is evident in the case of various financial crises that led to an increase in volatility, such as the 1998 Asian financial crisis and the 2008 global financial crisis. On the other hand, the EPU index demonstrated a higher uncertainty impact with respect to the Gulf war in 1991, the terrorist attacks of 11th September 2001, various US presidential elections over the years, and the US government shutdown in 2013. Overall, both the audit process and the other comparisons proved to be beneficial as this empirical analysis can be extended to other countries and other specific indices (Baker et al., 2016).

### 2.4.2 The Implications of Uncertainty on the Commodity Markets

In recent years, there has been an increasing amount of literature concerning uncertainty as it is a key concern in today's globalised world. Wang et al., (2015) conducted an empirical analysis in order to understand the predictability of EPU and the respective changes of 23 commodity prices. A time-varying parameter model was employed for the sample period from January 1985 to December 2013 based on the World Bank's Commodity Price Index and the EPU index. Wang et al., (2015) concluded that commodity prices tend to predict EPU, which is vital for the development of an economy. Moreover, the seminal work by Baker et al.,

(2016) encouraged various academic researchers to conduct extensive research concerning the impact of uncertainty on the commodity markets, thus enriching the literature. In their recent empirical investigation, Bahloul et al., (2018) employed a nonparametric causality-in-quantiles approach to investigate the price movements with respect to 21 future markets dealing with various commodities like agricultural commodities, energy, metals, and livestock. A large sample period ranging from May 1992 to August 2016 was selected, specifically focusing on daily return data while also including three uncertainty indices, namely the volatility index, the equity market uncertainty index, and the EPU index. Overall, Bahloul et al., (2018) concluded that uncertainty can be predicted for most of the commodity markets sampled.

Another strand of the literature analysed how uncertainty affects the precious metals, with empirical studies on gold being the most popular (Balcilar et al., 2016; Gao et al., 2016; Jones and Sackley, 2016; Li and Lucey, 2017; Raza et al., 2018; Bilgin et al., 2018; Gozgor et al.,2019). Recently, Chai et al., (2019) investigated the impact of EPU on global prices on a global scale by employing a time-varying parameter structural vector autoregression (VAR) with stochastic volatility for the period August 2006 to December 2017. The rationale for employing this model was to assess the effects of EPU over different time periods with respect to 13 advanced and 7 developing nations. Chai et al., (2019) noted that following the global financial crisis, uncertainty had increased on a global scale and, as a result, impacted gold prices. Moreover, Chai et al., (2019) found that EPU severely impacted gold prices during the long-lasting European sovereign debt crisis and the US elections held in November 2016, whereby Donald Trump rose to power. Through their work, Chai et al., (2019) reveal that developing nations proved vulnerable to EPU shocks on gold prices and that Japan registered the largest EPU shock on gold prices from the investigated advanced nations.
Yilanci and Kilci (2021) employed a bootstrap causality test developed by Hacker and Hatemi – J (2012) to assess the effect of EPU in order to predict the prices of five precious metals. A large sample period from January 1995 to August 2020 was considered, which included the recent COVID-19 pandemic period where uncertainty intensified. The causality tests concluded that the majority of the prices of precious metals indicate unidirectional causality except for the price of gold (Yilanci and Kilci, 2021). In fact, this causality relationship was witnessed mostly post the global financial crisis, and recently due to the Brexit referendum and the US

elections held in 2016. Overall, Yilanci and Kilci's (2021) study reaffirms the empirical work carried out by Jones and Sackley (2016), Bahloul et al., (2018), and Chai et al., (2019).

## 2.5 Measuring Geopolitical Risk

Geopolitical risk is deemed to be unique in nature as it is distinct from any kind of political risk (Bremmer and Keat, 2010, p. 38). Undoubtedly, measuring geopolitical risk proved to be a challenging task, and as such, it used to be measured intuitively or else using crude macro-economic data, resulting in a subjective approach (Pyo, 2021). Lee (2019) admits that measuring geopolitical risk effectively tends to be objective and rather challenging. As geopolitical events have intensified over the last decade, academics have sought to develop a proxy to measure geopolitical risk (Caldara and Iacoviello, 2018).

### 2.5.1 The Geopolitical Risk Index

The seminal study carried out by Caldara and Iacoviello (2018) offers an effective method of measuring geopolitical risk by accounting for the frequency of articles related to geopolitical risk. Within a short period of time, Caldara and Iacoviello's (2018) prominent work spawned considerable geopolitical risk literature, as similar studies are being conducted in relation to different economic sectors. Their study is rooted in various studies, such as Barro (2006), Gourio (2008), and Berkman et al., (2011); however, their methodological approach is based on the pioneering work of Baker et al., (2016) that established the EPU index, which is outlined in subsection 2.4.1. Caldara and Iacoviello (2018) computed a monthly index based on a number of geopolitical risk articles published by prominent newspapers in Canada, the United Kingdom, and the US.[6] The index covers the period from 1985 to date; however, it also includes a historical index dating back

[6] The selected newspapers include *The Boston Globe*, *Chicago Tribune*, *The Washington Post*, *Los Angeles Times*, *The New York Times*, *The Wall Street Journal*, and *Financial Times*, which are published in the US. On the other hand, *The Globe and Mail* is published in Canada, while *The Daily Telegraph* and *The Guardian* are published in the United Kingdom.

to the beginning of the 20th century, basing the data on three newspapers published in the US. The historical Geopolitical Risk (GPR) index illustrated a significant spike only during the World War I and II periods; however, the beginning of the 21st century was a major turning point as several significant spikes were noted.

Caldara and Iacoviello (2018) reveal that the highest spike in geopolitical risk occurred during the US Iraq invasion, followed by the spike following the 9/11 large-scale terrorist attacks and that noted during the Gulf War at the beginning of the 1990s. Other notable spikes were noted following the terrorist attacks that occurred in various European cities over the years. Conversely, during the 2008 global financial crisis, the index did not register a significant spike when compared to the other outlined geopolitical events. Caldara and Iacoviello's (2018) seminal work distinguish between the direct impact of geopolitical events (the GPR Act index) and the impact of geopolitical risks (the GPR Threat index). On the one hand, the GPR Act index deals with terrorist attacks and war-related attacks, while the GPR Threat index tackles tensions between countries, such as nuclear and military tensions. In addition to this, Caldara and Iacoviello (2018) computed the GPR indices concerning 17 emerging markets in Asia, Latin America, and Africa.[7] The GPR index is computed both on a monthly and daily basis in order to quantify geopolitical risk. The daily index is indeed crucial as it illustrates how a single event occurring on a particular day eventually leads to a significant spike in the GPR index. Since the year 2000, the GPR index was normalised to an average value of 100 from the year 2000 onwards for the rest of the sample, which is still being computed to this day (Caldara and Iacoviello, 2018).

Caldara and Iacoviello (2021) have recently enhanced their robust methodological approach by adopting a dictionary-based method. This method is based on a selection of words related to geopolitical risk, which are frequently used by journalists when writing about geopolitical events and threats. This methodological approach superseded the previously established methodology introduced in 2018. Caldara and Iacoviello

[7] Most of the selected emerging countries form part of the Asian continent. These include Turkey, Korea, Russia, India, Brazil, China, Indonesia, Saudi Arabia, Thailand, Israel, Malaysia, the Philippines, and Hong Kong. A number of the remaining emerging countries form part of Latin America, including Mexico, Colombia, and Venezuela. Only one African country is included in the GPR index: South Africa.

(2021) also adopted a broader definition of geopolitical risk by taking into consideration the geopolitical tensions emanating from both nation states as well as political actors. National governments are undoubtedly the most influential political actors; however, other political actors, including supranational and international institutions like the EU and the United Nations, are exerting significant power in today's globalised world (Rice and Zegart, 2018). Furthermore, due to the fact that the GPR index covers a long period of time, it was important for Caldara and Iacoviello (2021) to acknowledge that language evolves over time; indeed, they deemed it crucial that the GPR index covers the process of neologism to ensure an effective geopolitical risk measure.

## 2.6 Geopolitical Risks and the Commodity Markets

### 2.6.1 Geopolitical Risks, Macro-Economic Factors, and the Crude Oil Industry

For decades, the crude oil industry has been the most relevant commodity for the global economy (Cuando et al., 2020). However, the crude oil industry faces a paradox; while the demand for crude oil is always on the increase, the supply of the resource is scarce and therefore vulnerable to geopolitical uncertainty (Duan et al., 2021). Brandt and Gao (2019) adopted a distinctive approach by conducting a textual analysis of the crude oil market, which involved distinctively comparing macro-economic and geopolitical news from three information sources, namely the *Dow Jones Financial Wire*, *Barron's*, and *The Wall Street Journal*. When it comes to geopolitical news, Brandt and Gao (2019) considered the following event categories: terrorism, war and conflict, and civil unrest for the sample period of 13 years from January 2000 to the end of March 2013. Other event categories were related to the supply and demand of crude oil, economic growth, and entity-related information. Through their investigation, Brandt and Gao (2019) found that geopolitical news has a stronger immediate impact and tends to be unpredictable as uncertainty prevails; as a result, it leads to higher trading value in the commodity market.

Whenever oil prices increase, oil-exporting countries tend to benefit widely at the expense of oil-importing countries. Su et al., (2019) argue that the presence of geopolitical events does impact the commodity markets, especially crude oil prices. In their empirical study, Su et al., (2019) employed a wavelet approach in order to investigate the causality relationship between geopolitical risk, oil prices, and financial liquidity in terms of time and frequency. Monthly observations were noted for a sample period of 20 years (1998–2018), focusing on Saudi Arabia, one of the largest oil-exporting countries. Su et al., (2019) concluded that an increase in geopolitical risk affects both oil prices and financial liquidity. Besides, causality correlations were observed both in the short term and medium term when considering the frequency domain. This implies that oil prices are highly dependent on geopolitical risk, which would ultimately affect the financial liquidity of a country.

Similarly, Abdel-Latif and El-Gamal (2019) undertook a vector autoregressive analysis in order to investigate the dynamics of three crucial variables, namely oil prices, financial liquidity, and geopolitical risk on a global scale. Their empirical analysis is rooted in Jo (2014) and Ratti and Vespignani's (2013) studies. In contrast to Su et al., (2019), quarterly data for the period 1979 to 2017 was observed in relation to 70 countries. Moreover, Abdel-Latif and El-Gamal (2019) modified their model to factor in the assumption that the US influences all three aforementioned variables, adjusting the model to also cover the influence exerted by a number of countries on a collective basis. Abdel-Latif and El-Gamal (2019) postulate that low oil prices subsequently lead to an increase in geopolitical risk while making reference to the low prices in the late 1980s, which led to the first Iraq War at the beginning of the 1990s.

### 2.6.2 The Interrelationship between the Energy and Agricultural Markets

Over the years, various research academics have focused their attention on analysing the relationship between the energy and agricultural markets (Reboredo et al., 2012; Mensi et al., 2014; Koirala et al., 2015; Ghorbel et al., 2017; Jiang et al., 2018). Tiwari et al., (2021) draw our attention to the distinctive relationship between the energy and agricultural markets; however, they investigated the implications of geopolitical risks on crude oil and primary agricultural commodities, namely corn, soybean, wheat, and oats.

For the purpose of their empirical investigation, Tiwari et al., (2021) employed a copula approach to analyse co-movements between the energy and agricultural commodity markets over a large sample period of 28 years (April 1990–February 2018), as well as the dependence between both the energy and commodity markets using Caldara and Iacoviello's (2018) GPR index. In view of an increase in geopolitical risk, which has become prevalent in today's interconnected markets, a strong co-movement was noted between the energy market and the four aforementioned agricultural commodity markets. Indeed, the latter acted as a hedge against oil returns (Tiwari et al., 2021). Furthermore, the empirical investigation conducted by Tiwari et al., (2021) reaffirms the findings obtained by Cuando et al., (2020) through their time-varying analysis of crude oil prices in relation to geopolitical risk.

### 2.6.3 Geopolitical Risks and the Precious Metals

It has been widely acknowledged that during turbulent times, precious metals act as a safe haven and provide desirable diversification benefits (Hillier et al., 2006; Baur and Lucey, 2010; Baur and Mc Dermott, 2010). Qin et al., (2020) question whether gold should be stored in chaotic eras, especially in view of the recent increase in geopolitical events. A full and sub-sample bootstrap causality test was employed to examine the causal relationship between geopolitical risk and gold prices over the period January 1979 to December 2018. In the empirical analysis conducted by Qin et al., (2020), both positive and negative periods were noted. The results suggest that during positive periods, gold should be held, but, on the other hand, it was revealed that during negative periods, holding only gold is not sufficient. Qin et al., (2020) also concluded that gold prices could be a predictor of geopolitical risk.

In their pioneering study, Das et al., (2019a) analysed the impact of geopolitical risk on precious metals. A quantile regression analysis was used to study the sample period January 1985 to December 2017. Das et al., (2019a) noted a positive relationship based on the studied sample period; when geopolitical risk increased, gold return increased by 0.0029%. Besides, higher gold returns were registered when considering Caldara and Iacoviello's (2018) sub-index, namely in terms of geopolitical threats (Das et al.,2019a). In

contrast, a negative relationship was noted concerning the remaining precious metals, these being silver, platinum, and palladium; indeed, the latter tends to be vulnerable to geopolitical risk (Das et al., 2019a).

In the same vein, Baur and Smales (2020) undertook an econometric analysis to test whether various precious metals can act as a hedging mechanism in view of geopolitical risk. The sample period ranged from January 1985 to October 2018 and included the spot prices of four main precious metals, namely gold, palladium, platinum, and silver, due to their distinctive characteristics. An adjustment to Caldara and Iacoviello's (2018) GPR index was made to take into consideration the time lag of when such geopolitical events are published. Furthermore, Baur and Smales (2020) included the analysis of the 10 geopolitical events registering the largest geopolitical shocks.[8] Similar to the findings obtained by Das et al., (2019a), Baur and Smales (2020) noted that the return of precious metals is positively related to geopolitical risk; in particular, a stronger relationship was found when considering geopolitical threats. Additionally, both gold and silver illustrated a positive relationship to geopolitical risk. Baur and Smales (2020) also considered Caldara and Iacoviello's (2018) GPR sub-indices and noted that commodity returns are affected by geopolitical threats but not by geopolitical acts. With respect to the safe haven principle, Baur and Smales (2020) highlight that this principle does not hold from a geopolitical perspective.

In another comprehensive study on precious metals, Yilanci and Kilci (2021) employed Hacker and Hatemi – J's (2012) bootstrap causality test as well as a time-varying bootstrap test to investigate the role of geopolitical risk in predicting the prices of precious metals for the period January 1995 to August 2020. In contrast to other empirical studies, such as Das et al., (2019a) and Baur and Smales (2020), Yilanci and Kilci (2021) took into consideration five precious metals, namely gold, palladium, platinum, silver, and rhodium, in order to detect any instabilities in the causality relationship. Yilanci and Kilci (2021) found that throughout the entire period, there appeared to be no causality relationship between geopolitical risk and the prices of metals. However, a causality relationship was present in some periods of the total sample period.

[8] Such geopolitical events include the Gulf War, the Kuwait invasion, the US bombing of Libya, the large-scale terrorist attacks of 11th September 2001, the build-up to the Iraq War and the subsequent invasion by the US (including the events of both September 2002 and February and March 2003), the Paris terror attacks of November 2016, and the US–North Korea tensions of 2017–2018.

## 2.7 What is Terrorism?

Ever since the 9/11 large-scale terrorist attacks, such attacks have intensified due to the significant increase of terrorist organisations plotting various attacks in every corner of the world, which, in turn, receive widespread attention (Capone, 2016; Smales, 2021). Although there is a lack of consensus concerning the definition of terrorism, the raison d'être of a terrorist attack is to foster fear beyond the immediate victims and impact various economic sectors of a particular country (Capone 2016; Lee, 2018). Chesney et al., (2011) acknowledge that terrorism has three distinctive characteristics, namely the type of attack, the main target, and the place and time of occurrence. The nature of a terrorist attack varies; however, such attacks can involve suicide bombings as well as bombings in general, kidnapping, and armed assaults. Terrorists mainly target the military, high-government officials, oil-extracting companies, as well as the public in general. Therefore, the place and time of a terrorist attack are highly dependent on the chosen target.

Terrorism is distinctive from civil conflicts, as it can be carried beyond national borders and targets both military forces and civilians (Lee, 2018). Generally, countries are vulnerable to terrorist attacks due to their economic and political conditions. In fact, the higher civil liberties and economic openness enabled by the economic and political environments of developed nations make it easier for terrorist organisations to carry out such attacks when compared with emerging nations (Lee, 2018). However, developing nations are still vulnerable to terrorist attacks due to their lingering socio-economic problems (Piazza, 2006). Terrorist organisations act in a strategic manner, as made evident in the case of terrorist attacks in major cities across the world during the morning rush hours. Such attacks include the Madrid train bombings of 11th March 2004, the London bombings of 7th July 2005, the Moscow metro bombing of 29th March 2010, and the Brussels airport suicide bombing of 22nd March 2016 (Ramiah et al., 2019). The general public was, in fact, the main target for all the terrorist attacks mentioned here. On the other hand, the Charlie Hebdo attack of 7th January 2015 occurred during office hours; the Kouachi brothers killed 12 employees whilst injuring 11 others. The main target included journalists who worked for a satirical French magazine that had published numerous satirical cartoons related to Islam (Capone, 2016). The scope of the Charlie Hedbo attack was to silence secularism, which is a fundamental concept in Western cultures and values, especially in France.

Instead, the slogan "Je suis Charlie" quickly spread across social media platforms and the World Wide Web (Capone, 2016; Eroukhmanoff, 2019). Following the Charlie Hedbo attack, the EU adopted a directive on combating terrorism. This directive is broad in scope and takes into consideration the following four main pillars: the prevention of terrorist attacks, the protection of civilians in general, the pursuit of the organisation behind the attack, and the response to the attack in view of the ever-increasing terrorism threats (Capone, 2016).

### 2.7.1 The Impact of Terrorism on the Commodity Markets

Valdivia Orbaneja et al., (2018) acknowledge that the commodity markets are fragile to terrorism, which can lead to serious economic consequences. This is most evident in the crude oil industry during periods of economic stagnation, as terrorist organisations are incentivised to initiate attacks in oil-producing countries (Lee, 2018).

The first systematic study concerning the effects of terrorism on the financial markets, which include the stock, bond, and commodity markets, was conducted by Chesney et al.,(2011), who employed various models, such as an event study approach, a nonparametric approach, and the generalised autoregressive conditional heteroskedasticity (GARCH) extreme value theory approach, in order to analyse the impact of terrorist attacks on 17 well-known indices that also include the commodity indices.[9] In total, 77 terrorist attacks that had taken place in various countries across the globe were analysed. A period covering 11 years from January 1994 to August 2005 was taken into consideration. Chesney et al., (2011) concluded that investing in the commodity indices is preferable over gold, as the main precious metal, since the former react negatively to terrorism. Besides, the commodity market illustrated a negative reaction to a number of terrorist events; however, this reaction was short lived. Finally, Chensey et al., (2011) suggest that the commodity

[9] The Goldman Sachs Commodity Index, Goldman Sachs Commodity Index – Gold, and the Financial Times Stock Exchange, including both Europe/world oil and gas.

market might not be suitable as a good hedge for investment due to the market's reaction to that particular terrorist event.

Energy resources are a cause of major concern and are severely impacted by geopolitics (Colgan, 2013). Oil-producing countries are highly vulnerable to terrorism for two main reasons: firstly, crude oil is considered to be one of the most important commodities worldwide, and secondly, civilians from oil-producing countries do not benefit from the wealth created by the oil industry, which creates a negative sentiment leading to terrorist attacks. Lee (2018) undertook a large-*N* and small-*N* study to investigate the effects of terrorism on the oil industry, emphasising the importance of three mechanisms, namely the funding, targeting, and motivating mechanisms. In order to carry out their operations and successfully achieve their main objectives, terrorist organisations are highly dependent on funds, which are obtained through illegal activities as well as sponsorships. Furthermore, terrorist organisations are cognisant of the fact that the crude oil industry generates substantial profits; therefore, their main strategy is to specifically target oil-producing countries and oil infrastructures (Lee, 2018). Besides, terrorists are motivated to perform such attacks due to two important factors, namely the greed in the crude oil industry and the income disparities in oil-producing countries, since only the rich benefit from the industry, thus increasing the risk of violent conflicts. Through his study, Lee (2018) noted that the mechanisms of terrorism, as outlined in this paragraph, seem to be valid for both samples, and a positive relationship was evident; for instance, a unit increase in oil reserve results led to an increase of 17% during terrorist events. On the other hand, an increase in oil income led to an increase of 6.8% during terrorist events across national borders and a higher increase of 9.7% during domestic terrorist events. Furthermore, Lee (2018) postulates that oil-producing countries tend to sponsor terrorist groups, specifically whenever the oil-producing country in question is a US ally.

A different approach was undertaken by Ramiah et al., (2019), whereby the effects of terrorist attacks on the risk and returns of the commodity markets were analysed by undertaking an event study methodology complemented with various nonparametric techniques. In total, 20 worldwide terrorist attacks[10] were

[10] Terrorist attacks included various attacks and bombings namely: September 11 in 2001, Madrid train bombings in 2004, London bombings in 2005, Delhi bombings in 2005, Mumbai train bombings in 2006, Moscow metro bombings in 2006, Charlie Hedbo shooting and Paris attacks in 2015. However, during 2016, the world witnessed five major terrorist attacks namely: the Jakarta attacks, Brussels

included; these occurred over a 16-year period, starting with the large-scale terrorist attacks of 11th September 2001 and ending with the London Bridge attack of 3rd June 2017. Ramiah et al., (2019) studied the differences between the equity and commodity markets, concluding that the equity market immediately reacts to terrorist attacks, while the commodity markets witness a delay in reactions, which materialise after 120 days. In their empirical study, Ramiah et al., (2019) noted that contrary to the belief that terrorist activities lead to fear and panic, such activities generate positive abnormal returns, especially in the commodity market, although such an outcome depends on the sector. This is certainly true in the case of the Jakarta attacks, which occurred on 14th January 2016. These attacks led to positive abnormal returns in at least 27 agricultural commodity markets. Moreover, Ramiah et al., (2019) mention how, ever since the Paris attacks, which took place on 13th November 2015, terrorist attacks have intensified, affecting the risk structure of the commodity markets and causing greater uncertainty outcomes. In their comprehensive study, Ramiah et al., (2019) also noted the "v-shape risk" that was evident following the Brussels airport bombing of 22nd March 2016 (p. 22). This event coincided with the closing period of the March crude oil future contract when the spot and future prices would be converging, and thus, uncertainty would be minimised while nevertheless leading to a negative beta. Ramiah et al., (2019) also noted a "diamond shape" risk, which was evident following the Pukhrayan train derailment in India and both the terrorist attacks that occurred in Istanbul in 2017 (p. 22). This risk highlighted how the various sectors representing the respective market beta were affected differently (Ramiah et al., 2019, p. 22). In contrast to Chensey (2011), Ramiah et al., (2019) concluded that terrorist attacks do not have wide implications on the commodity markets as various commodities can satisfy basic human needs. Moreover, numerous commodities can be used to manufacture other goods and by-products, such as the agricultural commodities; furthermore, commodities like, for instance, gold and silver, can also act as a hedge against any abrupt changes in either an economic or financial context.

airport bombing, Nice attack, Pukhrayan train derailment and Istanbul nightclub attack. Similarly, in 2017, six major terrorist attacks occurred namely: Istanbul nightclub attack, Gao bombing, Quebec mosque shooting, Westminister attack, Stockholm truck attack, Manchester Arena attack and London bridge attack.

## 2.8 Conclusion

This chapter highlighted how geopolitical risk affects the globalised world by providing selective coverage of academic research that had been undertaken over the years. Studies that were conducted over the last decade were given special importance as during this period of time, geopolitical risk has intensified. As outlined in this chapter, various academics have contributed to the literature by introducing and explaining in detail the concepts related to geopolitical risk. Overall, these studies indicate that geopolitical risk should be given utmost importance, especially due to the intensified geopolitical events of today's globalised world. As a result, these events have serious implications on both the economy and the financial markets.

There is a growing body of literature that recognises the importance of acknowledging geopolitical risk in the financial markets. However, empirical research investigating how geopolitical risk affects the agricultural commodity market is limited. Generally, such studies only focus on the single most important commodity—crude oil. Other available empirical studies consider the precious metals and the spill over effect from the crude oil to the agricultural commodities. Studies related to other commodity markets are limited in number. Thus, the author intends to contribute to the academic literature by taking into consideration commodities like, for instance, softs and grains commodities. Therefore, the purpose of this study is to investigate and confirm the causality relationship between Caldara and Iacoviello's (2018) GPR sub - indices and the agricultural future commodity prices. In the following chapter, the author outlines in detail the methodology undertaken for this dissertation in order to reach the identified research objectives.

# Chapter 3 – Methodology

## 3.1 Introduction

This chapter provides a detailed account of the methodology employed in order to carry out this study. As outlined in the introductory chapter, the main aim of this dissertation was to investigate and confirm the causality relationship between the GPR sub-indices and the agricultural commodity market. Despite the fact that geopolitics has strong historical roots that date back to the 19th century, it was only recently that acknowledging the importance of risk emanating from geopolitics took such precedence.

Klin (2018) acknowledges that the geopolitical field is experiencing a renaissance. This was especially prevalent during the last decade when numerous empirical research studies were carried out by accounting for the implications of geopolitics on various economic sectors. As outlined in the previous chapters, the pioneering work of Caldara and Iacoviello (2018) spawned further literature on geopolitical risk. However, the author believes that this subject matter is still in its infancy, and consequently, additional research is required to develop further the knowledge in this field. In the following sections, the author describes the research process and the limitations of the model.

## 3.2 Preliminary Research

Prior to identifying the research objectives of this study, knowledge about geopolitical risk was gained through a review of various academic papers, peer-reviewed journals, articles, and monographs. In addition to this, consideration was also given to the dissertation topics submitted to the University of Malta, where it was noted that research on this area was limited. Initial discussions were held with the dissertation supervisor and resident academics who specialise in this area for further guidance on how to develop the subject matter further. As a result, a gap in the literature was identified due to the fact that most academics focus on the causality relationship between the GPR index and the two most researched commodity markets, namely the precious metals and the energy market. Once the preliminary research was carried out, the author drafted

a research proposal highlighting in detail the problem statement, emphasising why geopolitical risk matters in today's globalised world. Besides, the author outlined the research objectives, these being primarily to understand and acknowledge the importance of geopolitical risk. Thereafter, the proposal was submitted to the Department of Insurance within the Faculty of Economics, Management and Accountancy, and it was subsequently approved by the faculty board.

## 3.3 The Research Framework

In essence, research involves the accumulation of knowledge concerning a particular subject matter in order to provide valuable insights to multiple users (Saunders et al., 2019). Undoubtedly, a researcher should take into consideration various factors prior to undertaking a research project, such as the methodological approach, time, and cost factors to carry out the research, for instance. However, Creswell and Creswell (2018) state that a research framework depends on three important components, namely: the philosophical approach, the research design, and the research methods, which are all interlinked.

### 3.3.1 The Philosophical Research Approaches

Research philosophy refers to how new knowledge is developed in a particular field (Saunders et al., 2019). Creswell and Creswell (2018) add that the philosophical approach assists the researcher in selecting the most appropriate research method in order to effectively conduct their study. Saunders et al., (2019) mention five types of research philosophies, namely: positivism, critical realism, interpretivism, postmodernism and pragmatism. Each research philosophy has its distinctive characteristics, and as such, the research philosophy impacts the chosen theoretical and methodological approaches as well as the strategies undertaken to carry

out the study in question. Since this empirical study is quantitative in nature, the author will follow the doctrine of positivism.

Positivism has strong intellectual roots, dating back to the early years of the Greek philosopher Plato and the Greek mathematician Pythagoras (Hammond and Wellington, 2021). Nevertheless, positivism took precedence during the 18th century, better known as the Enlightenment period, when progress began to predominate over pre-established dogma, traditions, and beliefs (Hammond and Wellington, 2021). In particular, the French philosopher Auguste Comte significantly contributed to the field of positivism by distinguishing positivism from value-free science (Plé, 2000). In recent years, post - positivism has also flourished and is now considered to be another branch of positivist philosophy that challenges pre-established knowledge (Creswell and Creswell, 2018). Generally, when adopting the positivist research philosophy, researchers analyse a large sample of data by employing a deductive approach (Saunders et al., 2019).

## 3.4 The Research Design

Another important component of the research framework is the research design, which refers to the strategy undertaken by the researcher to select adequate tools with which to carry out their study in order to satisfactorily answer the research question posed in the introductory section. As a matter of fact, there are three main research methods that can be employed to carry out research, namely the qualitative, quantitative, or mixed-method approaches. Obviously, these research methods have distinctive characteristics; for instance, quantitative research is based on numerical data, while qualitative research is based on non-numerical data (Saunders et al., 2019).

Another principal distinction between these two research approaches is that while the qualitative research approach is subjective in nature as it depends on human participants, the quantitative research approach is objective in nature as it examines the relationship between variables (Saunders et al., 2019). As its name

suggests, the mixed-method research approach is based on a combination of both the quantitative and qualitative research approaches. Indeed, Molina-Azorin et al., (2017) acknowledge that the mixed-method approach has become more popular as it allows researchers to benefit from the strengths of both the qualitative and quantitative research methods.

As part of the research strategy, the author undertook a comprehensive review of the literature available on geopolitical risk. As outlined in the introductory chapters, the author found that geopolitical risks have intensified over the years, especially during the last decade, causing serious repercussions. Furthermore, the literature review chapter outlined that such studies have traditionally employed a quantitative approach, especially during the last decade, which saw an intensification of such studies due to the significant increase in geopolitical events. Several academic researchers undertook empirical research to assess the implications of geopolitical risk in relation to various sectors like tourism (Neacsu et al., 2018; Balli, 2019; Demir et al., 2019; Chiang Lee et al., 2020), banking (Phan et al., 2021), the shipping industry (Kotcharin and Maneenop, 2020), and the stock markets (Balcilar et al., 2018; Bouri et al., 2019; Bouras et al., 2019; Hoque and Zaidi, 2020; Smales, 2021). In the case of this study, the problem statement outlined in the introductory chapter highlighted the need and importance to conduct research on the impact of geopolitical risk on the commodity markets. Similar to previously established literature, the author employed a quantitative research approach as the leading methodological choice based on the premise of the positivist philosophy that empirical data illustrate the objectivity and reliability of the study in question.

For the purpose of this study, the author carried out explanatory research in order to understand better the causality relationship between the GPR index and the commodity markets. As outlined previously in the literature review chapter, the majority of the recent empirical studies published during the last decade focused mainly on the precious metals and oil industries. In this study, the author took a different approach from other academic researchers by analysing how the GPR index affects agricultural commodities, focusing on the last decade from 2010 to 2020.

Another critical research component that was taken into consideration was the time horizon of the data collected. Saunders et al., (2019) state that there are two distinctive approaches, namely cross-sectional

studies and longitudinal studies. Cross-sectional studies involve the analysis of data at one particular point in time, while on the other hand, longitudinal studies require data to be collected repeatedly over a period of time. In line with the research question posed in the introductory chapter and due to the issue of time constraints, the author decided to conduct a cross-sectional study in order to analyse the causal relationship between the GPR index and the commodity markets at a particular point in time.

## 3.5 Research Method: The Principal Tools Used and Data Collection

Creswell and Creswell (2018) explain that the research method, which is the third and final component of the research framework, refers to the process of how the researcher collects, analyses, and interprets the data. In the subsequent sections, the author outlines in detail the data collection and analysis process to ensure that this study employs a highly structured methodology so that it can be replicated by other researchers in the future (Saunders et al., 2019).

In order to assess the causality relationship, the author obtained time-series data related to both geopolitical risk and the commodity prices. For the purpose of this study, the author used the primary data collected from Caldara and Iacoviello's website entitled the *Geopolitical Risk Index*,[11] which publishes data on a daily and monthly basis. As previously described in the literature review chapter, GPR data are continuously being audited, with the most recent change in GPR methodology being implemented in November 2021. The author collected both the daily GPR – index and the GPR sub-indices data for the covering period 31st March 2000 - 31st March 2022 in order to measure the causality relationship between geopolitical risk and the agricultural commodity prices. Tiwari et al., (2021) suggest that the inclusion of the daily GPR sub-indices is crucial in order to understand the dynamics of the agricultural markets. Similarly, Baur and Smales (2020) acknowledge that the monthly GPR index data is an average of the geopolitical news occurring in that particular month. On the other hand, the agricultural commodity prices were obtained from Bloomberg LP

[11] Caldara, Dario and Iacoviello, Matteo (n.d.) *Geopolitical Risk (GPR) index*, available at: https://www.matteoiacoviello.com/gpr.htm - data {accessed on 5th December 2021}.

for the daily future commodity prices. The rationale for selecting the daily prices is to ensure that such agricultural future commodities capture the respective price movements throughout the sample period.

The author collected the primary data, namely the commodity prices obtained from the aforementioned sources and the GPR index data, on 4th April 2022. The data were subsequently exported to a Microsoft Excel worksheet and arranged in order to carry out the necessary econometric tests. Since the scope of this research was an empirical one, the author used E-Views 12 Student Version to carry out a number of econometric tests. McKenzie and Takaoka (2012) indeed view E-Views as a user-friendly software program that analyses quantitative data in an efficient and effective manner. E-Views includes a plethora of tests related to time series, including various autoregressive integrated moving averages models, autoregressive conditional heteroskedasticity models, as well as structural VAR models. Different econometric tests were employed to investigate the Granger causality as further outlined in section 3.7 below.

## 3.6 The Sampling Procedure

Due to both time and data constraints, the researcher opted to base the empirical research on a selected sample. In this context, a sample refers to a segment of the total population, which is selected by the researcher based on either probability or non-probability sampling (Creswell and Creswell, 2018). The main distinction between probability and non-probability sampling depends on whether the sample is easily identifiable, which would require the probability sampling technique (Saunders et al., 2019). Prior to selecting the sample for this empirical research study, the author took into consideration: the research objectives, the research question and research hypothesis outlined in the introductory chapter. Besides, the author also considered the variables selected, namely the GPR sub-indices and the agricultural commodity prices.

According to Saunders et al., (2019), homogenous sampling refers to a particular sample that is made up of items sharing several characteristics. As outlined in the literature review, Caldara and Iacoviello (2018,

2021) publish the GPR index on a daily basis. In order to investigate the causality relationship between the GPR sub-indices and the commodity markets, the author also collected the daily future commodity prices, which are traded on a world-renown exchange, the Chicago Board of Trade (CBOT). With respect to the sample period selected, the author accounted for both the annual US holidays/events and the weekend as highlighted on Bloomberg LP. Since future commodities do not trade on such days, the respective daily GPR index and GPR sub-indices were adjusted to account for any US holidays/events and the weekends throughout that particular year. Similar to the previously selected sample, the author used the homogenous sampling technique in order to select ten future commodities related to grain and soft commodities, as outlined in Table 3.1 below.

**Table 3.1: Sample Selected – Future Commodities**

| **Agricultural Sector** | **Future Commodities** | **Ticker Symbol** |
|---|---|---|
| **Grains** | Corn | ZC |
| | Oats | ZO |
| | Rough Rice | ZR |
| | Soybean | ZS |
| | Soybean Oil | ZL |
| | Wheat | ZW |
| **Softs** | Coffee | KC |
| | Cotton | CT |
| | Cocoa | CJ |
| | No. 11 Sugar | YO |

*Source: Adapted from Bloomberg (n.d.).*

## 3.7 Quantitative Data Analysis

In line with the theoretical foundations outlined in the previous chapters, this section provides a detailed overview of the empirical tests carried out to investigate the causality relationship between the GPR sub-indices and the agricultural future commodity prices. Recently, academics employed causality relationship in their empirical research on geopolitical risk for different types of commodities; however, such studies have failed to consider the causality relationship of the agricultural commodities (Li et al., 2020; Yilanci and Kilci., 2021; El – Khishin and El- Saeed., 2021).

This empirical research is rooted in the recent work of Yilanci and Kilci's (2021) in order to understand the role that the GPR sub-indices in predicting the prices of the agricultural commodities. However, various distinctions should be noted between Yilanci and Kilci's (2021) study and this research, such as for instance: the type of commodities investigated and the type of causality test employed. As outlined in the literature review chapter, Yilanci and Kilci (2021) employ both Hacker and Hatemi – J (2012) bootstrap causality and time – varying causality test to investigate the causality relationship on a monthly basis for both the global EPU index and the GPR index concerning the period January 1995 to August 2020. On the other hand, the author takes a different approach by employing a VAR Granger/Block Exogeneity Wald tests to assess the causality relationship between the GPR sub-indices and the daily agricultural future commodity prices for the period March 2000 to March 2022.

For the purpose of this study in order to investigate the aforementioned causality relationship, a number of statistical and econometric tests were also employed which will be discussed below. First and foremost, the date specification frequency was set as daily - five day a week, on E-Views since future commodities are not traded during the weekend. In order to ensure the reliability of the time-series data being analysed, a number of tests were carried out to assess the stationary. In essence, the concept of stationary refers to the distribution of the time-series data will not change over time (Stock and Watson, 2020). However, if the stationary properties are not employed, the causality relationship would be spurious. The Augmented Dickey-Fuller (ADF) (1979) test is one particular empirical test which was conducted is the unit-root test to check

whether all variables are stationary or need to be transformed. In total, three different Augmented Dickey – Fuller test are available which are: the ADF test with intercept and no trend; the ADT test with intercept and trend; and the ADF test with intercept and trend. However, for the purpose of this empirical research, the author employed the ADF test with no intercept and no trend on E-Views due to the type of data collected. Hill et al., (2018) acknowledges that the ADF test with no intercept and no trend has the following specifications to test for the non – stationary:

$$\Delta y_t = \alpha + \gamma\, y_{t-1} + \Sigma\, {}_{s=1}^{p-1} a_s \Delta y_{t-s} + v_t$$

*Equation (1)*

*Where:*

- $\Delta y_t$ *refers to the difference of* $Y_t$ *,*
- $\alpha$ *is the constant term,*
- $\gamma$ *is the lagged term coefficient.*
- *t is the time variable.*
- *P refers to the number of the lagged terms in order to ensure that* $v_t$ *is the white noise.*

The null hypothesis denoted by ($H_0$) illustrates that the variable being tested is non – stationary, implying that unit-root is evident in such variable. Conversely, the alternative hypothesis denoted by ($H_A$) that the variable is stationary and the unit-root is not evident. When the null hypothesis is rejected for such test, it means that the variable is stationary. On the other hand, if the null hypothesis is accepted, the author had to carry out the second difference tests to assess whether the variables are still stationary.

The seminal work of Granger (1969) introduced the definition of causality relationship which examines the relationship between two variables x and y with respect to one period ahead. Fundamentally, the directional causality relationship occurs when one variable is able to predict the other variable, or simply denoted as ''y is causing x" (Granger 1969). Conversely, a unidirectional causality is evident when one variable does not cause the other variable. While a bi-directional causality (also known as feedback) occurs whenever one

variable affects the other variable (Granger, 1969). Moreover, the innovative and seminal work of Sims (1980) pioneered a new approach to examine the Granger causality by introducing the concept of Vector Autoregression (VAR) model (Christiano 2012). In essence, the VAR model illustrates the dynamic relationship between the variables, whereby each variable accounts for their own lags and the lags of the other variables within the model (Cheng et al., 2012).

Once the stationarity property for both variables have been achieved, the VAR Lag Order Selection criteria test and the VAR Residual Serial Correlation Lagrange Multiplier (LM) test were run prior to specifying the VAR model. The scope of the VAR Lag Order Selection length criteria is to determine the optimal number of lags with respect to the independent variable. Clarke and Mirza (2006) acknowledge that such optimal lag length is required to avoid spurious causality. On the other hand, the VAR Residual Serial Correlation LM test depends on the aforementioned test, to ensure that the issue of serial correlation is eliminated at the chosen lag length from the respective variables.

Let us now consider the Granger causality concept in the context of the VAR model. Péguin – Feissolle et al., (2013) acknowledge that a causal relationship is evident when the second variable influences the variance of the prediction error's variance of the first variable. In fact, this has led to the introduction of the Granger non-causality concept whereby the null hypothesis of 'x does not cause y' for the respective time horizon. Indeed, for the purpose of this empirical study, the VAR equation was determined as follows:

$$y(t) = \gamma + B(L)y\,(t-1) + u\,(t)$$

*Equation (2)*

Where:

- Y refers to the set of variables included in the VAR.
- t denotes the time period such as for instance t =1, ....., T.
- $\gamma$ is the constant term
- B(L) refers to the matrix polynomial.

- $u\ (t)$ refers to the Gaussian vector having a zero and variance – covariance matrix.

The VAR matrix model specification was set up to assess the relationship between the independent variable and the dependent variable:

$$\begin{pmatrix} Y_t \\ X_t \\ Z_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} + \begin{pmatrix} \varphi^1 yy & \varphi^1 yx & \varphi^1 yz \\ \varphi^1 xy & \varphi^1 xx & \varphi^1 xz \\ \varphi^1 zy & \varphi^1 zx & \varphi^1 zz \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ Z_{t-1} \end{pmatrix} + \cdots\cdots\cdots\cdots + \begin{pmatrix} \varphi^P yy & \varphi^P yx & \varphi^P yz \\ \varphi^P xy & \varphi^P xx & \varphi^P xz \\ \varphi^P zy & \varphi^P zx & \varphi^P zz \end{pmatrix} \begin{pmatrix} Y_{t-p} \\ X_{t-p} \\ Z_{t-p} \end{pmatrix} + \begin{pmatrix} u_1 \\ u_2 \\ u_3 \end{pmatrix}$$

*Equation (3)*

Where:

- Y denotes the price of the future agricultural commodity.
- X and Z denote the GPR sub-indices: GPR Threat and GPR Act respectively.
- $\varphi$ refers to the matrix polynomial, whereby the under scripts of the $\varphi$ coefficients (x, y and z) are notation used to illustrate to which these variables belong.
- p denotes the lag length.

Moreover, the VAR matrix model can also be illustrated in terms of the lag operator denoted as (L):

$$\begin{pmatrix} Y_t \\ X_t \\ Z_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} + \begin{pmatrix} \varphi_{yy(L)} & \varphi_{yx(L)} & \varphi_{yz(L)} \\ \varphi_{xy(L)} & \varphi_{xx(L)} & \varphi_{xz(L)} \\ \varphi_{zy(L)} & \varphi_{zx(L)} & \varphi_{zz(L)} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ Z_{t-1} \end{pmatrix} + \begin{pmatrix} u_1 \\ u_2 \\ u_3 \end{pmatrix}$$

*Equation (4)*

Where:

- Y denotes the price the agricultural future commodity price.
- X represents the GPR Act.

- Z represents the GPR Threat.

$$\varphi_{m,n} = \sum_{i=0}^{P} \varphi^i \; L^i$$

Where:

- m = {y, x, z}.
- n = {y, x, z}.
- P denotes the lag length.

Since the stationarity principle was satisfied, the VAR Granger Causality/Block Exogeneity Wald tests were run to determine the causality relationship between the independent and dependent variable. As outlined in the introductory chapter, the following null and alternative hypothesis are used for this test:

$H_{0:}$ No causal relation between the GPR – sub index (GPR Act and GPR Threat) and the respective future commodity price.

$H_{A:}$ There is a causal relation between the GPR – sub index (GPR Act and GPR Threat) and the respective future commodity price.

## 3.8 Limitations of the Model

It is important to highlight that commodity prices are affected by other macroeconomic variables, such as inflation, supply, and demand, which are not controlled in this model. Data related to these macroeconomic variables were not available; hence, these variables could not be included in the model. For instance, since the empirical study is based on the daily prices, the data in relation to inflation could not be included in this model as the latter is issued on a monthly and annual basis. Moreover, similar to previous studies, the author

collected data related to the daily agricultural commodity prices and the GPR sub-indices. Therefore, the reader should keep in mind that the resulting Granger causality relationship solely captures the impact of geopolitical risk on the price of agricultural commodities.

Another limitation of the model is that the Johansen Cointegration test could not be performed since both the GPR sub-indices (GPR Threat and Act) were identified as stationary when conducting the difference level test. Overall, the scope of this test was to assess the long-term relationship between the GPR Act and Threat sub-indices and the respective agricultural commodity prices. However, while the GPR sub-indices were stationary, the agricultural commodity prices were non-stationary. Hence, the Johansen Cointegration test was not possible, so a distributed lag was adopted.

## 3.9 Ethical Considerations within the Research Design

Whenever a researcher is undertaking any research, issues related to data protection, such as privacy, confidentiality, and consent, should be given utmost priority, especially nowadays due to the existing rules and regulations (Creswell and Creswell, 2018). In particular, ethical consideration should be in line with the applicable regulation, the General Data Protection Regulation of the EU 2016/679. The main scope of this regulation is to empower individuals to have control over their personal data when such data are being collected and processed. Creswell and Creswell (2018) advocate that ethical issues are considered across the research types and throughout the research process.

As outlined in the previous section, the author conducted a quantitative study that did not involve any human respondents. In fact, the main variables used were the geopolitical risk measure, this being the GPR index, and the commodity prices, which are publicly available and easily accessible. As a result, there were no

significant issues related to ethical considerations, and ethical clearance was granted from the University of Malta prior to commencing the actual research.

## 3.10 Conclusion

This chapter outlined the methodology adopted for this study by providing a detailed assessment of how the study was carried out. The author explained the rationale behind choosing to conduct a quantitative study in order to assess the causality relationship between commodity prices and the GPR index. The author highlighted how the sample was defined and selected for this study and, subsequently, how the data were collected. The research limitations encountered during the research process were outlined, along with the mitigation measures adopted to control the limitations. In the following chapter, the author presents the findings of this study, followed by a comprehensive discussion of the results obtained.

# Chapter 4 – Findings, Analysis & Discussion

## 4.1 Introduction

This chapter provides a detailed presentation and analysis of the empirical data concerning the ten future commodities and two GPR sub-indices considered in this study, which were collected by employing the tests described in the previous chapter. Throughout this chapter, the author discusses the empirical findings by taking into consideration the research question posed in the introductory chapter and making reference to the results of other relevant empirical studies outlined in the literature review. For the sake of consistency, the author maintains the same presentation style when illustrating the data.

## 4.2 Statistical Description of the Variables

The main aim of this study was to assess the price movement effects of ten major agricultural future commodities for the sample period of 22 years from 31st March 2000 until 31st March 2022. Overall, this large sample takes into account a number of major geopolitical events that occurred during the last twenty-two years, which include the large-scale terrorist attacks of 11th September 2001, the US–Iraq war, the Arab Spring and the recent Russo–Ukrainian war. This empirical study recorded a grand total of 71,630 different points of data, which account for the data related to both the ten future commodities and the GPR sub-indices.

This empirical study made use of block exogeneity (i.e., VAR Granger causality) to test for the causality relationship between geopolitical risk and agricultural commodities. Table 4.1 outlines the main statistical properties which were obtained from the Descriptive Statistics function on E-Views Student Version No.12, with respect to the sample selected for this empirical study. The findings presented in the table show that cocoa has the highest mean and median among the agricultural commodity prices. Moreover, cocoa has the highest standard deviation, which means that its values are more spread out when compared to those of the other agricultural commodities. On the other hand, rough rice registered the lowest mean and median among the agricultural commodity prices. In addition to this, rough rice has the lowest standard deviation, which

means that its values are not as spread out when compared to those of the other agricultural commodities. Cocoa also has the largest range of values, while rough rice has the smallest range when considering the maximum and minimum values obtained. All variables are positively skewed, with the exception of cocoa and rough rice, which are negatively skewed. The Jarque–Bera test results were all positive, indicating that the data were not normally distributed.

**Table 4.1: Descriptive Statistics**

| Variable | Mean | Median | Maximum | Minimum | Standard Deviation | Skewness | Kurtosis | Jarque–Bera | Observations |
|---|---|---|---|---|---|---|---|---|---|
| **Cocoa** | 2219.426 | 2305.000 | 3774.00 | 674.00 | 661.3955 | (0.323891) | 2.292837 | 211.1480 | 5510 |
| **Coffee** | 125.1446 | 119.7500 | 304.90 | 41.50 | 49.21488 | 0.888628 | 3.942000 | 928.8945 | 5510 |
| **Corn** | 390.5204 | 365.7500 | 831.25 | 174.75 | 155.5385 | 0.810066 | 2.855730 | 607.3953 | 5510 |
| **Cotton** | 69.96968 | 65.32000 | 215.15 | 28.52 | 24.51531 | 2.220562 | 10.88385 | 18798.00 | 5510 |
| **No.11 Sugar** | 34.64693 | 32.27000 | 35.31000 | 4.99000 | 13.192226 | 0.675241 | 2.840206 | 424.5771 | 5510 |
| **Oats** | 265.6213 | 254.5000 | 772.25 | 95.00 | 109.6390 | 1.439915 | 6.910046 | 5414.006 | 5510 |
| **Rough Rice** | 11.11643 | 11.57000 | 24.46 | 3.43 | 3.4300 | (0.143381) | 2.668749 | 44.07062 | 5510 |
| **Soybean** | 14.22566 | 13.23500 | 1771.00 | 418.00 | 5.753274 | 0.785632 | 3.381945 | 600.3037 | 5510 |
| **Soybean Oil** | 956.0087 | 945.3750 | 82.18 | 14.38 | 323.9262 | 0.210937 | 2.159180 | 203.1713 | 5510 |
| **Wheat** | 515.0902 | 497.2500 | 1425.25 | 233.5000 | 178.2246 | 0.690465 | 3.388311 | 472.4258 | 5510 |
| **Daily GPR** | 112.8891 | 99.51920 | 1045.604 | 9.491598 | 69.03425 | 4.641369 | 39.79286 | 330573.3 | 5510 |
| **Daily GPR Act** | 113.9453 | 93.47909 | 1627.428 | 0.0000 | 108.1768 | 6.133046 | 60.94185 | 805312.9 | 5510 |
| **Daily GPR Threat** | 112.5335 | 98.16797 | 811.5252 | 7.89 | 67.28846 | 3.064505 | 20.85715 | 81833.31 | 5510 |

*Source: Author's computation.*

## 4.3 Diagnostic Tests

### 4.3.1 Augmented Dickey-Fuller – Unit Root Test

Stationarity is a desirable property when carrying out a time - series study in order to ensure that the mean and variance of the agricultural commodities do not change throughout the sample period. Before assessing the Granger causality, the first set of econometric tests was carried out to investigate the stationarity of the selected data. Although there are many statistical tests to assess stationarity, the Augmented Dickey–Fuller (ADF) test was carried out for both the agricultural commodities and the GPR sub-indices to test for the null hypothesis of the unit root. The following table presents the ADF unit root test results after being applied to both the level and the first difference of the variables used in the analysis.

**Table 4.2: ADF Unit - Root Test - The Agricultural Commodities**

| **Augmented Dickey - Fuller Test** | | |
|---|---|---|
| **Agricultural Future Commodity** | **Difference Level (p-value)** | **1st Difference (p-value)** |
| **Cocoa** | 0.0535 | 0.0001 |
| **Coffee** | 0.4522 | 0.0001 |
| **Corn** | 0.5459 | 0.0001 |
| **Cotton** | 0.3285 | 0.0001 |
| **No.11 Sugar** | 0.1586 | 0.0001 |
| **Oats** | 0.8837 | 0.0000 |
| **Rough Rice** | 0.1498 | 0.0001 |
| **Soybean** | 0.5211 | 0.0001 |
| **Soybean Oil** | 0.7623 | 0.0001 |
| **Wheat** | 0.2229 | 0.0000 |

*Source: Author's computation*

For the purpose of the ADF test, the author took into consideration a 5% significance level (0.05). As can be seen from the resulting probability values (p-values), all agricultural commodity prices, are non-stationary and integrated of order one (i.e., become stationary when differenced). The following table displays the ADF unit root test concerning the GPR sub-indices.

**Table 4.3: ADF Unit - Root Test - The GPR Sub-Indices**

| **Augmented Dickey - Fuller Test** | |
|---|---|
| **GPR Sub - Index** | **Difference Level (p-value)** |
| **GPR Act** | 0.0000 |
| **GPR Threat** | 0.0000 |

*Source: Author's computation*

As can be noted, contrary to the majority of the ADF unit root tests carried out for the agricultural future commodities, the null hypothesis concerning the presence of a unit root was rejected for both indices at the chosen level of significance.

## 4.3.2 Preliminary Tests: Determining the Optimal Lag Length and the Serial Correlation Test

Preliminary statistical tests were performed in order to examine the results of both the VAR model and the Granger causality test. A principal test related to the VAR model is the lag length test, which determines the optimal lag order for the VAR model underpinning the block exogeneity (VAR Granger causality) test. The scope of this test is to limit serial correlation whilst ensuring that the optimal degrees of freedom are also maintained. On the other hand, the main limitation of the optimal lag length test is the loss of observations when lagging the variables (i.e., the agricultural commodities) (Carter Hill et al., 2017). Therefore, the VAR lag order selection criteria test was performed to determine the optimal number of lags for the respective

agricultural commodities. Over the years, different types of information criteria were introduced, such as the Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan–Quinn information criterion (HQ), which can be applied to a time-series study. The likelihood ratio (LR) test has also proved to be beneficial when choosing the optimal number of lags in a VAR model (Hatemi-J & Hacker, 2009). Both tables 4.4 and 4.5 present the results of the only optimal lag length test selected for the VAR specification of the Granger causality test concerning the soft and grain commodities, respectively.[12] The optimal lag length was selected on the basis of the LR test.

The following table highlights the residual results, which correspond to the selected lag for the respective agricultural commodity prices model specification of the Granger test. The agricultural commodities were grouped into either softs or grains.[13] Furthermore, the author carried out additional tests to assess the robustness of the obtained empirical findings. The VAR residual serial correlation Lagrange multiplier (LM) test was carried out for every agricultural commodity price model specification of the Granger test to assess the quality of the residuals. Due to the dynamics between the respective variables, which accounted for the geopolitical implications on the respective commodity market, it was noted that a lag of 29 was optimal for cocoa, wheat, and rough rice, while a lag of 22 was optimal for corn, soybean, and soybean oil. On the other hand, a lag of 24 was optimal for coffee, oats, as well as no. 11 sugar.

[12] Reference should be made to Appendix B for the respective VAR Residual Serial Correlation LM tests.
[13] Vide Appendix – VAR residual correlation LM tests.

**Table 4.4: VAR Lag Order Selection Criteria - Softs Agricultural Commodities**

**VAR Lag Order Selection Criteria**

**Sample: 31/03/2000 – 31/03/2022**

**Endogenous variables: Cocoa_Last_Price 1 GPRD_ACT GPRD_THREAT**

**Exogenous variable: C, included observations: 5479**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 29 | -86039.70 | 20.68267* | 9.65e+09 | 31.50345 | 31.82188 | 31.61454 |

**Endogenous variables: Coffee_Last_Price 1 GPRD_ACT GPRD_THREAT**

**Exogenous variable: C, included observations: 5479**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 24 | -71177.44 | 17.65453* | 41792374 | 26.06185 | 26.32601 | 26.15401 |

**Endogenous variables: Cotton_Last_Price 1 GPRD_ACT GPRD_THREAT**

**Exogenous variable: C, included observations: 5479**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 29 | -67638.88 | 17.68253* | 11675159 | 24.78660 | 25.10503 | 24.89769 |

**Endogenous variables: No. 11 Sugar_Last_Price 1 GPRD_ACT GPRD_THREAT**

**Exogenous variable: C, included observations: 5479**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 28 | -59577.45 | 24.97959* | 613552.3 | 21.84064 | 22.14822 | 21.94795 |

(*) indicates lag order selected by the criterion.

LR: Sequential modified LR test statistic (each test at a 5% level of significance)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan – Quinn information criterion

*Source: Author's computation.*

**Table 4.5: VAR Lag Order Selection Criteria - Grains Agricultural Commodities**

| VAR Lag Order Selection Criteria<br><br>Sample: 31/03/2000 – 31/03/2022 | | | | | | |
|---|---|---|---|---|---|---|
| **Endogenous variables: Corn_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |
| 22 | -77188.83 | 22.81940* | 3.73e+08 | 28.24962 | 28.49206 | 28.33420 |
| **Endogenous variables: Oats_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |
| 24 | -75938.40 | 26.28971* | 2.38e+08 | 27.79974 | 28.06390 | 27.89190 |
| **Endogenous variables: Rough Rice_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |
| 29 | -56798.54 | 17.80199* | 223222.3 | 20.82955 | 21.14798 | 20.94064 |
| **Endogenous variables: Soybean_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |
| 22 | -80803.49 | 20.27593* | 1.39e+09 | 29.56908 | 29.81152 | 29.65366 |
| **Endogenous variables: Soybean Oil_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |
| 22 | -62739.28 | 36.18546 | 1907815 | 22.97510 | 23.21754 | 23.05968 |
| **Endogenous variables: Wheat_Last_Price 1 GPRD_ACT GPRD_THREAT**<br><br>**Exogenous variable: C, included observations: 5479** | | | | | | |
| **Lag** | **LogL** | **LR** | **FPE** | **AIC** | **SC** | **HQ** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 29 | -79420.32 | 20.65181* | 8.61e+08 | 29.08718 | 29.40561 | 29.19827 |

(*) indicates lag order selected by the criterion.

LR: Sequential modified LR test statistic (each test at a 5% level of significance)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan – Quinn information criterion

*Source: Author's computation*

The main scope of the LM statistical test is to detect the presence of serial correlation at the chosen lag length. If the serial correlation is still present, the residuals are rendered less efficient. The null hypothesis for this test is that of no serial correlation at lag h. In fact, the results outlined in the tables 4.6 and 4.7 reveal that the null hypothesis of no serial correlation was not rejected at the critical value of 0.05 for the residuals of the underlying VAR with respect to all soft commodity prices. Similarly, the null hypothesis of no serial correlation was not rejected for all the grains commodities. Therefore, these results imply that the issue of serial correlation was omitted.

**Table 4.6: Softs Agricultural Commodities - VAR Residual Serial Correlation LM Tests**

| **VAR Residual Serial Correlation LM Tests**<br><br>**Sample: 31/03/2000 – 31/03/2022** | | | | | | |
|---|---|---|---|---|---|---|
| **Null hypothesis: No serial correlation at lag h** | | | | | | |
| **Cocoa (Included observations: 5487)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 22 | 225.8812 | 198 | 0.0848 | 1.141859 | (198, 16048.8) | 0.0848 |
| **Coffee (Included observations: 5487)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 22 | 198.3033 | 198 | 0.4806 | 1.001591 | (198, 16048.8) | 0.4806 |
| **Cotton (Included observations: 5480)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 29 | 249.2561 | 261 | 0.6889 | 0.954692 | (261, 15905.3) | 0.6890 |
| **No. 11 Sugar (Included observations: 5481)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 28 | 283.7904 | 252 | 0.0823 | 1.127319 | (252, 15925.9) | 0.0823 |
| (*) Edgeworth expansion corrected LR statistic | | | | | | |

*Source: Author's computation.*

**Table 4.7: Grains Agricultural Commodities - VAR Residual Serial Correlation LM Tests**

| **VAR Residual Serial Correlation LM Tests**<br><br>**Sample: 31/03/2000 – 31/03/2022** | | | | | | |
|---|---|---|---|---|---|---|
| **Null hypothesis: No serial correlation at lag h** | | | | | | |
| **Corn (Included observations: 5487)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 22 | 181.2116 | 198 | 0.7981 | 0.914779 | (198,16048.8 | 0.7982 |
| **Oats (Included observations: 5485)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 24 | 225.3146 | 216 | 0.3178 | 1.043475 | (216, 16008.1) | 0.3179 |
| **Rough Rice (included observations: 5480)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 29 | 236.6769 | 261 | 0.8577 | 0.906155 | (261, 15905.3) | 0.8578 |
| **Soybean (included observations: 5487)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 22 | 185.3197 | 198 | 0.7316 | 0.935636 | (198, 16048.8) | 0.7316 |
| **Soybean Oil (included observations: 5487)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 22 | 206.0596 | 198 | 0.3325 | 1.041017 | (198, 16048.8) | 0.3325 |
| **Wheat (included observations: 5480)** | | | | | | |
| **Lag** | **LRE* stat** | **Degrees of Freedom** | **Probability** | **Rao F-stat** | **Degrees of Freedom** | **Probability** |
| 29 | 234.3727 | 261 | 0.8806 | 0.897269 | (261, 15905.3) | 0.8807 |
| (*) Edgeworth expansion corrected LR statistic | | | | | | |

*Source: Author's computation.*

### 4.3.3 The Causality Relationship between the Agricultural Commodity Prices and the GPR Sub – Indices

As outlined in the introductory chapter, this study aimed to examine the Granger causality between the agricultural commodity prices and the respective GPR sub-indices. The estimated VAR model for all agricultural commodities was computed on the basis of the selected lag length, as outlined in subsection 4.3.2. The scope of the VAR model is to account for the dynamics and relationship between an independent variable (the agricultural commodity price) and a dependent variable (GPR sub-indices).[14] Subsequently, the VAR Granger Causality/Block Exogeneity Wald test, which is also known as VAR Granger Causality test was employed to assess the causality relationship for all agricultural commodities. The VAR Granger causality test revealed the causality direction amongst the aforementioned variables and whether the causality relationship was unidirectional, bidirectional, or neutral. The employed null hypothesis states that the independent variable (i.e., agricultural commodity price) does not cause the dependent variable (i.e., GPR Daily Act and GPR Daily Threat). Table 4.8 presents the obtained empirical results, which indicate that the studied GPR sub-indices Granger cause changes in the agricultural commodity prices. Furthermore, the results also indicate whether both sub-indices jointly contain sufficient information to "predict" the future commodity price of the commodity in question.

[14] Vide Appendix B: Vector Autoregressive Model – Section III: VAR Estimates.

**Table 4.8: Soft Agricultural Commodities - VAR Granger Causality**

| **VAR Granger Causality/Block Exogeneity Wald Test**<br><br>**Sample: 31/03/2000 – 31/03/2022** | | | |
|---|---|---|---|
| **Excluded** | **Chi-Square** | **Degrees of Freedom** | **Probability** |
| **Dependent Variable: Cocoa Future Price (included observations 5487)** | | | |
| GPRD _ Act | 20.07076 | 22 | 0.5786 |
| GPRD _ Threat | 19.24960 | 22 | 0.6299 |
| **All** | **39.61217** | **44** | **0.6600** |
| **Dependent Variable: Coffee Future Price (included observations 5487)** | | | |
| GPRD _ Act | 16.83384 | 22 | 0.7725 |
| GPRD _ Threat | 43.46527 | 22 | 0.0041 |
| **All** | **58.13955** | **44** | **0.0749** |
| **Dependent Variable: Cotton Future Price (included observations 5480)** | | | |
| GPRD _ Act | 29.91529 | 29 | 0.4182 |
| GPRD _ Threat | 19.89438 | 29 | 0.8962 |
| **All** | **49.34170** | **58** | **0.7838** |
| **Dependent Variable: No. 11 Sugar Future Price (included observations 5481)** | | | |
| GPRD_ Act | 21.77311 | 28 | 0.7917 |
| GPRD_ Threat | 26.18746 | 28 | 0.5627 |
| **All** | **27.04766** | **56** | **0.7972** |

*Source: Author's computation*

Since the critical p-value was set at 0.05, it can be concluded that the null hypothesis was not rejected for cocoa, cotton, and no. 11 sugar at all levels of significance. Although the null hypothesis concerning coffee was not rejected at all levels, it can be noted that the GPR Threat sub-index on its own Granger causes the price of coffee. A possible explanation for this might be that geopolitical event such as war and nuclear threats affect the price of coffee futures.

**Table 4.9: Grains Agricultural Commodities - VAR Granger Causality**

| **VAR Granger Causality/Block Exogeneity Wald Test**<br><br>**Sample: 31/03/2000 – 31/03/2022** | | | |
|---|---|---|---|
| **Excluded** | **Chi-Square** | **Degrees of Freedom** | **Probability** |
| **Dependent Variable: Corn Future Price (included observations 5487)** | | | |
| GPRD _ Act | 15.72131 | 22 | 0.8295 |
| GPRD _ Threat | 29.45956 | 22 | 0.1322 |
| **All** | **43.99508** | **44** | **0.4719** |
| **Dependent Variable: Oats Future Price (included observations 5485)** | | | |
| GPRD _ Act | 39.90133 | 24 | 0.0448 |
| GPRD _ Threat | 38.38025 | 24 | 0.0317 |
| **All** | **76.51345** | **48** | **0.0055** |
| **Dependent Variable: Rough Rice Future Price (included observations 5480)** | | | |
| GPRD _ Act | 17.43909 | 29 | 0.9549 |
| GPRD _ Threat | 31.71250 | 29 | 0.3326 |
| **All** | **50.10420** | **58** | **0.7601** |
| **Dependent Variable: Wheat Future Price (included observations 5480)** | | | |
| GPRD_ Act | 26.25644 | 29 | 0.6118 |
| GPRD_ Threat | 78.53201 | 29 | 0.0000 |
| **All** | **100.0333** | **58** | **0.0005** |
| **Dependent Variable: Soybean Future Price (included observations 5487)** | | | |
| GPRD_ Act | 18.45569 | 22 | 0.6787 |
| GPRD_ Threat | 28.10236 | 22 | 0.1723 |
| **All** | **46.82797** | **44** | **0.3572** |
| **Dependent Variable: Soybean Oil Future Price (included observations 5487)** | | | |
| GPRD_ Act | 12.85083 | 22 | 0.9372 |
| GPRD_ Threat | 36.49668 | 22 | 0.0268 |
| **All** | **46.49765** | **44** | **0.3699** |

*Source: Author's computation*

In contrast, the grains commodities registered a different Granger causality result as outlined in Table 4.9. The null hypothesis concerning corn, rough rice, and soybean was not rejected. This implies that the GPR sub-indices do not Granger cause the change in price for these aforementioned commodities. However, on taking a closer look at the empirical results obtained for both oats and wheat at all significant levels, it can be noted that the null hypothesis was rejected at the critical value of 0.05. This implies that both GPR sub-indices Granger cause the change in prices for both oats and wheat in tandem. Nonetheless, it is important to highlight that the null hypothesis with respect to the GPR Act for the wheat futures was not rejected. On the other hand, the GPR Threat sub-index tends to Granger cause the soybean oil future commodity price. Overall, based on the empirical results obtained from the estimation models, a Granger causality relationship existed for certain agricultural commodities throughout the period 2000–2022.

## 4.4 Discussion of Empirical Findings

This empirical dissertation sought to analyse the Granger causality relationship between the GPR Threat and Act sub-indices and the prices of ten future commodities. Due to the fact that geopolitical risk has intensified, especially during the last decade, it is hoped that these empirical results can shed further insights into how geopolitics affects the agricultural industry. Although it is a known fact that commodity prices can be determined by a number of factors, such as the law of supply and demand, seasonality factors, and the weather, as outlined in the introductory chapter, geopolitical factors also play a significant role (Aloui and Hamida, 2021).

When comparing both geopolitical threats and geopolitical acts, the author noted that the GPR Threat sub-index plays a more significant role as it impacts oats, wheat, soybean oil, and coffee. A plausible explanation for this Granger causality result might be due to the different categories of geopolitical threats. Indeed, in their seminal work, Caldara and Iacoviello (2021) identified five main categories of geopolitical threats for the establishment of the GPR Threat as a sub-index, which include war, military buildup, nuclear threats, terrorist threats, and peace threats. Another important finding was that a Granger causality relationship between the GPR Threat and the following commodities: coffee, soybean oil, wheat, oats.

Perhaps the most compelling finding of this study is the Granger causal relationship between the GPR Act and oats. In essence, this means that the beginning and escalation of war affects the price of oats.

Another significant implication emanating from this study's findings is how the studied GPR sub-indices could provide information concerning the agricultural commodity prices. These findings, in fact, highlight the predictive power of the GPR sub-indices in relation to changes in future commodity prices, as these contain information that can shed light on the course prices are likely to take following a particular geopolitical event. The VAR Granger causality test employed for this empirical study suggests that changes in the agricultural future commodity prices are reflected within less than a month after a particular geopolitical event. For instance, changes in the commodity prices for both oats and wheat, for instance, occur within 24 days and 29 days, respectively. On the other hand, when each GPR sub-index is considered separately, it can be noted that the GPR Threat sub-index leads to a price change for both coffee and soybean oil within 22 days. Additionally, the same sub-index leads to a price change for wheat within 29 days. In contrast, the GPR Act only leads to a price change for oats within 24 days. Based on these findings, it can be concluded that the aforementioned commodities are vulnerable to the increase in geopolitical threats and the possibility of geopolitical conflicts affecting the food system on a global scale.

The causal relationship identified for both oats and wheat is pivotal to understanding better the "bigger picture" of how geopolitics influences both the production and the distribution of agricultural commodities. Over the years, agricultural commodities have become more vulnerable due to the intensification of geopolitical events. Indeed, the "food regime" concept coined by Friedmann and McMichael (1989) interprets how both economic and political issues have influenced the food system over the years, a theory whose relevance will likely remain in the foreseeable future. A possible explanation for the causality revealed by this study is that both oats and wheat are considered to be staple foods across the globe. Wheat, however, is a principal agricultural commodity as both emerging and under-developed nations are highly dependent on such import (Magnan, 2017).

As a matter of fact, wheat played a crucial role during both the first food regime period and second food regime period as both the UK and the US established and maintained a worldwide market for staple foods while simultaneously meeting their respective geopolitical goals. During the first food regime period (1870 -1930s), the UK stimulated the food production of both wheat and meat in various colonised countries which has lead access of basic food to other continents such as Asia, North and South America. As a result, industralisation flourished in the UK and also the finance of international trade operated by the city of London (McMichael, 2009 a). On the other hand, the second food regime period (1950 -1970s) was dominated by the US, as the emerging superpower whereby its government intervened in the food production to ensure that the US becomes the main food exporter. The US government donated such surplus to third world countries in order to ensure full support during the Cold War period (Magnan, 2017). Mc Michael (2009 b) acknowledges that third food regime period began in the late 1980s and it is still present till nowadays. Globalisation plays a dominant role in the third food regime period as emerging countries such as China and Brazil are heavily involved in numerous food supply chains.

Undoubtedly, geopolitical implications have impacted each food regime period differently. Nevertheless, it is evident that both emerging and developing nations are becoming highly vulnerable to food insecurity which poses a significant threat to the supply of various agricultural commodities across the globe. Eventually, the respective governments have to intervene in order to secure food supply to the whole nation. Also, any geopolitical event might lead to an abrupt change in the price of affected agricultural commodities, leading to an increase in geopolitical risk, which would also impact the volatility of the commodity prices. As a result, significant price increases may take place, which would result in commodity price inflation, also known as “agflation” (McMichael, 2009 b, p.285). For instance, this situation was evident in the case of the Arab Spring uprising, which was initiated due to an increase in various commodity prices in Tunisia in 2010–2011 and such geopolitical event spread particularly quickly across other Northern African and Middle Eastern neighbouring countries with serious economic repercussions.

These empirical findings have significant implications for the understanding of how the studied GPR sub-indices could provide information on agricultural commodity prices. Moreover, these empirical findings also highlight the predictive power of the indices when it comes to changes in future commodity prices; indeed, they may contain information that can shed light on the course prices are likely to take following a particular geopolitical event. It is important to note that such empirical findings highlight the commodities' vulnerability to both geopolitical acts and geopolitical threats. Eventually, such situations would intensify uncertainty in the agricultural commodity and would also impact the interrelationship between the agricultural and the energy commodity markets (Tiwari et al., 2021).

As outlined in the literature review, empirical studies concerning the implications of geopolitical risk on the commodity market only intensified following Caldara and Iacoviello's (2018) seminal work. Up to now, however, research on geopolitical risk has focused predominantly on the energy markets (Bouioyour et al., 2019; Cunado et al., 2020; Su et al., 2019;) and precious metals (Baur and Smales, 2020; Das et al., 2019a; Qin et al., 2020; Yilanci and Kilci, 2021) rather than on the agricultural market. The author notes that these empirical findings broadly support the work of other previous studies, which have demonstrated the importance of taking geopolitical risk into account when considering the commodity markets. Indeed, the author believes that this empirical study, which examined the agricultural commodity market, provides an in-depth insight into current debated geopolitical events that have significantly impacted the price of agricultural commodities.

Previous empirical studies employed different methodological approaches and concentrated on different types of commodities, such as the energy and precious metals markets. Notwithstanding the relatively limited research on the agricultural market, the author undertook a compare – contrast approach to recent studies on the geopolitical implications on other commodities. On the same line of thoughts of this study, Bouoiyour et al., (2019) also questions whether geopolitical threats or geopolitical acts impact on oil future commodity prices. However, contrary to the empirical findings outlined above, the recent research by Bouioyour et al., (2019) outlined that geopolitical acts have significant impact on the oil market. On the other hand, this research outlined that various agricultural commodities prices are influenced mostly by geopolitical threats

rather than geopolitical acts, with the exception of wheat and oats which is impacted by both GPR Threat and GPR Act. Nevertheless, this difference between the two commodities markets is that the oil market tends to be more complex in nature when compared to the agricultural market. Moreover, Bouioyour et al., (2019) highlights several factors which affect the oil price which are categorised as geopolitical threats such as: the characteristics of the oil market whereby both the buyers and sellers have imperfect information, the impact of previous geopolitical events on supply disruption and the rise of populism across the globe. It seems possible that these factors are also applicable to the agricultural commodities markets and as such geopolitical threats are being witnessed lately.

Let us now consider the previous empirical research of geopolitical implications on precious metals. A key distinction between the agricultural and the precious metal commodities is that the latter act as a safe haven as well as a hedging instrument especially during periods when geopolitical risk intensifies (Qin 2020). Similar to the empirical findings outlined above, the comprehensive study of Baur and Smales (2020) confirms that in particular precious metals are impacted by the GPR Threats rather than the GPR Acts. A possible explanation for this might be that geopolitical event such as war and nuclear threats affect both the agricultural and the precious metals commodities. Conversely, this empirical research differs from the recent study of Yilanci and Kilci (2021) since the causality relationship is evident in certain periods concerning the precious metals market for the period January 1995 to August 2020. A plausible explanation of the causality instabilities identified by Yilanci and Kilci (2021) is due to the inclusion of monthly GPR data rather than the daily GPR index. Moreover, Yilanci and Kilci (2021) fail to account for the GPR sub-indices in order to understand better the causality relationship in the precious market.

### 4.4.1 Discussion of Findings within the Current Geopolitical Context: The Russo – Ukrainian War

From a practical perspective, these empirical findings are particularly relevant with respect to the ongoing Russo–Ukrainian war since much of the increase in agricultural commodity prices stems from the economic effects of war. It is important to note that the ongoing war is rooted in a series of geopolitical events which go beyond the geopolitical events that occurred in the last decade. Both Russia and Ukraine formed part of the Union of Soviet Socialist Republics (USSR) for several decades. Undoubtedly, the disintegration of the USSR in the early 1990s brought about significant changes in ex-Soviet states. Indeed, Ukraine and 14 other nations gained independence in 1991, and subsequently, Russia lost its dominance and global power (Dadak, 2010). Both nations began pursuing liberal market strategies in order for their economies to prosper (Moiso, 2022).

Over the years, Russia adopted various strategies to ensure that ex-Soviet states remain in Moscow's sphere of influence, for instance, by supporting pro-Russian presidents and favourable energy policies. Nevertheless, Ukraine's geopolitical positioning had also been shaped by Western politics, including the EU and North Atlantic Treaty Organisation. Following the Maidan uprising in Kyiv in 2014, Russia pursued its territorial geopolitical strategies by illegally annexing and occupying Crimea (Moisio, 2022). Russia has also proceeded to occupy other oblasts[15] in eastern Ukraine, namely the Luhansk and Donetsk regions (better known as the Donbas region). Eventually, the eight-year conflict led up to a full-scale invasion (Kuzio, 2018; Krnjevic Miskovic, 2020; Moisio, 2022). The diplomatic relationship between Ukraine and Russia turned sour as the former failed to recognise the Donbas region as an independent, autonomous region. On 24th February 2022, Russian President Vladimir Putin announced Russia's special military operation, whereby Russia invaded Ukraine and the scope of this invasion was to take full control of Ukraine whilst introducing a pro-Russian government.

[15] Oblasts is another term for regions of Russia and ex- USSR states.

Both Russia and Ukraine are major producers and exporters of various agricultural commodities, such as oats, corn, and wheat (World Bank, 2022). In fact, wheat is the most important commodity produced by both nations, with both of them jointly producing 30% of the wheat traded (Behnassi and El Haiba, 2022). With immediate effect, the Russian invasion of Ukraine accelerated the prices of various commodities, especially those concerning both energy and agriculture. The subsequent advancement of the Russian military force across Ukraine halted both the production and the exportation of grains since numerous Ukrainian ports had been closed for a period of time until the beginning of August 2022. Behnassi and El Haiba (2022) acknowledge that developing nations, such as Egypt, Lebanon, and Tunisia, are highly dependent on wheat imports originating from Ukraine. Thus, if the Russo–Ukrainian war persists, the world will face a food shortage crisis. Consequently, food security would not be guaranteed to all nations. This situation would bring about serious consequences in terms of the quantity and quality of food, with emerging and underdeveloped nations suffering the most (Behnassi and El Haiba, 2022; Jagtap et al., 2022).

## 4.5 Conclusion

Overall, these empirical results further highlight the importance of assessing the risk emanating from geopolitics. Over the last decade, the world has witnessed a significant number of geopolitical events in recent years, and consequently, uncertainty has intensified and taken precedence. Similar to previously established literature, this empirical study found that geopolitical risk also impacts the agricultural commodity market. Moreover, it is now understood that the GPR index plays an important role in determining agricultural commodity prices.

In the following chapter, the author concludes this dissertation by providing a summary of the salient findings of this study. The author puts forward various recommendations so that the economic actors can better manage geopolitical risks. As a result of this empirical study, suggestions for further research on the impact of geopolitical risk on agricultural commodities are also provided.

# Chapter 5 – Conclusion

## 5.1 Introduction

The previous four chapters provided a comprehensive explanation of the implications of geopolitical risks on the commodity markets. In the first chapter, the author introduced the concept of geopolitics, mainly discussing its historical roots and how it evolved over time, especially due to the globalisation phenomenon. The literature review section provided a comprehensive review of the literature available on geopolitical risk, measuring the risk and taking it into perspective across various commodity markets. Due to the increase in terrorist attacks over the years, the literature focused on the cause and effect of such terrorist attacks on the commodity markets. The third chapter outlined the methodological approach to carrying out this study as well as its limitations. Subsequently, the discussion of the empirical results and findings was presented in the fourth chapter.

This fifth and final chapter includes a summary of all the salient points of this dissertation. The aim of this study was to investigate the causality relationship between the GPR sub-indices and the agricultural future commodity prices. This chapter addresses the limitations pertaining to this study while discussing the respective mitigations implemented to overcome such limitations. As part of the concluding remarks, the author points out any potential research that can be undertaken in order to contribute to the growing literature on geopolitical risk.

## 5.2 Summary of the Salient Findings

As outlined in the introductory chapter, this study aimed to address the following research question: Is there a causal relationship between the GPR sub-indices (GPR threat and GPR act) and commodity prices when considering agricultural future commodities (grains and softs)? Consequently, a Granger causality test was employed for the sample period 31st March 2000–31st March 2022 in order to determine the causality

relationship between the GPR Threat and Act sub-indices and the agricultural commodity prices, thus answering the research question. The Granger causality analysis revealed that in tandem, the GPR sub-indices impact the prices of certain grain commodities, including wheat and oats. On the other hand, when each respective GPR sub-index was considered separately, it was noted that the GPR Threat had further implications when compared to the GPR Act.

Overall, this empirical study strengthens the idea that certain agricultural commodities, specifically grains, more than softs, are susceptible to geopolitical events during the period 2000 - 2022. Indeed, this sample period included several geopolitical events which occurred over the last 22 years. In fact, both the Arab Spring and the on-going Russo-Ukrainian war are two geopolitical events which have impacted the agricultural commodities market. These empirical findings highlight the predictive power of the GPR sub-indices in relation to changes in future commodity prices, as these contain information that can shed light on the course prices are likely to take following a particular geopolitical event. Overall, these empirical findings complement earlier studies on the implications of geopolitical risk on other commodity markets (see Baur and Smales, 2020; Bouioyour et al., 2019; Cunado et al., 2020; Das et al., 2019a; Su et al., 2019; Tiwari et al., 2021; Yilanci and Kilci, 2021).

## 5.3 Significance of the Study

As outlined in the introductory chapter, the scope of this empirical study was to shed further light on the implications of geopolitical risk on the agricultural commodity markets. Before this study, evidence on the implications of geopolitical risk concerning the agricultural commodity markets was limited, as outlined in the literature review chapter. Indeed, the findings from this study make several contributions to the current literature. Firstly, this research study appears to be the first study to investigate the Granger causality relationship between the GPR sub-indices (GPR Threat and GPR Act) and the agricultural

commodities (softs and grains). This study has gone some way towards enhancing our understanding of how the geopolitical acts and geopolitical threats impact the agricultural commodities' prices.

In fact, such research findings are envisaged to be beneficial to various economic stakeholders, such as policymakers, businesses, institutional investors. Undoubtedly, in today's uncertain world, geopolitical risks are significantly on the increase, generally materialising as either a threat or an act. First and foremost, this study on the effects of geopolitical risk on the commodity markets is of utmost importance to policymakers as they need to make effective decisions when faced with such an increase in geopolitical risk. Indeed, the primary function of policymakers is to undertake actions in the best possible way, especially during an unforeseeable crisis that could severely affect the overall economy. Corporate entities are also significantly dependent on the agricultural commodity market; therefore, this empirical study can assist these economic actors by providing them with adequate knowledge on how to deal with geopolitical risk. Ever since the financialisation of the commodity market took precedence, institutional investors only accounted for financial risks that involve market, credit, and liquidity risks. This empirical study, however, has clearly illustrated the importance of accounting for non-financial risks, namely geopolitical risks, when trading such commodities.

Overall, this empirical study should assist various actors in developing suitable strategies to better manage geopolitical risks while encouraging them not to underreact to geopolitical events but to counteract the situation of an increase in geopolitical risk. Yet, to a certain extent, geopolitical risk could prove uncontrollable, leading to serious economic repercussions. This issue is clearly illustrated in the current ongoing Russo-Ukrainian war and such impact could potentially spill over onto other commodities, with ordinary citizens bearing this additional cost.

## 5.4 Limitations of the Study

Primarily, the scope of this empirical research study was to build on previous similar empirical studies that considered the importance of acknowledging geopolitical risk in the commodity markets. However, this empirical study took a different approach from previously established literature by analysing the causality relationship between the GPR sub- indices and the agricultural commodity markets, rather than other popular commodities such as the crude oil market or the precious metals markets. However, as with any other study undertaken, this research project comes with a number of limitations as a result of the selected methodology.

One of the main research limitations is that this study focuses solely on agricultural commodities. Hence, in order to mitigate this limitation, the author selected a wide range of grains and soft future commodities, all of which are traded on the CBOT. In addition to this, the 22-year sample period used for the purpose of this study could also have led to bias, and as such, the results might not hold if a different time period is used. In view of this limitation, the chosen sample period considers various geopolitical events that occurred during these two decades, including the large-scale terrorist attacks in the US, the Arab Spring in 2011, the Ukraine–Russia conflict in 2014, and the US–China trade retaliation in 2018. Moreover, the author also taken into account, the current major geopolitical event: the Russo-Ukrainian war which began on 24th February 2022 and still the war has no sign of abating up until the writing of this dissertation. It is envisaged that this invasion will lead to further uncertainty and serious repercussions on the global commodity markets. Due to the time constraints, the author only included the first five weeks period of the war, until 31st March 2022. Therefore, the author acknowledges that a certain degree of bias might exist due to the geopolitical events associated with the researched sample period.

## 5.5 Recommendations

As outlined in the introductory chapter, the concept of geopolitics has strong historical roots, while the concept of risk gained significance following the 2008 financial crisis. Geopolitical risk is present and constantly changing, and it has direct implications on several economic actors, such as national governments, businesses, institutional investors, and ordinary citizens. Without a doubt, any geopolitical event brings about uncertainty, which could affect the respective economic actors from reaching their objectives. For instance, a sudden increase in geopolitical risk could impact a national government's objectives to lower inflation, especially in the long term. Such an increase in geopolitical risk could also lead to a decrease in business profits, effectively impacting the business strategies of the affected organisations. Perhaps one of the most fundamental processes that should be carried out by all economic actors is the implementation of risk management principles, especially since non-financial events have become common and widespread nowadays, in order to monitor and mitigate geopolitical risks more effectively. Another important recommendation is that all economic actors should pay attention to any abrupt changes in geopolitics that could hinder them from reaching their respective objectives.

Risk management is a cyclical process that highlights the importance of assessing both the vulnerability and the threats emanating from geopolitics. Essentially, national governments are the main actors responsible for managing and mitigating such risks; however, as the world has become more globalised and interconnected, other economic actors, such as institutional investors and corporate entities, are urged to implement risk management principles in order to effectively manage geopolitical risks. As a matter of fact, the ISO (2018) advocates the risk management process as an adequate tool to assess risk. Fundamentally, the assessment of risk and the treatment of risk are the core principles of the risk management process. The following paragraph provides an overview of the process from a geopolitical perspective.

The assessment of risk is dependent on three elements, namely identifying, analysing, and evaluating the risk. Primarily, international news is the main source from which to obtain information so as to develop effective risk management strategies. Therefore, the author recommends that all economic actors should be

more vigilant when monitoring the development of any international news story. As geopolitical events occur on a daily basis, economic actors should never underestimate international political news, which could potentially have long-lasting effects. Secondly, it is important that economic actors analyse their risk exposure from time to time. Ideally, a risk matrix is used to this end so as to outline both the likelihood that the geopolitical event will occur as well as its impact in order to determine the related severity to loss. Finally, it is important that such geopolitical risks are evaluated to ensure that they fall within the risk appetite of the respective economic actor.

Eventually, the treatment of risk is a crucial element which should be finally implemented by businesses in order to mitigate risks emanating from geopolitical events is to opt for political risk insurance. It is evident that geopolitical risk is complex as it can vary across different countries and economic sectors. Additionally, Baublyte et al., (2012) acknowledge that insurance underwriting can be a complicated process as geopolitics poses both unique and rare risks. In fact, political risk is only insurable if the following four main criteria are met: the separability of risks, the calculated probability of the event materialising is high or low, a significant number of identical risks are being insured, and the overall risk value is within the insurer's risk appetite (Baublyte et al.,2012). However, the geopolitical environment tends to change abruptly, leading to an amplification in uncertainty, which, in turn, could result in various actions that would not be covered by a comprehensive political risk insurance policy, such as government expropriation.

## 5.6 Areas for Further Research

This study provided an in-depth analysis of how geopolitical risk affects various agricultural commodity prices. As outlined in both the introduction and the literature review, the concept of geopolitical risk was introduced and comprehensively defined in recent years. Consequently, following an in-depth review of the literature available on geopolitical risk, the author considers research in the area to be still in its infancy stages. Without a doubt, geopolitics will continue to dominate, both in the near and distant future, as geopolitical threats and acts are constantly on the increase, thus resulting in greater uncertainty. This

highlights the importance of additional research in order to further develop the knowledge of geopolitics while acknowledging its constant changes. This study may act as a guide for any future studies that can be taken into consideration by other researchers in order to substantiate the literature on geopolitical risk. That said, further empirical studies should be carried out as follows:

First and foremost, further work is required to assess the causality relationship between geopolitical risk and the agricultural commodity market. Due to the fact that the financialisation of commodities has become more widespread in the financial industry, further studies should be undertaken to investigate in detail the implications of the GPR sub- indices for both the future and spot prices of agricultural commodities. Such an empirical study could provide a clearer understanding of how geopolitical risk impacts immediate prices in comparison to future prices. Besides, such a study could be applicable to a broad range of commodities, including precious metals, currencies and energy commodities.

In future investigations, it might be possible to use a different empirical approach by employing an event study in order to assess the impact of the geopolitical risk on the various commodity markets. The scope of an event study is to examine the impact caused by a particular event on commodity prices. For instance, one particular event that can be studied is the recent Russo-Ukrainian war, which started on 24th February 2022, in order to assess the impact of the geopolitical index on various commodity prices. Moreover, comparison can be made with the other events, such as the Russian annexation of Crimea from Ukraine in 2014.

One main theme that merits further research involves the implications of both uncertainty and geopolitical risk for the commodity markets. As outlined throughout this dissertation, uncertainty plays a crucial role within a geopolitical context, affecting both the commodity markets as well as the overall economy. Empirical studies should be undertaken by accounting for two indices, namely the EPU index and the GPR index, as well as their implications for the commodity markets. Since both indices are available for several advanced and emerging nations, a comparative study can be carried out to understand better how both advanced and emerging nations are affected by geopolitical risk and uncertainty, respectively. Similarly, another

empirical study involving both the EPU and GPR sub-indices can be carried out in order to assess the causality relationship between geopolitical risk and both spot and future commodity prices.

Since geopolitical risk is considered to be dynamic and constantly changing, it is recommended that another empirical study similar to this one is conducted in the near future, for instance, within five or ten years from now. Undoubtedly, due to the globalisation phenomenon, geopolitical risks will still be present. Moreover, in addition to the heightened geopolitical tensions, nations are also facing constant power struggles concerning both their physical and space-specific territory.

## 5.7 Concluding Remarks

This study has shown how geopolitical risk can be complex in nature and that it can impact various economic sectors, including the agricultural commodity market. Indeed, it is important to understand that geopolitical risk is constantly changing and should never be underestimated by various economic actors. Consequently, the findings of this empirical study should provide useful information to both policymakers and governments to help them acknowledge the importance of geopolitical risk when setting their national policies related to food security. Traders too can benefit from the findings of this study, especially due to the phenomenon of the financialisation of commodities.

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# Appendices

## Appendix A: Statistical Tests: Descriptive and Stationary Tests.

This appendix outlines the outputs generated by EViews Student Version 12, to test the main variables. Reference should be made to Sections 4.1 and 4.2 in Chapter 4: Discussion and Analysis, for the interpretation of the statistical results.

## Section I: Descriptive Statistics

**EViews Output 1: Statistical Description – Cocoa**

| | COCOA_LAST_PRICE |
|---|---|
| Mean | 2219.426 |
| Median | 2305.000 |
| Maximum | 3774.000 |
| Minimum | 674.0000 |
| Std. Dev. | 661.3955 |
| Skewness | -0.323891 |
| Kurtosis | 2.292837 |
| | |
| Jarque-Bera | 211.1480 |
| Probability | 0.000000 |
| | |
| Sum | 12229037 |
| Sum Sq. Dev. | 2.41E+09 |
| | |
| Observations | 5510 |

**EViews Output 2: Variable Statistical Description – Coffee**

| | COFFEE_LAST_PRICE |
|---|---|
| Mean | 125.1446 |
| Median | 119.7500 |
| Maximum | 304.9000 |
| Minimum | 41.50000 |
| Std. Dev. | 49.21488 |
| Skewness | 0.888628 |
| Kurtosis | 3.942000 |
| | |
| Jarque-Bera | 928.8945 |
| Probability | 0.000000 |
| | |
| Sum | 689546.9 |
| Sum Sq. Dev. | 13343373 |
| | |
| Observations | 5510 |

**EViews Output 3: Variable Statistical Description – Corn**

| | CORN_LAST_PRICE |
|---|---|
| Mean | 390.5204 |
| Median | 365.7500 |
| Maximum | 831.2500 |
| Minimum | 174.7500 |
| Std. Dev. | 155.5385 |
| Skewness | 0.810066 |
| Kurtosis | 2.855730 |
| | |
| Jarque-Bera | 607.3953 |
| Probability | 0.000000 |
| | |
| Sum | 2151768. |
| Sum Sq. Dev. | 1.33E+08 |
| | |
| Observations | 5510 |

**EViews Output 4: Variable Statistical Description – Cotton**

| | COTTON_LAST_PRICE |
|---|---|
| Mean | 69.96968 |
| Median | 65.32000 |
| Maximum | 215.1500 |
| Minimum | 28.52000 |
| Std. Dev. | 24.51531 |
| Skewness | 2.220562 |
| Kurtosis | 10.88385 |
| | |
| Jarque-Bera | 18798.00 |
| Probability | 0.000000 |
| | |
| Sum | 385533.0 |
| Sum Sq. Dev. | 3310910. |
| | |
| Observations | 5510 |

**EViews Output 5: Variable Statistical Description – No.11 Sugar**

| | SUGAR_LAST_PRICE |
|---|---|
| Mean | 14.22566 |
| Median | 13.23500 |
| Maximum | 35.31000 |
| Minimum | 4.990000 |
| Std. Dev. | 5.753274 |
| Skewness | 0.785632 |
| Kurtosis | 3.381945 |
| | |
| Jarque-Bera | 600.3037 |
| Probability | 0.000000 |
| | |
| Sum | 78383.36 |
| Sum Sq. Dev. | 182348.8 |
| | |
| Observations | 5510 |

**EViews Output 6: Variable Statistical Description – Oats**

| | OATS_LAST_PRICE |
|---|---|
| Mean | 265.6213 |
| Median | 254.5000 |
| Maximum | 772.2500 |
| Minimum | 95.00000 |
| Std. Dev. | 109.6390 |
| Skewness | 1.439915 |
| Kurtosis | 6.910046 |
| | |
| Jarque-Bera | 5414.006 |
| Probability | 0.000000 |
| | |
| Sum | 1463574. |
| Sum Sq. Dev. | 66222056 |
| | |
| Observations | 5510 |

**EViews Output 7: Variable Statistical Description – Rough Rice**

| | ROUGH_RICE_LAST_PRICE |
|---|---|
| Mean | 11.11643 |
| Median | 11.57000 |
| Maximum | 24.46000 |
| Minimum | 3.430000 |
| Std. Dev. | 3.752489 |
| Skewness | -0.143381 |
| Kurtosis | 2.668749 |
| | |
| Jarque-Bera | 44.07062 |
| Probability | 0.000000 |
| | |
| Sum | 61251.51 |
| Sum Sq. Dev. | 77573.17 |
| | |
| Observations | 5510 |

**EViews Output 8: Variable Statistical Description – Soybean**

| | SOYBEAN_LAST_PRICE |
|---|---|
| Mean | 956.0087 |
| Median | 945.3750 |
| Maximum | 1771.000 |
| Minimum | 418.0000 |
| Std. Dev. | 323.9262 |
| Skewness | 0.210937 |
| Kurtosis | 2.159180 |
| | |
| Jarque-Bera | 203.1713 |
| Probability | 0.000000 |
| | |
| Sum | 5267608. |
| Sum Sq. Dev. | 5.78E+08 |
| | |
| Observations | 5510 |

**EViews Output 9: Variable Statistical Description – Soybean Oil**

| | SOYBEAN_OIL_LAST_PRICE |
|---|---|
| Mean | 34.64693 |
| Median | 32.27000 |
| Maximum | 82.18000 |
| Minimum | 14.38000 |
| Std. Dev. | 13.19226 |
| Skewness | 0.675241 |
| Kurtosis | 2.840206 |
| | |
| Jarque-Bera | 424.5771 |
| Probability | 0.000000 |
| | |
| Sum | 190904.6 |
| Sum Sq. Dev. | 958763.0 |
| | |
| Observations | 5510 |

**EViews Output 10: Variable Statistical Description – Wheat**

| | WHEAT_LAST_PRICE |
|---|---|
| Mean | 515.0902 |
| Median | 497.2500 |
| Maximum | 1425.250 |
| Minimum | 233.5000 |
| Std. Dev. | 178.2246 |
| Skewness | 0.690465 |
| Kurtosis | 3.388311 |
| | |
| Jarque-Bera | 472.4258 |
| Probability | 0.000000 |
| | |
| Sum | 2838147. |
| Sum Sq. Dev. | 1.75E+08 |
| | |
| Observations | 5510 |

**EViews Output 11: Variable Statistical Description – GPR Daily Index**

| | GPRD |
|---|---|
| Mean | 112.8891 |
| Median | 99.51920 |
| Maximum | 1045.604 |
| Minimum | 9.491598 |
| Std. Dev. | 69.03425 |
| Skewness | 4.641369 |
| Kurtosis | 39.79286 |
| | |
| Jarque-Bera | 330573.3 |
| Probability | 0.000000 |
| | |
| Sum | 622019.2 |
| Sum Sq. Dev. | 26254395 |
| | |
| Observations | 5510 |

**EViews Output 12: Variable Statistical Description – GPR Daily Sub- Index: Act**

| | GPRD_ACT |
|---|---|
| Mean | 113.9453 |
| Median | 93.47909 |
| Maximum | 1627.428 |
| Minimum | 0.000000 |
| Std. Dev. | 108.1768 |
| Skewness | 6.133046 |
| Kurtosis | 60.94185 |
| | |
| Jarque-Bera | 805312.9 |
| Probability | 0.000000 |
| | |
| Sum | 627838.4 |
| Sum Sq. Dev. | 64467582 |
| | |
| Observations | 5510 |

**EViews Output 13: Variable Statistical Description – GPR Daily Sub- Index: Threat**

| | GPRD_THREAT |
|---|---|
| Mean | 112.5335 |
| Median | 98.16797 |
| Maximum | 811.5252 |
| Minimum | 7.892561 |
| Std. Dev. | 67.28846 |
| Skewness | 3.064505 |
| Kurtosis | 20.85715 |
| | |
| Jarque-Bera | 81833.31 |
| Probability | 0.000000 |
| | |
| Sum | 620059.5 |
| Sum Sq. Dev. | 24943306 |
| | |
| Observations | 5510 |

## Section II: Testing Stationarity - Unit - Root Test

**EViews Output 14: Augmented Dickey - Fuller Test – Cocoa (Difference Level Test)**

Null Hypothesis: COCOA_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.834903 | 0.0535 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COCOA_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:41
Sample (adjusted): 4/03/2000 5/13/2021
Included observations: 5509 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| COCOA_LAST_PRICE(-1) | -0.002466 | 0.000870 | -2.834903 | 0.0046 |
| C | 5.808078 | 2.014206 | 2.883557 | 0.0039 |

| | | | |
|---|---|---|---|
| R-squared | 0.001457 | Mean dependent var | 0.335814 |
| Adjusted R-squared | 0.001276 | S.D. dependent var | 42.72298 |
| S.E. of regression | 42.69571 | Akaike info criterion | 10.34644 |
| Sum squared resid | 10038842 | Schwarz criterion | 10.34884 |
| Log likelihood | -28497.26 | Hannan-Quinn criter. | 10.34727 |
| F-statistic | 8.036677 | Durbin-Watson stat | 1.991448 |
| Prob(F-statistic) | 0.004601 | | |

**EViews Output 15: Augmented Dickey - Fuller Test – Cocoa (1st Difference Level Test)**

Null Hypothesis: D(COCOA_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -73.96196 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COCOA_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:42
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(COCOA_LAST_PRICE(-1)) | -0.996741 | 0.013476 | -73.96196 | 0.0000 |
| C | 0.337685 | 0.575770 | 0.586493 | 0.5576 |

| | | | |
|---|---|---|---|
| R-squared | 0.498377 | Mean dependent var | 0.002723 |
| Adjusted R-squared | 0.498286 | S.D. dependent var | 60.32595 |
| S.E. of regression | 42.72994 | Akaike info criterion | 10.34804 |
| Sum squared resid | 10053119 | Schwarz criterion | 10.35044 |
| Log likelihood | -28496.50 | Hannan-Quinn criter. | 10.34888 |
| F-statistic | 5470.371 | Durbin-Watson stat | 2.000047 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 16: Augmented Dickey - Fuller Test – Coffee (Difference Level Test)**

Null Hypothesis: COFFEE_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.659016 | 0.4522 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COFFEE_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:43
Sample (adjusted): 4/03/2000 5/13/2021
Included observations: 5509 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| COFFEE_LAST_PRICE(-1) | -0.001285 | 0.000774 | -1.659016 | 0.0972 |
| C | 0.183024 | 0.104116 | 1.757888 | 0.0788 |

| | | | |
|---|---|---|---|
| R-squared | 0.000500 | Mean dependent var | 0.022273 |
| Adjusted R-squared | 0.000318 | S.D. dependent var | 2.828076 |
| S.E. of regression | 2.827626 | Akaike info criterion | 4.917115 |
| Sum squared resid | 44031.05 | Schwarz criterion | 4.919516 |
| Log likelihood | -13542.19 | Hannan-Quinn criter. | 4.917953 |
| F-statistic | 2.752334 | Durbin-Watson stat | 2.025123 |
| Prob(F-statistic) | 0.097170 | | |

**EViews Output 17: Augmented Dickey - Fuller Test – Coffee (1st Difference Level Test)**

Null Hypothesis: D(COFFEE_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -75.20516 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COFFEE_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:44
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(COFFEE_LAST_PRICE(-1)) | -1.013625 | 0.013478 | -75.20516 | 0.0000 |
| C | 0.022859 | 0.038109 | 0.599837 | 0.5486 |

| | | | |
|---|---|---|---|
| R-squared | 0.506711 | Mean dependent var | 0.001117 |
| Adjusted R-squared | 0.506622 | S.D. dependent var | 4.026489 |
| S.E. of regression | 2.828243 | Akaike info criterion | 4.917551 |
| Sum squared resid | 44042.25 | Schwarz criterion | 4.919953 |
| Log likelihood | -13540.94 | Hannan-Quinn criter. | 4.918389 |
| F-statistic | 5655.816 | Durbin-Watson stat | 1.999744 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 18: Augmented Dickey - Fuller Test – Corn (Difference Level)**

Null Hypothesis: CORN_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.476073 | 0.5459 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CORN_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:46
Sample (adjusted): 4/03/2000 5/13/2021
Included observations: 5509 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| CORN_LAST_PRICE(-1) | -0.001079 | 0.000731 | -1.476073 | 0.1400 |
| C | 0.514240 | 0.307113 | 1.674432 | 0.0941 |

| | | | |
|---|---|---|---|
| R-squared | 0.000395 | Mean dependent var | 0.093075 |
| Adjusted R-squared | 0.000214 | S.D. dependent var | 8.433043 |
| S.E. of regression | 8.432141 | Akaike info criterion | 7.102341 |
| Sum squared resid | 391553.2 | Schwarz criterion | 7.104743 |
| Log likelihood | -19561.40 | Hannan-Quinn criter. | 7.103179 |
| F-statistic | 2.178791 | Durbin-Watson stat | 1.948402 |
| Prob(F-statistic) | 0.139982 | | |

**EViews Output 19: Augmented Dickey - Fuller Test – Corn (1st Difference Level Test)**

Null Hypothesis: D(CORN_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -72.36043 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CORN_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:46
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(CORN_LAST_PRICE(-1)) | -0.975009 | 0.013474 | -72.36043 | 0.0000 |
| C | 0.091132 | 0.113620 | 0.802077 | 0.4225 |

| | | | |
|---|---|---|---|
| R-squared | 0.487434 | Mean dependent var | 0.002269 |
| Adjusted R-squared | 0.487341 | S.D. dependent var | 11.77637 |
| S.E. of regression | 8.431904 | Akaike info criterion | 7.102285 |
| Sum squared resid | 391460.1 | Schwarz criterion | 7.104687 |
| Log likelihood | -19557.69 | Hannan-Quinn criter. | 7.103123 |
| F-statistic | 5236.032 | Durbin-Watson stat | 1.998352 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 20: Augmented Dickey - Fuller Test – Cotton (Difference Level)**

Null Hypothesis: COTTON_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.908803 | 0.3285 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COTTON_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:59
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| COTTON_LAST_PRICE(-1) | -0.001562 | 0.000819 | -1.908803 | 0.0563 |
| D(COTTON_LAST_PRICE(-1)) | 0.125415 | 0.013390 | 9.366103 | 0.0000 |
| C | 0.121484 | 0.060663 | 2.002601 | 0.0453 |

| | | | |
|---|---|---|---|
| R-squared | 0.016089 | Mean dependent var | 0.014034 |
| Adjusted R-squared | 0.015731 | S.D. dependent var | 1.498939 |
| S.E. of regression | 1.487102 | Akaike info criterion | 3.632081 |
| Sum squared resid | 12174.16 | Schwarz criterion | 3.635683 |
| Log likelihood | -9999.750 | Hannan-Quinn criter. | 3.633337 |
| F-statistic | 45.00797 | Durbin-Watson stat | 2.000009 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 21: Augmented Dickey - Fuller Test – Cotton (1st Difference Level)**

Null Hypothesis: D(COTTON_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -65.43819 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COTTON_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:59
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(COTTON_LAST_PRICE(-1)) | -0.875666 | 0.013382 | -65.43819 | 0.0000 |
| C | 0.012190 | 0.020043 | 0.608177 | 0.5431 |

| | | | |
|---|---|---|---|
| R-squared | 0.437483 | Mean dependent var | -0.000799 |
| Adjusted R-squared | 0.437381 | S.D. dependent var | 1.983070 |
| S.E. of regression | 1.487459 | Akaike info criterion | 3.632379 |
| Sum squared resid | 12182.22 | Schwarz criterion | 3.634781 |
| Log likelihood | -10001.57 | Hannan-Quinn criter. | 3.633217 |
| F-statistic | 4282.156 | Durbin-Watson stat | 1.999635 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 22: Augmented Dickey - Fuller Test – No.11 Sugar (Difference Level)**

Null Hypothesis: SUGAR_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.342656 | 0.1586 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SUGAR_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 20:01
Sample (adjusted): 4/03/2000 5/13/2021
Included observations: 5509 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| SUGAR_LAST_PRICE(-1) | -0.001870 | 0.000798 | -2.342656 | 0.0192 |
| C | 0.029061 | 0.012246 | 2.373222 | 0.0177 |

| | | | |
|---|---|---|---|
| R-squared | 0.000996 | Mean dependent var | 0.002467 |
| Adjusted R-squared | 0.000814 | S.D. dependent var | 0.340906 |
| S.E. of regression | 0.340767 | Akaike info criterion | 0.685129 |
| Sum squared resid | 639.4859 | Schwarz criterion | 0.687531 |
| Log likelihood | -1885.189 | Hannan-Quinn criter. | 0.685967 |
| F-statistic | 5.488037 | Durbin-Watson stat | 2.023238 |
| Prob(F-statistic) | 0.019182 | | |

**EViews Output 23: Augmented Dickey - Fuller Test – No.11 Sugar (1st Difference)**

Null Hypothesis: D(SUGAR_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -75.13607 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SUGAR_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 20:02
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(SUGAR_LAST_PRICE(-1)) | -1.012503 | 0.013476 | -75.13607 | 0.0000 |
| C | 0.002496 | 0.004594 | 0.543381 | 0.5869 |

| | | | |
|---|---|---|---|
| R-squared | 0.506252 | Mean dependent var | 1.82E-06 |
| Adjusted R-squared | 0.506162 | S.D. dependent var | 0.485163 |
| S.E. of regression | 0.340941 | Akaike info criterion | 0.686151 |
| Sum squared resid | 640.0230 | Schwarz criterion | 0.688552 |
| Log likelihood | -1887.659 | Hannan-Quinn criter. | 0.686988 |
| F-statistic | 5645.429 | Durbin-Watson stat | 2.000303 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 24: Augmented Dickey - Fuller Test – Oats (Difference Level)**

Null Hypothesis: OATS_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.526267 | 0.8837 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OATS_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:50
Sample (adjusted): 4/06/2000 5/13/2021
Included observations: 5506 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| OATS_LAST_PRICE(-1) | -0.000440 | 0.000836 | -0.526267 | 0.5987 |
| D(OATS_LAST_PRICE(-1)) | 0.083146 | 0.013489 | 6.163861 | 0.0000 |
| D(OATS_LAST_PRICE(-2)) | -0.039060 | 0.013528 | -2.887415 | 0.0039 |
| D(OATS_LAST_PRICE(-3)) | -0.043346 | 0.013535 | -3.202434 | 0.0014 |
| C | 0.226767 | 0.239765 | 0.945792 | 0.3443 |

| | | | |
|---|---|---|---|
| R-squared | 0.010378 | Mean dependent var | 0.109880 |
| Adjusted R-squared | 0.009659 | S.D. dependent var | 6.789215 |
| S.E. of regression | 6.756349 | Akaike info criterion | 6.659750 |
| Sum squared resid | 251111.0 | Schwarz criterion | 6.665756 |
| Log likelihood | -18329.29 | Hannan-Quinn criter. | 6.661845 |
| F-statistic | 14.42218 | Durbin-Watson stat | 2.002041 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 25: Augmented Dickey - Fuller Test – Oats (1st Difference)**

Null Hypothesis: D(OATS_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -44.73665 | 0.0000 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OATS_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:51
Sample (adjusted): 4/06/2000 5/13/2021
Included observations: 5506 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(OATS_LAST_PRICE(-1)) | -1.000405 | 0.022362 | -44.73665 | 0.0000 |
| D(OATS_LAST_PRICE(-1),2) | 0.083175 | 0.018262 | 4.554436 | 0.0000 |
| D(OATS_LAST_PRICE(-2),2) | 0.043763 | 0.013511 | 3.239015 | 0.0012 |
| C | 0.110047 | 0.091081 | 1.208236 | 0.2270 |

| | | | |
|---|---|---|---|
| R-squared | 0.461443 | Mean dependent var | -0.000499 |
| Adjusted R-squared | 0.461149 | S.D. dependent var | 9.203419 |
| S.E. of regression | 6.755905 | Akaike info criterion | 6.659437 |
| Sum squared resid | 251123.7 | Schwarz criterion | 6.664242 |
| Log likelihood | -18329.43 | Hannan-Quinn criter. | 6.661113 |
| F-statistic | 1571.394 | Durbin-Watson stat | 2.002089 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 26: Augmented Dickey - Fuller Test – Rough Rice (Difference Level)**

Null Hypothesis: ROUGH_RICE_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.371991 | 0.1498 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ROUGH_RICE_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:52
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| ROUGH_RICE_LAST_PRICE(-1) | -0.001750 | 0.000738 | -2.371991 | 0.0177 |
| D(ROUGH_RICE_LAST_PRICE(-1)) | 0.129522 | 0.013364 | 9.692001 | 0.0000 |
| C | 0.021083 | 0.008655 | 2.435953 | 0.0149 |

| | | | |
|---|---|---|---|
| R-squared | 0.017559 | Mean dependent var | 0.001866 |
| Adjusted R-squared | 0.017202 | S.D. dependent var | 0.207127 |
| S.E. of regression | 0.205338 | Akaike info criterion | -0.327773 |
| Sum squared resid | 232.1115 | Schwarz criterion | -0.324170 |
| Log likelihood | 905.6861 | Hannan-Quinn criter. | -0.326516 |
| F-statistic | 49.19502 | Durbin-Watson stat | 1.999696 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 27: Augmented Dickey - Fuller Test – Rough Rice (1st Difference)**

Null Hypothesis: D(ROUGH_RICE_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -65.19745 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ROUGH_RICE_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:52
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(ROUGH_RICE_LAST_PRICE(-1)) | -0.871335 | 0.013365 | -65.19745 | 0.0000 |
| C | 0.001631 | 0.002768 | 0.589194 | 0.5558 |

| | | | |
|---|---|---|---|
| R-squared | 0.435670 | Mean dependent var | 3.63E-05 |
| Adjusted R-squared | 0.435568 | S.D. dependent var | 0.273430 |
| S.E. of regression | 0.205424 | Akaike info criterion | -0.327114 |
| Sum squared resid | 232.3487 | Schwarz criterion | -0.324713 |
| Log likelihood | 902.8729 | Hannan-Quinn criter. | -0.326277 |
| F-statistic | 4250.708 | Durbin-Watson stat | 1.999442 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 28: Augmented Dickey - Fuller Test – Soybean (Difference Level)**

Null Hypothesis: SOYBEAN_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.524896 | 0.5211 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOYBEAN_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:53
Sample (adjusted): 4/03/2000 5/13/2021
Included observations: 5509 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| SOYBEAN_LAST_PRICE(-1) | -0.001035 | 0.000679 | -1.524896 | 0.1273 |
| C | 1.183929 | 0.684910 | 1.728591 | 0.0839 |

| | | | |
|---|---|---|---|
| R-squared | 0.000422 | Mean dependent var | 0.194727 |
| Adjusted R-squared | 0.000241 | S.D. dependent var | 16.31200 |
| S.E. of regression | 16.31004 | Akaike info criterion | 8.421802 |
| Sum squared resid | 1464958. | Schwarz criterion | 8.424203 |
| Log likelihood | -23195.85 | Hannan-Quinn criter. | 8.422640 |
| F-statistic | 2.325308 | Durbin-Watson stat | 1.957866 |
| Prob(F-statistic) | 0.127342 | | |

**EViews Output 29: Augmented Dickey - Fuller Test – Soybean (1st Difference)**

Null Hypothesis: D(SOYBEAN_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -72.69681 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOYBEAN_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:54
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(SOYBEAN_LAST_PRICE(-1)) | -0.980224 | 0.013484 | -72.69681 | 0.0000 |
| C | 0.190565 | 0.219805 | 0.866971 | 0.3860 |

| | | | |
|---|---|---|---|
| R-squared | 0.489752 | Mean dependent var | -0.008488 |
| Adjusted R-squared | 0.489659 | S.D. dependent var | 22.83343 |
| S.E. of regression | 16.31178 | Akaike info criterion | 8.422015 |
| Sum squared resid | 1465004. | Schwarz criterion | 8.424416 |
| Log likelihood | -23192.23 | Hannan-Quinn criter. | 8.422853 |
| F-statistic | 5284.826 | Durbin-Watson stat | 1.998566 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 30: Augmented Dickey - Fuller Test – Soybean Oil (Difference Level)**

Null Hypothesis: SOYBEAN_OIL_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.980515 | 0.7623 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOYBEAN_OIL_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 19:57
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| SOYBEAN_OIL_LAST_PRICE(-1) | -0.000605 | 0.000617 | -0.980515 | 0.3269 |
| D(SOYBEAN_OIL_LAST_PRICE(-1)) | 0.042998 | 0.013491 | 3.187223 | 0.0014 |
| C | 0.029880 | 0.022875 | 1.306194 | 0.1915 |

| | | | |
|---|---|---|---|
| R-squared | 0.001978 | Mean dependent var | 0.009332 |
| Adjusted R-squared | 0.001615 | S.D. dependent var | 0.604051 |
| S.E. of regression | 0.603563 | Akaike info criterion | 1.828612 |
| Sum squared resid | 2005.407 | Schwarz criterion | 1.832214 |
| Log likelihood | -5032.998 | Hannan-Quinn criter. | 1.829868 |
| F-statistic | 5.454581 | Durbin-Watson stat | 1.998340 |
| Prob(F-statistic) | 0.004300 | | |

**EViews Output 31: Augmented Dickey - Fuller Test – Soybean Oil (1st Level)**

Null Hypothesis: D(SOYBEAN_OIL_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -71.01937 | 0.0001 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOYBEAN_OIL_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 19:57
Sample (adjusted): 4/04/2000 5/13/2021
Included observations: 5508 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(SOYBEAN_OIL_LAST_PRICE(-1)) | -0.957478 | 0.013482 | -71.01937 | 0.0000 |
| C | 0.008916 | 0.008134 | 1.096159 | 0.2731 |

| | | | |
|---|---|---|---|
| R-squared | 0.478092 | Mean dependent var | -0.000456 |
| Adjusted R-squared | 0.477997 | S.D. dependent var | 0.835381 |
| S.E. of regression | 0.603561 | Akaike info criterion | 1.828424 |
| Sum squared resid | 2005.758 | Schwarz criterion | 1.830825 |
| Log likelihood | -5033.479 | Hannan-Quinn criter. | 1.829261 |
| F-statistic | 5043.751 | Durbin-Watson stat | 1.998239 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 32: Augmented Dickey - Fuller Test – Wheat (Difference Level)**

Null Hypothesis: WHEAT_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.155904 | 0.2229 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WHEAT_LAST_PRICE)
Method: Least Squares
Date: 05/27/22 Time: 15:17
Sample (adjusted): 4/06/2000 5/13/2021
Included observations: 5506 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| WHEAT_LAST_PRICE(-1) | -0.002102 | 0.000975 | -2.155904 | 0.0311 |
| D(WHEAT_LAST_PRICE(-1)) | 0.053951 | 0.013457 | 4.008967 | 0.0001 |
| D(WHEAT_LAST_PRICE(-2)) | 0.017998 | 0.013477 | 1.335424 | 0.1818 |
| D(WHEAT_LAST_PRICE(-3)) | -0.070057 | 0.013476 | -5.198541 | 0.0000 |
| C | 1.218915 | 0.530935 | 2.295787 | 0.0217 |

| | | | |
|---|---|---|---|
| R-squared | 0.008844 | Mean dependent var | 0.136170 |
| Adjusted R-squared | 0.008123 | S.D. dependent var | 12.89204 |
| S.E. of regression | 12.83957 | Akaike info criterion | 7.943848 |
| Sum squared resid | 906864.5 | Schwarz criterion | 7.949854 |
| Log likelihood | -21864.41 | Hannan-Quinn criter. | 7.945943 |
| F-statistic | 12.27151 | Durbin-Watson stat | 2.001884 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 33: Augmented Dickey - Fuller Test – Wheat (1st Difference)**

Null Hypothesis: D(WHEAT_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -44.75045 | 0.0000 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WHEAT_LAST_PRICE,2)
Method: Least Squares
Date: 05/27/22 Time: 15:14
Sample (adjusted): 4/06/2000 5/13/2021
Included observations: 5506 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(WHEAT_LAST_PRICE(-1)) | -1.001910 | 0.022389 | -44.75045 | 0.0000 |
| D(WHEAT_LAST_PRICE(-1),2) | 0.054671 | 0.018536 | 2.949480 | 0.0032 |
| D(WHEAT_LAST_PRICE(-2),2) | 0.071433 | 0.013466 | 5.304829 | 0.0000 |
| C | 0.136785 | 0.173120 | 0.790112 | 0.4295 |

| | | | |
|---|---|---|---|
| R-squared | 0.476344 | Mean dependent var | -0.003950 |
| Adjusted R-squared | 0.476058 | S.D. dependent var | 17.74406 |
| S.E. of regression | 12.84382 | Akaike info criterion | 7.944329 |
| Sum squared resid | 907630.8 | Schwarz criterion | 7.949134 |
| Log likelihood | -21866.74 | Hannan-Quinn criter. | 7.946005 |
| F-statistic | 1668.299 | Durbin-Watson stat | 2.002064 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 34: Augmented Dickey - Fuller Test – GPR Daily ACT (Difference Level)**

Null Hypothesis: GPRD_ACT has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -9.557421 | 0.0000 |
| Test critical values: | 1% level | -3.431357 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GPRD_ACT)
Method: Least Squares
Date: 05/27/22 Time: 15:22
Sample (adjusted): 4/07/2000 5/13/2021
Included observations: 5505 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| GPRD_ACT(-1) | -0.067870 | 0.007101 | -9.557421 | 0.0000 |
| D(GPRD_ACT(-1)) | -0.443835 | 0.014257 | -31.13009 | 0.0000 |
| D(GPRD_ACT(-2)) | -0.239259 | 0.015174 | -15.76787 | 0.0000 |
| D(GPRD_ACT(-3)) | -0.152670 | 0.014952 | -10.21088 | 0.0000 |
| D(GPRD_ACT(-4)) | -0.101284 | 0.013430 | -7.541699 | 0.0000 |
| C | 7.803750 | 1.075312 | 7.257196 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.214340 | Mean dependent var | 0.029942 |
| Adjusted R-squared | 0.213626 | S.D. dependent var | 59.27939 |
| S.E. of regression | 52.56762 | Akaike info criterion | 10.76317 |
| Sum squared resid | 15195686 | Schwarz criterion | 10.77038 |
| Log likelihood | -29619.62 | Hannan-Quinn criter. | 10.76568 |
| F-statistic | 300.0426 | Durbin-Watson stat | 2.001470 |
| Prob(F-statistic) | 0.000000 | | |

**EViews Output 35: Augmented Dickey - Fuller Test – GPR Daily Threat (Difference Level)**

Null Hypothesis: GPRD_THREAT has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=32)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -11.80195 | 0.0000 |
| Test critical values: | 1% level | -3.431358 | |
| | 5% level | -2.861870 | |
| | 10% level | -2.566988 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GPRD_THREAT)
Method: Least Squares
Date: 05/27/22 Time: 15:23
Sample (adjusted): 4/10/2000 5/13/2021
Included observations: 5504 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| GPRD_THREAT(-1) | -0.128727 | 0.010907 | -11.80195 | 0.0000 |
| D(GPRD_THREAT(-1)) | -0.492915 | 0.015823 | -31.15142 | 0.0000 |
| D(GPRD_THREAT(-2)) | -0.301504 | 0.016696 | -18.05879 | 0.0000 |
| D(GPRD_THREAT(-3)) | -0.218675 | 0.016527 | -13.23155 | 0.0000 |
| D(GPRD_THREAT(-4)) | -0.164360 | 0.015748 | -10.43695 | 0.0000 |
| D(GPRD_THREAT(-5)) | -0.057560 | 0.013492 | -4.266273 | 0.0000 |
| C | 14.60159 | 1.368699 | 10.66823 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.284342 | Mean dependent var | 0.055521 |
| Adjusted R-squared | 0.283561 | S.D. dependent var | 53.24675 |
| S.E. of regression | 45.06950 | Akaike info criterion | 10.45556 |
| Sum squared resid | 11165833 | Schwarz criterion | 10.46397 |
| Log likelihood | -28766.70 | Hannan-Quinn criter. | 10.45849 |
| F-statistic | 364.0074 | Durbin-Watson stat | 2.002252 |
| Prob(F-statistic) | 0.000000 | | |

# Appendix B: Vector Autoregressive Model

This appendix outlines the outputs generated by EViews Student Version 12, in order to set up the VAR estimation model to carry out the VAR Granger Causality/Block Exogeneity Wald test. Reference should be made to Sections 4.3.2 onwards for the interpretation of the statistical results.

## Section I: VAR Lag Order Selection Criteria

**EViews Output 36: VAR Lag Order Selection Criteria – Cocoa**

VAR Lag Order Selection Criteria
Endogenous variables: COCOA_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:08
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -92038.48 | NA | 7.83e+10 | 33.59791 | 33.60153 | 33.59918 |
| 1 | -87132.13 | 9805.532 | 1.31e+10 | 31.81023 | 31.82471 | 31.81528 |
| 2 | -86559.86 | 1143.088 | 1.07e+10 | 31.60462 | 31.62995 | 31.61346 |
| 3 | -86413.04 | 293.1063 | 1.01e+10 | 31.55431 | 31.59050 | 31.56694 |
| 4 | -86347.25 | 131.2614 | 9.94e+09 | 31.53358 | 31.58062 | 31.54999 |
| 5 | -86271.41 | 151.2335 | 9.70e+09 | 31.50919 | 31.56708* | 31.52938* |
| 6 | -86252.07 | 38.55896 | 9.67e+09 | 31.50541 | 31.57416 | 31.52939 |
| 7 | -86239.03 | 25.96316 | 9.65e+09 | 31.50394 | 31.58354 | 31.53171 |
| 8 | -86229.61 | 18.76144 | 9.65e+09 | 31.50378 | 31.59425 | 31.53534 |
| 9 | -86217.15 | 24.79993 | 9.64e+09 | 31.50252 | 31.60384 | 31.53786 |
| 10 | -86197.39 | 39.29062 | 9.60e+09 | 31.49859 | 31.61077 | 31.53772 |
| 11 | -86186.85 | 20.94730 | 9.59e+09 | 31.49803 | 31.62106 | 31.54095 |
| 12 | -86181.48 | 10.66202 | 9.61e+09 | 31.49935 | 31.63324 | 31.54606 |
| 13 | -86170.99 | 20.82165 | 9.60e+09 | 31.49881 | 31.64355 | 31.54931 |
| 14 | -86161.33 | 19.17975 | 9.60e+09 | 31.49857 | 31.65417 | 31.55285 |
| 15 | -86145.82 | 30.76537 | 9.58e+09* | 31.49619* | 31.66264 | 31.55426 |
| 16 | -86141.42 | 8.710755 | 9.59e+09 | 31.49787 | 31.67518 | 31.55973 |
| 17 | -86137.48 | 7.817381 | 9.61e+09 | 31.49972 | 31.68788 | 31.56536 |
| 18 | -86130.74 | 13.34043 | 9.62e+09 | 31.50054 | 31.69956 | 31.56997 |
| 19 | -86124.53 | 12.29269 | 9.63e+09 | 31.50156 | 31.71144 | 31.57478 |
| 20 | -86110.31 | 28.11020 | 9.61e+09 | 31.49966 | 31.72039 | 31.57666 |
| 21 | -86103.28 | 13.90670 | 9.62e+09 | 31.50037 | 31.73196 | 31.58117 |
| 22 | -86086.74 | 32.67014 | 9.59e+09 | 31.49762 | 31.74007 | 31.58220 |
| 23 | -86082.89 | 7.604237 | 9.61e+09 | 31.49950 | 31.75280 | 31.58787 |
| 24 | -86074.68 | 16.19956 | 9.61e+09 | 31.49979 | 31.76395 | 31.59195 |
| 25 | -86069.96 | 9.298308 | 9.63e+09 | 31.50136 | 31.77637 | 31.59730 |
| 26 | -86061.13 | 17.40802 | 9.63e+09 | 31.50142 | 31.78728 | 31.60115 |
| 27 | -86055.78 | 10.54615 | 9.64e+09 | 31.50275 | 31.79947 | 31.60626 |
| 28 | -86050.21 | 10.96320 | 9.65e+09 | 31.50400 | 31.81158 | 31.61130 |
| 29 | -86039.70 | 20.68267* | 9.65e+09 | 31.50345 | 31.82188 | 31.61454 |
| 30 | -86033.81 | 11.58619 | 9.66e+09 | 31.50458 | 31.83387 | 31.61946 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 37: VAR Lag Order Selection Criteria – Coffee**

VAR Lag Order Selection Criteria
Endogenous variables: COFFEE_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:15
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -77155.72 | NA | 3.42e+08 | 28.16526 | 28.16887 | 28.16652 |
| 1 | -72246.79 | 9810.694 | 57253627 | 26.37663 | 26.39111 | 26.38168 |
| 2 | -71676.60 | 1138.914 | 46648530 | 26.17178 | 26.19711 | 26.18062 |
| 3 | -71529.12 | 294.4204 | 44349094 | 26.12123 | 26.15742 | 26.13386 |
| 4 | -71462.82 | 132.2855 | 43431112 | 26.10032 | 26.14736 | 26.11673 |
| 5 | -71387.47 | 150.2519 | 42391921 | 26.07610 | 26.13400* | 26.09630 |
| 6 | -71368.03 | 38.75779 | 42230581 | 26.07229 | 26.14104 | 26.09627* |
| 7 | -71355.90 | 24.15957 | 42182383 | 26.07114 | 26.15075 | 26.09892 |
| 8 | -71344.09 | 23.52145 | 42139069 | 26.07012 | 26.16058 | 26.10168 |
| 9 | -71330.82 | 26.39917 | 42073482 | 26.06856 | 26.16988 | 26.10391 |
| 10 | -71312.98 | 35.46492 | 41938041 | 26.06533 | 26.17751 | 26.10447 |
| 11 | -71302.27 | 21.30136 | 41911766 | 26.06471 | 26.18774 | 26.10763 |
| 12 | -71297.25 | 9.961167 | 41972792 | 26.06616 | 26.20005 | 26.11287 |
| 13 | -71291.72 | 10.98465 | 42025955 | 26.06743 | 26.21217 | 26.11792 |
| 14 | -71279.57 | 24.11167 | 41977649 | 26.06628 | 26.22188 | 26.12056 |
| 15 | -71264.96 | 28.97328 | 41891795 | 26.06423 | 26.23068 | 26.12230 |
| 16 | -71259.96 | 9.905440 | 41953056 | 26.06569 | 26.24300 | 26.12755 |
| 17 | -71255.63 | 8.572497 | 42024687 | 26.06740 | 26.25556 | 26.13304 |
| 18 | -71236.41 | 38.07084 | 41868086 | 26.06366 | 26.26268 | 26.13309 |
| 19 | -71229.71 | 13.24594 | 41903361 | 26.06451 | 26.27438 | 26.13772 |
| 20 | -71216.55 | 26.03442 | 41839736 | 26.06299 | 26.28372 | 26.13999 |
| 21 | -71208.28 | 16.33548 | 41850992 | 26.06325 | 26.29484 | 26.14405 |
| 22 | -71190.39 | 35.35935 | 41715290* | 26.06001* | 26.30245 | 26.14459 |
| 23 | -71186.39 | 7.895755 | 41791534 | 26.06183 | 26.31513 | 26.15020 |
| 24 | -71177.44 | 17.65453* | 41792374 | 26.06185 | 26.32601 | 26.15401 |
| 25 | -71173.12 | 8.521871 | 41863843 | 26.06356 | 26.33857 | 26.15950 |
| 26 | -71168.33 | 9.438065 | 41928285 | 26.06510 | 26.35096 | 26.16483 |
| 27 | -71165.96 | 4.676183 | 42029855 | 26.06752 | 26.36424 | 26.17103 |
| 28 | -71160.49 | 10.75683 | 42084184 | 26.06881 | 26.37638 | 26.17611 |
| 29 | -71154.58 | 11.63732 | 42131658 | 26.06993 | 26.38837 | 26.18102 |
| 30 | -71149.07 | 10.84153 | 42185368 | 26.07121 | 26.40049 | 26.18608 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 38: VAR Lag Order Selection Criteria – Corn**

VAR Lag Order Selection Criteria
Endogenous variables: CORN_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:18
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -83148.07 | NA | 3.05e+09 | 30.35265 | 30.35626 | 30.35391 |
| 1 | -78230.94 | 9827.084 | 5.09e+08 | 28.56103 | 28.57550 | 28.56608 |
| 2 | -77661.71 | 1137.001 | 4.15e+08 | 28.35653 | 28.38186 | 28.36537 |
| 3 | -77514.92 | 293.0512 | 3.94e+08 | 28.30623 | 28.34242 | 28.31886 |
| 4 | -77446.54 | 136.4437 | 3.86e+08 | 28.28455 | 28.33160 | 28.30097 |
| 5 | -77371.73 | 149.1689 | 3.77e+08 | 28.26053 | 28.31843* | 28.28073* |
| 6 | -77355.27 | 32.81936 | 3.76e+08 | 28.25781 | 28.32656 | 28.28179 |
| 7 | -77341.18 | 28.05221 | 3.75e+08 | 28.25595 | 28.33556 | 28.28373 |
| 8 | -77331.42 | 19.43331 | 3.75e+08 | 28.25568 | 28.34614 | 28.28724 |
| 9 | -77315.96 | 30.77372 | 3.74e+08 | 28.25332 | 28.35463 | 28.28866 |
| 10 | -77298.83 | 34.05484 | 3.73e+08 | 28.25035 | 28.36252 | 28.28948 |
| 11 | -77290.91 | 15.74009 | 3.73e+08 | 28.25074 | 28.37378 | 28.29367 |
| 12 | -77277.30 | 27.04574 | 3.72e+08 | 28.24906 | 28.38295 | 28.29577 |
| 13 | -77269.89 | 14.70270 | 3.73e+08 | 28.24964 | 28.39438 | 28.30014 |
| 14 | -77258.54 | 22.52366 | 3.72e+08 | 28.24878 | 28.40438 | 28.30307 |
| 15 | -77242.54 | 31.73105 | 3.71e+08* | 28.24623* | 28.41268 | 28.30430 |
| 16 | -77238.51 | 7.995240 | 3.72e+08 | 28.24804 | 28.42535 | 28.30990 |
| 17 | -77230.34 | 16.17464 | 3.72e+08 | 28.24835 | 28.43651 | 28.31399 |
| 18 | -77223.89 | 12.77115 | 3.72e+08 | 28.24928 | 28.44830 | 28.31871 |
| 19 | -77214.57 | 18.45182 | 3.72e+08 | 28.24916 | 28.45903 | 28.32238 |
| 20 | -77204.11 | 20.69505 | 3.72e+08 | 28.24862 | 28.46936 | 28.32563 |
| 21 | -77200.38 | 7.365874 | 3.73e+08 | 28.25055 | 28.48214 | 28.33134 |
| 22 | -77188.83 | 22.81940* | 3.73e+08 | 28.24962 | 28.49206 | 28.33420 |
| 23 | -77185.81 | 5.952258 | 3.73e+08 | 28.25180 | 28.50510 | 28.34017 |
| 24 | -77178.30 | 14.83153 | 3.74e+08 | 28.25234 | 28.51650 | 28.34450 |
| 25 | -77174.78 | 6.945995 | 3.74e+08 | 28.25434 | 28.52935 | 28.35029 |
| 26 | -77169.95 | 9.518961 | 3.75e+08 | 28.25587 | 28.54173 | 28.35560 |
| 27 | -77165.49 | 8.785628 | 3.76e+08 | 28.25752 | 28.55425 | 28.36104 |
| 28 | -77162.87 | 5.161494 | 3.76e+08 | 28.25985 | 28.56743 | 28.36716 |
| 29 | -77157.32 | 10.91045 | 3.77e+08 | 28.26111 | 28.57955 | 28.37220 |
| 30 | -77155.14 | 4.298476 | 3.78e+08 | 28.26360 | 28.59289 | 28.37848 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 39: VAR Lag Order Selection Criteria – Cotton**

VAR Lag Order Selection Criteria
Endogenous variables: COTTON_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:22
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -73679.99 | NA | 96290278 | 26.89651 | 26.90013 | 26.89777 |
| 1 | -68729.94 | 9892.860 | 15859006 | 25.09288 | 25.10735 | 25.09793 |
| 2 | -68159.81 | 1138.808 | 12921691 | 24.88805 | 24.91338 | 24.89689 |
| 3 | -68013.51 | 292.0637 | 12290039 | 24.83793 | 24.87412 | 24.85055 |
| 4 | -67948.61 | 129.4885 | 12041808 | 24.81753 | 24.86457 | 24.83394 |
| 5 | -67871.42 | 153.9367 | 11745754 | 24.79263 | 24.85053* | 24.81283* |
| 6 | -67853.22 | 36.28171 | 11706358 | 24.78927 | 24.85803 | 24.81326 |
| 7 | -67837.20 | 31.90212 | 11676419 | 24.78671 | 24.86632 | 24.81449 |
| 8 | -67824.46 | 25.36764 | 11660482 | 24.78535 | 24.87581 | 24.81691 |
| 9 | -67811.46 | 25.86638 | 11643471 | 24.78389 | 24.88521 | 24.81923 |
| 10 | -67793.47 | 35.78256 | 11605312 | 24.78060 | 24.89278 | 24.81974 |
| 11 | -67782.11 | 22.56062 | 11595360 | 24.77975 | 24.90278 | 24.82267 |
| 12 | -67775.20 | 13.74503 | 11604172 | 24.78051 | 24.91439 | 24.82721 |
| 13 | -67768.62 | 13.06215 | 11614433 | 24.78139 | 24.92613 | 24.83189 |
| 14 | -67755.16 | 26.69334 | 11595574 | 24.77976 | 24.93536 | 24.83405 |
| 15 | -67738.64 | 32.76683 | 11563781* | 24.77702* | 24.94347 | 24.83509 |
| 16 | -67733.58 | 10.04346 | 11580398 | 24.77845 | 24.95576 | 24.84031 |
| 17 | -67723.23 | 20.48903 | 11574726 | 24.77796 | 24.96613 | 24.84361 |
| 18 | -67714.88 | 16.53417 | 11577473 | 24.77820 | 24.97722 | 24.84763 |
| 19 | -67709.73 | 10.20322 | 11593733 | 24.77960 | 24.98948 | 24.85282 |
| 20 | -67699.97 | 19.29110 | 11590546 | 24.77933 | 25.00006 | 24.85633 |
| 21 | -67687.55 | 24.55998 | 11576069 | 24.77808 | 25.00967 | 24.85887 |
| 22 | -67676.07 | 22.66687 | 11565626 | 24.77718 | 25.01962 | 24.86176 |
| 23 | -67673.36 | 5.354188 | 11592210 | 24.77947 | 25.03277 | 24.86784 |
| 24 | -67663.42 | 19.62266 | 11588223 | 24.77913 | 25.04328 | 24.87128 |
| 25 | -67660.31 | 6.131229 | 11613178 | 24.78128 | 25.05629 | 24.87722 |
| 26 | -67654.51 | 11.42839 | 11626768 | 24.78245 | 25.06831 | 24.88217 |
| 27 | -67651.83 | 5.274415 | 11653642 | 24.78475 | 25.08147 | 24.88827 |
| 28 | -67647.87 | 7.807379 | 11675088 | 24.78659 | 25.09417 | 24.89389 |
| 29 | -67638.88 | 17.68253* | 11675159 | 24.78660 | 25.10503 | 24.89769 |
| 30 | -67634.41 | 8.792805 | 11694488 | 24.78825 | 25.11754 | 24.90313 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 40: VAR Lag Order Selection Criteria – No.11 Sugar**

VAR Lag Order Selection Criteria
Endogenous variables: SUGAR_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:45
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -65570.32 | NA | 4988304. | 23.93624 | 23.93986 | 23.93750 |
| 1 | -60664.04 | 9805.395 | 834803.9 | 22.14858 | 22.16306 | 22.15363 |
| 2 | -60093.70 | 1139.224 | 680134.5 | 21.94368 | 21.96901 | 21.95251 |
| 3 | -59948.02 | 290.8431 | 647031.8 | 21.89378 | 21.92997 | 21.90641 |
| 4 | -59882.78 | 130.1661 | 633884.7 | 21.87325 | 21.92029 | 21.88966 |
| 5 | -59802.18 | 160.7167 | 617533.4 | 21.84712 | 21.90502* | 21.86732* |
| 6 | -59785.92 | 32.41193 | 615898.5 | 21.84447 | 21.91322 | 21.86845 |
| 7 | -59772.56 | 26.62101 | 614918.2 | 21.84288 | 21.92248 | 21.87065 |
| 8 | -59762.58 | 19.86837 | 614698.3 | 21.84252 | 21.93298 | 21.87408 |
| 9 | -59745.68 | 33.61732 | 612929.4 | 21.83964 | 21.94096 | 21.87498 |
| 10 | -59721.88 | 47.33400 | 609626.7 | 21.83423 | 21.94641 | 21.87337 |
| 11 | -59709.11 | 25.37652 | 608789.0 | 21.83286 | 21.95589 | 21.87578 |
| 12 | -59704.38 | 9.408314 | 609737.4 | 21.83441 | 21.96830 | 21.88112 |
| 13 | -59695.86 | 16.91883 | 609843.9 | 21.83459 | 21.97933 | 21.88508 |
| 14 | -59686.62 | 18.32930 | 609791.3 | 21.83450 | 21.99010 | 21.88878 |
| 15 | -59668.24 | 36.44197 | 607708.1* | 21.83108* | 21.99753 | 21.88915 |
| 16 | -59659.96 | 16.41874 | 607867.2 | 21.83134 | 22.00865 | 21.89320 |
| 17 | -59654.59 | 10.62997 | 608674.3 | 21.83267 | 22.02083 | 21.89831 |
| 18 | -59648.63 | 11.81706 | 609348.4 | 21.83377 | 22.03279 | 21.90321 |
| 19 | -59640.52 | 16.03594 | 609548.0 | 21.83410 | 22.04398 | 21.90732 |
| 20 | -59630.30 | 20.21207 | 609276.9 | 21.83366 | 22.05439 | 21.91066 |
| 21 | -59623.61 | 13.23569 | 609789.8 | 21.83450 | 22.06608 | 21.91529 |
| 22 | -59612.99 | 20.97833 | 609429.8 | 21.83391 | 22.07635 | 21.91849 |
| 23 | -59611.47 | 2.996325 | 611096.9 | 21.83664 | 22.08994 | 21.92501 |
| 24 | -59603.97 | 14.79999 | 611432.0 | 21.83719 | 22.10134 | 21.92934 |
| 25 | -59600.31 | 7.218950 | 612625.3 | 21.83913 | 22.11414 | 21.93508 |
| 26 | -59594.17 | 12.10479 | 613265.4 | 21.84018 | 22.12604 | 21.93991 |
| 27 | -59590.13 | 7.951755 | 614378.0 | 21.84199 | 22.13871 | 21.94551 |
| 28 | -59577.45 | 24.97959* | 613552.3 | 21.84064 | 22.14822 | 21.94795 |
| 29 | -59570.50 | 13.67718 | 614012.0 | 21.84139 | 22.15983 | 21.95248 |
| 30 | -59562.00 | 16.70826 | 614125.7 | 21.84158 | 22.17086 | 21.95645 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion

**EViews Output 41: VAR Lag Order Selection Criteria – Oats**

VAR Lag Order Selection Criteria
Endogenous variables: OATS_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:26
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -81958.28 | NA | 1.98e+09 | 29.91833 | 29.92195 | 29.91960 |
| 1 | -77024.19 | 9860.969 | 3.27e+08 | 28.12053 | 28.13500 | 28.12558 |
| 2 | -76448.58 | 1149.744 | 2.66e+08 | 27.91370 | 27.93903 | 27.92254 |
| 3 | -76297.78 | 301.0501 | 2.53e+08 | 27.86194 | 27.89812 | 27.87456 |
| 4 | -76230.37 | 134.5038 | 2.48e+08 | 27.84062 | 27.88766 | 27.85703 |
| 5 | -76153.13 | 154.0334 | 2.41e+08 | 27.81571 | 27.87360* | 27.83590 |
| 6 | -76133.05 | 40.01988 | 2.40e+08 | 27.81166 | 27.88041 | 27.83565* |
| 7 | -76120.21 | 25.56802 | 2.40e+08 | 27.81026 | 27.88987 | 27.83803 |
| 8 | -76106.73 | 26.84762 | 2.40e+08 | 27.80862 | 27.89909 | 27.84018 |
| 9 | -76092.95 | 27.41896 | 2.39e+08 | 27.80688 | 27.90820 | 27.84223 |
| 10 | -76070.04 | 45.55036 | 2.38e+08 | 27.80180 | 27.91398 | 27.84094 |
| 11 | -76053.74 | 32.40869 | 2.37e+08 | 27.79914 | 27.92217 | 27.84206 |
| 12 | -76047.10 | 13.17931 | 2.38e+08 | 27.80000 | 27.93389 | 27.84671 |
| 13 | -76039.74 | 14.61080 | 2.38e+08 | 27.80060 | 27.94534 | 27.85110 |
| 14 | -76027.29 | 24.71130 | 2.38e+08 | 27.79934 | 27.95494 | 27.85362 |
| 15 | -76014.38 | 25.60762 | 2.37e+08* | 27.79791* | 27.96436 | 27.85598 |
| 16 | -76010.03 | 8.613023 | 2.38e+08 | 27.79961 | 27.97692 | 27.86147 |
| 17 | -76005.15 | 9.671227 | 2.38e+08 | 27.80111 | 27.98928 | 27.86676 |
| 18 | -75997.77 | 14.61303 | 2.38e+08 | 27.80170 | 28.00072 | 27.87114 |
| 19 | -75987.59 | 20.13860 | 2.38e+08 | 27.80128 | 28.01115 | 27.87449 |
| 20 | -75974.13 | 26.62134 | 2.38e+08 | 27.79965 | 28.02038 | 27.87665 |
| 21 | -75965.22 | 17.62611 | 2.38e+08 | 27.79968 | 28.03126 | 27.88047 |
| 22 | -75954.42 | 21.31781 | 2.37e+08 | 27.79902 | 28.04147 | 27.88360 |
| 23 | -75951.72 | 5.333873 | 2.38e+08 | 27.80132 | 28.05462 | 27.88969 |
| 24 | -75938.40 | 26.28971* | 2.38e+08 | 27.79974 | 28.06390 | 27.89190 |
| 25 | -75930.72 | 15.15462 | 2.38e+08 | 27.80023 | 28.07523 | 27.89617 |
| 26 | -75923.29 | 14.63777 | 2.38e+08 | 27.80080 | 28.08667 | 27.90053 |
| 27 | -75919.51 | 7.444136 | 2.38e+08 | 27.80271 | 28.09943 | 27.90622 |
| 28 | -75914.49 | 9.893978 | 2.39e+08 | 27.80416 | 28.11173 | 27.91146 |
| 29 | -75907.00 | 14.74238 | 2.39e+08 | 27.80471 | 28.12314 | 27.91580 |
| 30 | -75902.59 | 8.671557 | 2.39e+08 | 27.80638 | 28.13567 | 27.92126 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 42: VAR Lag Order Selection Criteria – Rough Rice**

VAR Lag Order Selection Criteria
Endogenous variables: ROUGH_RICE_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:35
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -62840.47 | NA | 1841571. | 22.93976 | 22.94338 | 22.94102 |
| 1 | -57886.60 | 9900.508 | 302883.3 | 21.13473 | 21.14921 | 21.13978 |
| 2 | -57317.00 | 1137.761 | 246832.2 | 20.93010 | 20.95543 | 20.93893 |
| 3 | -57171.43 | 290.5973 | 234829.3 | 20.88025 | 20.91643 | 20.89287 |
| 4 | -57103.81 | 134.9176 | 229857.8 | 20.85885 | 20.90589 | 20.87526 |
| 5 | -57026.85 | 153.4806 | 224225.4 | 20.83404 | 20.89194* | 20.85424* |
| 6 | -57010.56 | 32.46287 | 223629.7 | 20.83138 | 20.90013 | 20.85536 |
| 7 | -56997.39 | 26.23490 | 223289.5 | 20.82986 | 20.90946 | 20.85763 |
| 8 | -56988.60 | 17.50672 | 223306.4 | 20.82993 | 20.92039 | 20.86149 |
| 9 | -56968.80 | 39.38117 | 222428.5 | 20.82599 | 20.92731 | 20.86134 |
| 10 | -56942.55 | 52.21574 | 221031.8 | 20.81969 | 20.93187 | 20.85883 |
| 11 | -56932.20 | 20.56888 | 220923.0 | 20.81920 | 20.94223 | 20.86212 |
| 12 | -56927.63 | 9.076635 | 221280.6 | 20.82082 | 20.95470 | 20.86753 |
| 13 | -56923.58 | 8.044977 | 221680.7 | 20.82262 | 20.96737 | 20.87312 |
| 14 | -56913.33 | 20.32630 | 221580.1 | 20.82217 | 20.97777 | 20.87645 |
| 15 | -56893.78 | 38.78548 | 220728.0* | 20.81832* | 20.98477 | 20.87639 |
| 16 | -56887.84 | 11.77708 | 220974.6 | 20.81943 | 20.99674 | 20.88129 |
| 17 | -56884.29 | 7.030249 | 221414.8 | 20.82142 | 21.00959 | 20.88707 |
| 18 | -56880.74 | 7.025836 | 221855.9 | 20.82341 | 21.02243 | 20.89284 |
| 19 | -56874.16 | 13.01982 | 222052.1 | 20.82430 | 21.03417 | 20.89751 |
| 20 | -56865.93 | 16.27937 | 222114.5 | 20.82458 | 21.04531 | 20.90158 |
| 21 | -56857.69 | 16.29229 | 222176.0 | 20.82485 | 21.05644 | 20.90565 |
| 22 | -56847.02 | 21.07048 | 222041.1 | 20.82425 | 21.06669 | 20.90883 |
| 23 | -56844.83 | 4.331261 | 222593.5 | 20.82673 | 21.08003 | 20.91510 |
| 24 | -56829.81 | 29.63909 | 222105.1 | 20.82453 | 21.08869 | 20.91669 |
| 25 | -56823.63 | 12.17473 | 222334.5 | 20.82556 | 21.10057 | 20.92151 |
| 26 | -56814.75 | 17.50908 | 222344.2 | 20.82561 | 21.11147 | 20.92534 |
| 27 | -56810.39 | 8.598952 | 222720.9 | 20.82730 | 21.12402 | 20.93081 |
| 28 | -56807.59 | 5.506772 | 223225.9 | 20.82956 | 21.13714 | 20.93687 |
| 29 | -56798.54 | 17.80199* | 223222.3 | 20.82955 | 21.14798 | 20.94064 |
| 30 | -56795.85 | 5.288801 | 223737.4 | 20.83185 | 21.16114 | 20.94673 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion

**EViews Output 43: VAR Lag Order Selection Criteria – Soybean**

VAR Lag Order Selection Criteria
Endogenous variables: SOYBEAN_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:38
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -86761.58 | NA | 1.14e+10 | 31.67168 | 31.67530 | 31.67295 |
| 1 | -81851.69 | 9812.603 | 1.91e+09 | 29.88271 | 29.89719 | 29.88776 |
| 2 | -81282.12 | 1137.693 | 1.55e+09 | 29.67809 | 29.70342 | 29.68692 |
| 3 | -81138.14 | 287.4279 | 1.48e+09 | 29.62882 | 29.66500 | 29.64144 |
| 4 | -81069.07 | 137.8053 | 1.45e+09 | 29.60689 | 29.65393 | 29.62330 |
| 5 | -80993.26 | 151.1887 | 1.41e+09 | 29.58250 | 29.64040* | 29.60270 |
| 6 | -80973.84 | 38.69486 | 1.41e+09 | 29.57870 | 29.64745 | 29.60268* |
| 7 | -80960.40 | 26.76960 | 1.41e+09 | 29.57708 | 29.65669 | 29.60485 |
| 8 | -80943.72 | 33.21528 | 1.40e+09 | 29.57427 | 29.66474 | 29.60583 |
| 9 | -80923.31 | 40.61822 | 1.40e+09 | 29.57011 | 29.67143 | 29.60545 |
| 10 | -80905.01 | 36.39519 | 1.39e+09 | 29.56671 | 29.67889 | 29.60585 |
| 11 | -80894.92 | 20.04918 | 1.39e+09 | 29.56631 | 29.68935 | 29.60924 |
| 12 | -80890.71 | 8.361706 | 1.39e+09 | 29.56806 | 29.70195 | 29.61477 |
| 13 | -80885.17 | 10.98963 | 1.39e+09 | 29.56933 | 29.71407 | 29.61982 |
| 14 | -80873.76 | 22.64916 | 1.39e+09 | 29.56845 | 29.72404 | 29.62273 |
| 15 | -80856.13 | 34.96592 | 1.39e+09* | 29.56530* | 29.73175 | 29.62337 |
| 16 | -80851.02 | 10.13356 | 1.39e+09 | 29.56672 | 29.74402 | 29.62857 |
| 17 | -80844.23 | 13.44666 | 1.39e+09 | 29.56752 | 29.75569 | 29.63317 |
| 18 | -80837.74 | 12.85326 | 1.39e+09 | 29.56844 | 29.76746 | 29.63787 |
| 19 | -80829.96 | 15.39030 | 1.39e+09 | 29.56888 | 29.77876 | 29.64210 |
| 20 | -80820.65 | 18.42199 | 1.39e+09 | 29.56877 | 29.78950 | 29.64578 |
| 21 | -80813.76 | 13.61356 | 1.39e+09 | 29.56954 | 29.80113 | 29.65033 |
| 22 | -80803.49 | 20.27593* | 1.39e+09 | 29.56908 | 29.81152 | 29.65366 |
| 23 | -80799.11 | 8.651886 | 1.40e+09 | 29.57077 | 29.82406 | 29.65913 |
| 24 | -80791.64 | 14.74376 | 1.40e+09 | 29.57132 | 29.83548 | 29.66348 |
| 25 | -80783.67 | 15.72787 | 1.40e+09 | 29.57170 | 29.84671 | 29.66764 |
| 26 | -80775.39 | 16.31722 | 1.40e+09 | 29.57196 | 29.85783 | 29.67169 |
| 27 | -80774.03 | 2.679733 | 1.40e+09 | 29.57475 | 29.87147 | 29.67827 |
| 28 | -80770.44 | 7.058136 | 1.40e+09 | 29.57673 | 29.88430 | 29.68403 |
| 29 | -80765.27 | 10.18286 | 1.41e+09 | 29.57812 | 29.89656 | 29.68921 |
| 30 | -80764.56 | 1.393840 | 1.41e+09 | 29.58115 | 29.91044 | 29.69603 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 44: VAR Lag Order Selection Criteria – Soybean Oil**

VAR Lag Order Selection Criteria
Endogenous variables: SOYBEAN_OIL_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:41
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -68703.54 | NA | 15655369 | 25.07996 | 25.08357 | 25.08122 |
| 1 | -63787.71 | 9824.483 | 2610843. | 23.28881 | 23.30329 | 23.29386 |
| 2 | -63218.49 | 1136.987 | 2127985. | 23.08432 | 23.10965 | 23.09315 |
| 3 | -63072.71 | 291.0265 | 2024347. | 23.03439 | 23.07057 | 23.04701 |
| 4 | -63005.02 | 135.0493 | 1981443. | 23.01297 | 23.06001 | 23.02938 |
| 5 | -62931.86 | 145.9032 | 1935572. | 22.98954 | 23.04744* | 23.00974* |
| 6 | -62915.89 | 31.82443 | 1930655. | 22.98700 | 23.05575 | 23.01099 |
| 7 | -62901.91 | 27.84295 | 1927151. | 22.98518 | 23.06479 | 23.01296 |
| 8 | -62891.18 | 21.37453 | 1925930. | 22.98455 | 23.07501 | 23.01611 |
| 9 | -62873.70 | 34.76942 | 1919982. | 22.98146 | 23.08278 | 23.01680 |
| 10 | -62852.51 | 42.14885 | 1911455. | 22.97701 | 23.08918 | 23.01614 |
| 11 | -62839.22 | 26.41481 | 1908464. | 22.97544 | 23.09847 | 23.01836 |
| 12 | -62835.08 | 8.211224 | 1911857. | 22.97722 | 23.11110 | 23.02392 |
| 13 | -62827.98 | 14.10282 | 1913182. | 22.97791 | 23.12265 | 23.02840 |
| 14 | -62817.65 | 20.49597 | 1912254. | 22.97742 | 23.13302 | 23.03171 |
| 15 | -62798.21 | 38.55218 | 1904982.* | 22.97361* | 23.14007 | 23.03168 |
| 16 | -62794.99 | 6.380309 | 1909006. | 22.97572 | 23.15303 | 23.03758 |
| 17 | -62786.29 | 17.24363 | 1909213. | 22.97583 | 23.16400 | 23.04148 |
| 18 | -62781.64 | 9.214455 | 1912245. | 22.97742 | 23.17644 | 23.04685 |
| 19 | -62772.08 | 18.91408 | 1911856. | 22.97721 | 23.18709 | 23.05043 |
| 20 | -62762.34 | 19.25008 | 1911345. | 22.97695 | 23.19768 | 23.05395 |
| 21 | -62757.59 | 9.387080 | 1914314. | 22.97850 | 23.21008 | 23.05929 |
| 22 | -62739.28 | 36.18546* | 1907815. | 22.97510 | 23.21754 | 23.05968 |
| 23 | -62735.78 | 6.905778 | 1911652. | 22.97711 | 23.23040 | 23.06547 |
| 24 | -62728.35 | 14.66927 | 1912747. | 22.97768 | 23.24183 | 23.06983 |
| 25 | -62721.80 | 12.91850 | 1914459. | 22.97857 | 23.25358 | 23.07451 |
| 26 | -62716.77 | 9.905175 | 1917240. | 22.98002 | 23.26589 | 23.07975 |
| 27 | -62710.17 | 12.99979 | 1918923. | 22.98090 | 23.27762 | 23.08441 |
| 28 | -62705.10 | 9.996852 | 1921674. | 22.98233 | 23.28991 | 23.08963 |
| 29 | -62698.70 | 12.58537 | 1923504. | 22.98328 | 23.30171 | 23.09437 |
| 30 | -62696.06 | 5.187232 | 1927978. | 22.98560 | 23.31489 | 23.10048 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**EViews Output 45: VAR Lag Order Selection Criteria – Wheat**

VAR Lag Order Selection Criteria
Endogenous variables: WHEAT_LAST_PRICE1 GPRD_ACT GPRD_THREAT
Exogenous variables: C
Date: 05/27/22 Time: 20:49
Sample: 3/31/2000 3/03/2022
Included observations: 5479

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -85469.74 | NA | 7.12e+09 | 31.20012 | 31.20374 | 31.20138 |
| 1 | -80544.34 | 9843.602 | 1.18e+09 | 29.40549 | 29.41996 | 29.41054 |
| 2 | -79977.59 | 1132.043 | 9.66e+08 | 29.20190 | 29.22723 | 29.21073 |
| 3 | -79815.63 | 323.3295 | 9.13e+08 | 29.14606 | 29.18225 | 29.15868 |
| 4 | -79748.78 | 133.3819 | 8.94e+08 | 29.12494 | 29.17198 | 29.14135 |
| 5 | -79669.45 | 158.2102 | 8.71e+08 | 29.09927 | 29.15717* | 29.11947* |
| 6 | -79652.06 | 34.64959 | 8.69e+08 | 29.09621 | 29.16496 | 29.12019 |
| 7 | -79631.95 | 40.05369 | 8.65e+08 | 29.09215 | 29.17176 | 29.11993 |
| 8 | -79622.42 | 18.99082 | 8.65e+08 | 29.09196 | 29.18242 | 29.12352 |
| 9 | -79605.90 | 32.86366 | 8.63e+08 | 29.08921 | 29.19053 | 29.12456 |
| 10 | -79586.21 | 39.15203 | 8.59e+08 | 29.08531 | 29.19749 | 29.12445 |
| 11 | -79576.10 | 20.09717 | 8.59e+08 | 29.08491 | 29.20794 | 29.12783 |
| 12 | -79571.35 | 9.434889 | 8.60e+08 | 29.08646 | 29.22034 | 29.13317 |
| 13 | -79565.19 | 12.23780 | 8.61e+08 | 29.08749 | 29.23223 | 29.13799 |
| 14 | -79551.20 | 27.74567 | 8.60e+08 | 29.08567 | 29.24127 | 29.13996 |
| 15 | -79533.54 | 35.02909 | 8.57e+08 | 29.08251 | 29.24897 | 29.14058 |
| 16 | -79526.55 | 13.84861 | 8.58e+08 | 29.08325 | 29.26056 | 29.14510 |
| 17 | -79516.72 | 19.47979 | 8.57e+08 | 29.08294 | 29.27111 | 29.14859 |
| 18 | -79512.52 | 8.320633 | 8.59e+08 | 29.08469 | 29.28371 | 29.15413 |
| 19 | -79503.93 | 16.99462 | 8.59e+08 | 29.08484 | 29.29472 | 29.15806 |
| 20 | -79492.97 | 21.66714 | 8.58e+08 | 29.08413 | 29.30486 | 29.16114 |
| 21 | -79485.74 | 14.30761 | 8.59e+08 | 29.08477 | 29.31636 | 29.16557 |
| 22 | -79466.22 | 38.56509 | 8.56e+08 | 29.08093 | 29.32338 | 29.16551 |
| 23 | -79455.99 | 20.18504 | 8.55e+08* | 29.08049* | 29.33378 | 29.16885 |
| 24 | -79447.86 | 16.05646 | 8.55e+08 | 29.08080 | 29.34496 | 29.17296 |
| 25 | -79443.99 | 7.628931 | 8.57e+08 | 29.08267 | 29.35768 | 29.17862 |
| 26 | -79438.67 | 10.48228 | 8.58e+08 | 29.08402 | 29.36988 | 29.18375 |
| 27 | -79434.54 | 8.129575 | 8.60e+08 | 29.08580 | 29.38252 | 29.18931 |
| 28 | -79430.81 | 7.347858 | 8.61e+08 | 29.08772 | 29.39530 | 29.19502 |
| 29 | -79420.32 | 20.65181* | 8.61e+08 | 29.08718 | 29.40561 | 29.19827 |
| 30 | -79416.22 | 8.063509 | 8.62e+08 | 29.08896 | 29.41825 | 29.20384 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

## Section II: VAR Residual Serial Correlation LM Test

**EViews Output 46: VAR Residual Serial Correlation LM Test – Cocoa**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:12
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.933438 | 9 | 0.5409 | 0.881524 | (9, 13178.8) | 0.5409 |
| 2 | 9.822516 | 9 | 0.3650 | 1.091507 | (9, 13178.8) | 0.3650 |
| 3 | 14.05891 | 9 | 0.1202 | 1.562519 | (9, 13178.8) | 0.1202 |
| 4 | 11.30507 | 9 | 0.2554 | 1.256324 | (9, 13178.8) | 0.2554 |
| 5 | 25.24804 | 9 | 0.0027 | 2.807281 | (9, 13178.8) | 0.0027 |
| 6 | 16.25945 | 9 | 0.0617 | 1.807240 | (9, 13178.8) | 0.0617 |
| 7 | 17.53144 | 9 | 0.0410 | 1.948716 | (9, 13178.8) | 0.0410 |
| 8 | 12.30991 | 9 | 0.1964 | 1.368043 | (9, 13178.8) | 0.1964 |
| 9 | 19.38829 | 9 | 0.0221 | 2.155267 | (9, 13178.8) | 0.0221 |
| 10 | 12.12485 | 9 | 0.2064 | 1.347467 | (9, 13178.8) | 0.2064 |
| 11 | 14.97284 | 9 | 0.0917 | 1.664152 | (9, 13178.8) | 0.0917 |
| 12 | 10.53446 | 9 | 0.3090 | 1.170653 | (9, 13178.8) | 0.3090 |
| 13 | 20.76065 | 9 | 0.0138 | 2.307943 | (9, 13178.8) | 0.0138 |
| 14 | 16.38377 | 9 | 0.0593 | 1.821066 | (9, 13178.8) | 0.0593 |
| 15 | 13.57828 | 9 | 0.1381 | 1.509074 | (9, 13178.8) | 0.1381 |
| 16 | 17.42012 | 9 | 0.0425 | 1.936334 | (9, 13178.8) | 0.0425 |
| 17 | 12.14989 | 9 | 0.2050 | 1.350252 | (9, 13178.8) | 0.2050 |
| 18 | 12.50183 | 9 | 0.1865 | 1.389382 | (9, 13178.8) | 0.1865 |
| 19 | 6.468492 | 9 | 0.6923 | 0.718707 | (9, 13178.8) | 0.6923 |
| 20 | 13.39297 | 9 | 0.1456 | 1.488468 | (9, 13178.8) | 0.1456 |
| 21 | 5.894679 | 9 | 0.7504 | 0.654937 | (9, 13178.8) | 0.7504 |
| 22 | 4.841682 | 9 | 0.8479 | 0.537921 | (9, 13178.8) | 0.8479 |
| 23 | 10.36107 | 9 | 0.3221 | 1.151377 | (9, 13178.8) | 0.3221 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.933438 | 9 | 0.5409 | 0.881524 | (9, 13178.8) | 0.5409 |
| 2 | 17.85579 | 18 | 0.4652 | 0.992048 | (18, 15307.9) | 0.4652 |
| 3 | 29.60873 | 27 | 0.3320 | 1.096779 | (27, 15797.7) | 0.3320 |
| 4 | 38.37751 | 36 | 0.3622 | 1.066187 | (36, 15973.4) | 0.3622 |
| 5 | 54.52956 | 45 | 0.1561 | 1.212202 | (45, 16051.7) | 0.1561 |
| 6 | 61.90371 | 54 | 0.2148 | 1.146717 | (54, 16090.7) | 0.2148 |
| 7 | 81.20310 | 63 | 0.0611 | 1.289744 | (63, 16110.8) | 0.0611 |
| 8 | 90.26154 | 72 | 0.0716 | 1.254418 | (72, 16120.7) | 0.0716 |
| 9 | 99.15709 | 81 | 0.0833 | 1.224923 | (81, 16124.8) | 0.0833 |
| 10 | 109.5833 | 90 | 0.0786 | 1.218403 | (90, 16125.1) | 0.0786 |
| 11 | 121.1001 | 99 | 0.0651 | 1.224143 | (99, 16123.0) | 0.0651 |
| 12 | 127.0786 | 108 | 0.1014 | 1.177417 | (108, 16119... | 0.1014 |
| 13 | 136.7149 | 117 | 0.1028 | 1.169284 | (117, 16114... | 0.1028 |
| 14 | 144.1116 | 126 | 0.1288 | 1.144450 | (126, 16108... | 0.1288 |
| 15 | 157.4007 | 135 | 0.0910 | 1.166806 | (135, 16102... | 0.0910 |
| 16 | 170.3475 | 144 | 0.0661 | 1.184001 | (144, 16095... | 0.0661 |
| 17 | 181.8958 | 153 | 0.0553 | 1.189991 | (153, 16088... | 0.0553 |
| 18 | 185.6342 | 162 | 0.0984 | 1.146791 | (162, 16080... | 0.0984 |
| 19 | 196.8182 | 171 | 0.0858 | 1.151966 | (171, 16073... | 0.0858 |
| 20 | 203.8551 | 180 | 0.1074 | 1.133425 | (180, 16065... | 0.1074 |
| 21 | 215.3282 | 189 | 0.0918 | 1.140291 | (189, 16057... | 0.0918 |
| 22 | 225.8812 | 198 | 0.0848 | 1.141859 | (198, 16048... | 0.0848 |
| 23 | 235.4378 | 207 | 0.0852 | 1.138440 | (207, 16040... | 0.0853 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 47: VAR Residual Serial Correlation LM Test – Coffee**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:16
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 4.929871 | 9 | 0.8404 | 0.547720 | (9, 13178.8) | 0.8404 |
| 2 | 17.54737 | 9 | 0.0408 | 1.950488 | (9, 13178.8) | 0.0408 |
| 3 | 12.29695 | 9 | 0.1971 | 1.366602 | (9, 13178.8) | 0.1971 |
| 4 | 11.93813 | 9 | 0.2168 | 1.326708 | (9, 13178.8) | 0.2168 |
| 5 | 6.812738 | 9 | 0.6566 | 0.756965 | (9, 13178.8) | 0.6566 |
| 6 | 16.81315 | 9 | 0.0517 | 1.868823 | (9, 13178.8) | 0.0517 |
| 7 | 9.216978 | 9 | 0.4175 | 1.024195 | (9, 13178.8) | 0.4175 |
| 8 | 10.69777 | 9 | 0.2970 | 1.188808 | (9, 13178.8) | 0.2970 |
| 9 | 6.160071 | 9 | 0.7238 | 0.684430 | (9, 13178.8) | 0.7238 |
| 10 | 18.04670 | 9 | 0.0346 | 2.006029 | (9, 13178.8) | 0.0346 |
| 11 | 16.39573 | 9 | 0.0591 | 1.822397 | (9, 13178.8) | 0.0591 |
| 12 | 9.998598 | 9 | 0.3506 | 1.111082 | (9, 13178.8) | 0.3506 |
| 13 | 10.43266 | 9 | 0.3166 | 1.159335 | (9, 13178.8) | 0.3166 |
| 14 | 8.942322 | 9 | 0.4426 | 0.993665 | (9, 13178.8) | 0.4426 |
| 15 | 9.650424 | 9 | 0.3795 | 1.072377 | (9, 13178.8) | 0.3795 |
| 16 | 16.69053 | 9 | 0.0538 | 1.855185 | (9, 13178.8) | 0.0538 |
| 17 | 6.559502 | 9 | 0.6829 | 0.728821 | (9, 13178.8) | 0.6829 |
| 18 | 9.849901 | 9 | 0.3628 | 1.094552 | (9, 13178.8) | 0.3628 |
| 19 | 5.468641 | 9 | 0.7917 | 0.607592 | (9, 13178.8) | 0.7917 |
| 20 | 15.47372 | 9 | 0.0787 | 1.719854 | (9, 13178.8) | 0.0787 |
| 21 | 5.609121 | 9 | 0.7783 | 0.623203 | (9, 13178.8) | 0.7783 |
| 22 | 4.807448 | 9 | 0.8508 | 0.534116 | (9, 13178.8) | 0.8508 |
| 23 | 11.21598 | 9 | 0.2612 | 1.246419 | (9, 13178.8) | 0.2612 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 4.929871 | 9 | 0.8404 | 0.547720 | (9, 13178.8) | 0.8404 |
| 2 | 23.93630 | 18 | 0.1571 | 1.330139 | (18, 15307.9) | 0.1571 |
| 3 | 30.98437 | 27 | 0.2718 | 1.147786 | (27, 15797.7) | 0.2718 |
| 4 | 41.35681 | 36 | 0.2482 | 1.149064 | (36, 15973.4) | 0.2482 |
| 5 | 43.95605 | 45 | 0.5161 | 0.976830 | (45, 16051.7) | 0.5161 |
| 6 | 51.05234 | 54 | 0.5888 | 0.945385 | (54, 16090.7) | 0.5888 |
| 7 | 59.89932 | 63 | 0.5875 | 0.950749 | (63, 16110.8) | 0.5875 |
| 8 | 70.10463 | 72 | 0.5413 | 0.973677 | (72, 16120.7) | 0.5413 |
| 9 | 75.96732 | 81 | 0.6373 | 0.937778 | (81, 16124.8) | 0.6373 |
| 10 | 78.65962 | 90 | 0.7977 | 0.873741 | (90, 16125.1) | 0.7977 |
| 11 | 91.11197 | 99 | 0.7014 | 0.920152 | (99, 16123.0) | 0.7014 |
| 12 | 99.00797 | 108 | 0.7204 | 0.916539 | (108, 16119... | 0.7204 |
| 13 | 109.1378 | 117 | 0.6851 | 0.932628 | (117, 16114... | 0.6851 |
| 14 | 121.8382 | 126 | 0.5882 | 0.966901 | (126, 16108... | 0.5882 |
| 15 | 134.9832 | 135 | 0.4842 | 0.999932 | (135, 16102... | 0.4842 |
| 16 | 141.6562 | 144 | 0.5396 | 0.983707 | (144, 16095... | 0.5397 |
| 17 | 157.2039 | 153 | 0.3912 | 1.027667 | (153, 16088... | 0.3912 |
| 18 | 169.2026 | 162 | 0.3331 | 1.044750 | (162, 16080... | 0.3332 |
| 19 | 173.6966 | 171 | 0.4282 | 1.015908 | (171, 16073... | 0.4282 |
| 20 | 179.0551 | 180 | 0.5059 | 0.994773 | (180, 16065... | 0.5059 |
| 21 | 183.5702 | 189 | 0.5978 | 0.971157 | (189, 16057... | 0.5978 |
| 22 | 198.3033 | 198 | 0.4806 | 1.001591 | (198, 16048... | 0.4806 |
| 23 | 205.7742 | 207 | 0.5110 | 0.994089 | (207, 16040... | 0.5111 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 48: VAR Residual Serial Correlation LM Test – Corn**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:21
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.022128 | 9 | 0.7377 | 0.669100 | (9, 13178.8) | 0.7377 |
| 2 | 14.79989 | 9 | 0.0966 | 1.644919 | (9, 13178.8) | 0.0966 |
| 3 | 9.023302 | 9 | 0.4351 | 1.002666 | (9, 13178.8) | 0.4351 |
| 4 | 9.005122 | 9 | 0.4368 | 1.000645 | (9, 13178.8) | 0.4368 |
| 5 | 8.721489 | 9 | 0.4634 | 0.969118 | (9, 13178.8) | 0.4634 |
| 6 | 8.574885 | 9 | 0.4774 | 0.952822 | (9, 13178.8) | 0.4774 |
| 7 | 15.17424 | 9 | 0.0863 | 1.686549 | (9, 13178.8) | 0.0863 |
| 8 | 6.157265 | 9 | 0.7241 | 0.684119 | (9, 13178.8) | 0.7241 |
| 9 | 7.293474 | 9 | 0.6066 | 0.810395 | (9, 13178.8) | 0.6066 |
| 10 | 10.40118 | 9 | 0.3190 | 1.155836 | (9, 13178.8) | 0.3190 |
| 11 | 15.65013 | 9 | 0.0746 | 1.739474 | (9, 13178.8) | 0.0746 |
| 12 | 12.72918 | 9 | 0.1752 | 1.414661 | (9, 13178.8) | 0.1752 |
| 13 | 11.93624 | 9 | 0.2169 | 1.326497 | (9, 13178.8) | 0.2169 |
| 14 | 8.122186 | 9 | 0.5219 | 0.902504 | (9, 13178.8) | 0.5219 |
| 15 | 5.489363 | 9 | 0.7897 | 0.609894 | (9, 13178.8) | 0.7897 |
| 16 | 6.129047 | 9 | 0.7269 | 0.680983 | (9, 13178.8) | 0.7269 |
| 17 | 5.141571 | 9 | 0.8218 | 0.571245 | (9, 13178.8) | 0.8218 |
| 18 | 11.38241 | 9 | 0.2504 | 1.264923 | (9, 13178.8) | 0.2504 |
| 19 | 5.130475 | 9 | 0.8228 | 0.570012 | (9, 13178.8) | 0.8228 |
| 20 | 6.360830 | 9 | 0.7033 | 0.706742 | (9, 13178.8) | 0.7033 |
| 21 | 5.752943 | 9 | 0.7644 | 0.639186 | (9, 13178.8) | 0.7644 |
| 22 | 8.601765 | 9 | 0.4748 | 0.955810 | (9, 13178.8) | 0.4748 |
| 23 | 10.30560 | 9 | 0.3263 | 1.145210 | (9, 13178.8) | 0.3263 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.022128 | 9 | 0.7377 | 0.669100 | (9, 13178.8) | 0.7377 |
| 2 | 19.84433 | 18 | 0.3417 | 1.102601 | (18, 15307.9) | 0.3417 |
| 3 | 24.87658 | 27 | 0.5814 | 0.921351 | (27, 15797.7) | 0.5814 |
| 4 | 32.58470 | 36 | 0.6318 | 0.905090 | (36, 15973.4) | 0.6318 |
| 5 | 40.65463 | 45 | 0.6564 | 0.903370 | (45, 16051.7) | 0.6564 |
| 6 | 44.36254 | 54 | 0.8222 | 0.821333 | (54, 16090.7) | 0.8222 |
| 7 | 55.40527 | 63 | 0.7408 | 0.879295 | (63, 16110.8) | 0.7408 |
| 8 | 59.90217 | 72 | 0.8448 | 0.831713 | (72, 16120.7) | 0.8448 |
| 9 | 64.95508 | 81 | 0.9035 | 0.801564 | (81, 16124.8) | 0.9035 |
| 10 | 68.33590 | 90 | 0.9569 | 0.758824 | (90, 16125.1) | 0.9569 |
| 11 | 81.29797 | 99 | 0.9021 | 0.820790 | (99, 16123.0) | 0.9021 |
| 12 | 85.40974 | 108 | 0.9467 | 0.790324 | (108, 16119... | 0.9467 |
| 13 | 96.18846 | 117 | 0.9202 | 0.821642 | (117, 16114... | 0.9202 |
| 14 | 106.4115 | 126 | 0.8965 | 0.844072 | (126, 16108... | 0.8965 |
| 15 | 115.2760 | 135 | 0.8894 | 0.853423 | (135, 16102... | 0.8894 |
| 16 | 123.5205 | 144 | 0.8906 | 0.857285 | (144, 16095... | 0.8906 |
| 17 | 140.2226 | 153 | 0.7622 | 0.916175 | (153, 16088... | 0.7622 |
| 18 | 150.1087 | 162 | 0.7390 | 0.926305 | (162, 16080... | 0.7390 |
| 19 | 157.7147 | 171 | 0.7585 | 0.921977 | (171, 16073... | 0.7586 |
| 20 | 162.5990 | 180 | 0.8194 | 0.902888 | (180, 16065... | 0.8194 |
| 21 | 166.8664 | 189 | 0.8752 | 0.882330 | (189, 16057... | 0.8753 |
| 22 | 181.2116 | 198 | 0.7981 | 0.914779 | (198, 16048... | 0.7982 |
| 23 | 188.8497 | 207 | 0.8123 | 0.911848 | (207, 16040... | 0.8124 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 49: VAR Residual Serial Correlation LM Test – Cotton**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:24
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.408462 | 9 | 0.6984 | 0.712035 | (9, 13110.7) | 0.6984 |
| 2 | 10.05041 | 9 | 0.3464 | 1.116842 | (9, 13110.7) | 0.3464 |
| 3 | 7.622849 | 9 | 0.5726 | 0.847003 | (9, 13110.7) | 0.5726 |
| 4 | 12.23183 | 9 | 0.2006 | 1.359363 | (9, 13110.7) | 0.2006 |
| 5 | 7.421485 | 9 | 0.5933 | 0.824623 | (9, 13110.7) | 0.5933 |
| 6 | 13.27347 | 9 | 0.1506 | 1.475182 | (9, 13110.7) | 0.1506 |
| 7 | 1.572975 | 9 | 0.9966 | 0.174739 | (9, 13110.7) | 0.9966 |
| 8 | 6.589546 | 9 | 0.6798 | 0.732160 | (9, 13110.7) | 0.6798 |
| 9 | 6.955120 | 9 | 0.6418 | 0.772790 | (9, 13110.7) | 0.6418 |
| 10 | 8.906221 | 9 | 0.4460 | 0.989652 | (9, 13110.7) | 0.4460 |
| 11 | 7.524737 | 9 | 0.5827 | 0.836099 | (9, 13110.7) | 0.5827 |
| 12 | 7.979305 | 9 | 0.5362 | 0.886623 | (9, 13110.7) | 0.5362 |
| 13 | 9.207228 | 9 | 0.4184 | 1.023111 | (9, 13110.7) | 0.4184 |
| 14 | 17.50792 | 9 | 0.0413 | 1.946104 | (9, 13110.7) | 0.0413 |
| 15 | 8.681621 | 9 | 0.4672 | 0.964686 | (9, 13110.7) | 0.4672 |
| 16 | 3.650600 | 9 | 0.9329 | 0.405570 | (9, 13110.7) | 0.9329 |
| 17 | 5.935371 | 9 | 0.7464 | 0.659459 | (9, 13110.7) | 0.7464 |
| 18 | 3.361692 | 9 | 0.9482 | 0.373470 | (9, 13110.7) | 0.9482 |
| 19 | 3.673790 | 9 | 0.9315 | 0.408147 | (9, 13110.7) | 0.9315 |
| 20 | 7.811657 | 9 | 0.5532 | 0.867989 | (9, 13110.7) | 0.5532 |
| 21 | 5.843690 | 9 | 0.7555 | 0.649270 | (9, 13110.7) | 0.7555 |
| 22 | 9.772352 | 9 | 0.3692 | 1.085932 | (9, 13110.7) | 0.3692 |
| 23 | 8.278450 | 9 | 0.5063 | 0.919873 | (9, 13110.7) | 0.5063 |
| 24 | 20.59145 | 9 | 0.0146 | 2.289125 | (9, 13110.7) | 0.0146 |
| 25 | 14.91681 | 9 | 0.0932 | 1.657923 | (9, 13110.7) | 0.0932 |
| 26 | 6.514887 | 9 | 0.6875 | 0.723863 | (9, 13110.7) | 0.6875 |
| 27 | 1.995115 | 9 | 0.9915 | 0.221637 | (9, 13110.7) | 0.9915 |
| 28 | 8.131146 | 9 | 0.5210 | 0.903500 | (9, 13110.7) | 0.5210 |
| 29 | 9.357176 | 9 | 0.4050 | 1.039780 | (9, 13110.7) | 0.4050 |
| 30 | 11.43947 | 9 | 0.2468 | 1.271268 | (9, 13110.7) | 0.2468 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.408462 | 9 | 0.6984 | 0.712035 | (9, 13110.7) | 0.6984 |
| 2 | 13.21852 | 18 | 0.7784 | 0.734295 | (18, 15228.7) | 0.7784 |
| 3 | 21.98017 | 27 | 0.7384 | 0.814002 | (27, 15715.9) | 0.7384 |
| 4 | 29.93347 | 36 | 0.7517 | 0.831379 | (36, 15890.6) | 0.7517 |
| 5 | 32.90994 | 45 | 0.9096 | 0.731101 | (45, 15968.5) | 0.9096 |
| 6 | 42.38450 | 54 | 0.8737 | 0.784662 | (54, 16007.3) | 0.8737 |
| 7 | 46.08267 | 63 | 0.9460 | 0.731130 | (63, 16027.2) | 0.9460 |
| 8 | 61.84044 | 72 | 0.7978 | 0.858675 | (72, 16037.1) | 0.7978 |
| 9 | 70.13524 | 81 | 0.8001 | 0.865627 | (81, 16041.0) | 0.8001 |
| 10 | 71.71836 | 90 | 0.9218 | 0.796465 | (90, 16041.3) | 0.9218 |
| 11 | 79.63257 | 99 | 0.9236 | 0.803932 | (99, 16039.2) | 0.9236 |
| 12 | 89.14167 | 108 | 0.9067 | 0.824950 | (108, 16035.4) | 0.9067 |
| 13 | 97.59477 | 117 | 0.9036 | 0.833688 | (117, 16030.5) | 0.9036 |
| 14 | 116.0560 | 126 | 0.7262 | 0.920847 | (126, 16024.7) | 0.7262 |
| 15 | 132.4918 | 135 | 0.5450 | 0.981400 | (135, 16018.4) | 0.5450 |
| 16 | 139.1200 | 144 | 0.5993 | 0.966018 | (144, 16011.5) | 0.5993 |
| 17 | 149.4289 | 153 | 0.5665 | 0.976604 | (153, 16004.3) | 0.5666 |
| 18 | 158.8625 | 162 | 0.5550 | 0.980590 | (162, 15996.8) | 0.5550 |
| 19 | 163.2691 | 171 | 0.6511 | 0.954611 | (171, 15989.0) | 0.6511 |
| 20 | 170.4546 | 180 | 0.6833 | 0.946738 | (180, 15981.1) | 0.6833 |
| 21 | 181.4192 | 189 | 0.6409 | 0.959712 | (189, 15973.0) | 0.6409 |
| 22 | 191.5951 | 198 | 0.6148 | 0.967507 | (198, 15964.8) | 0.6148 |
| 23 | 202.0924 | 207 | 0.5833 | 0.976190 | (207, 15956.5) | 0.5833 |
| 24 | 214.6881 | 216 | 0.5124 | 0.993933 | (216, 15948.1) | 0.5125 |
| 25 | 221.7751 | 225 | 0.5483 | 0.985614 | (225, 15939.7) | 0.5483 |
| 26 | 235.1271 | 234 | 0.4670 | 1.004897 | (234, 15931.1) | 0.4671 |
| 27 | 241.1561 | 243 | 0.5214 | 0.992398 | (243, 15922.6) | 0.5215 |
| 28 | 245.5789 | 252 | 0.6021 | 0.974365 | (252, 15913.9) | 0.6022 |
| 29 | 249.2561 | 261 | 0.6889 | 0.954692 | (261, 15905.3) | 0.6890 |
| 30 | 257.9627 | 270 | 0.6904 | 0.955095 | (270, 15896.6) | 0.6905 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 50: VAR Residual Serial Correlation LM Test – No.11 Sugar**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:45
Sample: 3/31/2000 3/03/2022
Included observations: 5481

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 12.13877 | 9 | 0.2056 | 1.349017 | (9, 13120.4) | 0.2056 |
| 2 | 15.34852 | 9 | 0.0818 | 1.705934 | (9, 13120.4) | 0.0818 |
| 3 | 20.83340 | 9 | 0.0134 | 2.316043 | (9, 13120.4) | 0.0134 |
| 4 | 19.57824 | 9 | 0.0207 | 2.176403 | (9, 13120.4) | 0.0207 |
| 5 | 10.26739 | 9 | 0.3293 | 1.140963 | (9, 13120.4) | 0.3293 |
| 6 | 14.90256 | 9 | 0.0936 | 1.656339 | (9, 13120.4) | 0.0936 |
| 7 | 10.00556 | 9 | 0.3500 | 1.111856 | (9, 13120.4) | 0.3500 |
| 8 | 13.87719 | 9 | 0.1268 | 1.542314 | (9, 13120.4) | 0.1268 |
| 9 | 12.09215 | 9 | 0.2082 | 1.343833 | (9, 13120.4) | 0.2082 |
| 10 | 4.272140 | 9 | 0.8926 | 0.474633 | (9, 13120.4) | 0.8926 |
| 11 | 9.557537 | 9 | 0.3875 | 1.062052 | (9, 13120.4) | 0.3875 |
| 12 | 13.67781 | 9 | 0.1343 | 1.520143 | (9, 13120.4) | 0.1343 |
| 13 | 10.13565 | 9 | 0.3396 | 1.126318 | (9, 13120.4) | 0.3396 |
| 14 | 10.22277 | 9 | 0.3328 | 1.136003 | (9, 13120.4) | 0.3328 |
| 15 | 12.39634 | 9 | 0.1919 | 1.377655 | (9, 13120.4) | 0.1919 |
| 16 | 14.92964 | 9 | 0.0929 | 1.659351 | (9, 13120.4) | 0.0929 |
| 17 | 4.275303 | 9 | 0.8924 | 0.474984 | (9, 13120.4) | 0.8924 |
| 18 | 13.25234 | 9 | 0.1515 | 1.472833 | (9, 13120.4) | 0.1515 |
| 19 | 16.37948 | 9 | 0.0594 | 1.820593 | (9, 13120.4) | 0.0594 |
| 20 | 7.182029 | 9 | 0.6182 | 0.798009 | (9, 13120.4) | 0.6182 |
| 21 | 6.835204 | 9 | 0.6543 | 0.759462 | (9, 13120.4) | 0.6543 |
| 22 | 12.38755 | 9 | 0.1923 | 1.376677 | (9, 13120.4) | 0.1923 |
| 23 | 10.23521 | 9 | 0.3318 | 1.137385 | (9, 13120.4) | 0.3318 |
| 24 | 21.32851 | 9 | 0.0113 | 2.371129 | (9, 13120.4) | 0.0113 |
| 25 | 13.60128 | 9 | 0.1372 | 1.511633 | (9, 13120.4) | 0.1372 |
| 26 | 10.96248 | 9 | 0.2783 | 1.218237 | (9, 13120.4) | 0.2783 |
| 27 | 18.98793 | 9 | 0.0253 | 2.110734 | (9, 13120.4) | 0.0253 |
| 28 | 12.02206 | 9 | 0.2121 | 1.336040 | (9, 13120.4) | 0.2121 |
| 29 | 11.32677 | 9 | 0.2540 | 1.258737 | (9, 13120.4) | 0.2540 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 12.13877 | 9 | 0.2056 | 1.349017 | (9, 13120.4) | 0.2056 |
| 2 | 29.47285 | 18 | 0.0429 | 1.638104 | (18, 15240.1) | 0.0429 |
| 3 | 35.92675 | 27 | 0.1169 | 1.331082 | (27, 15727.6) | 0.1169 |
| 4 | 44.75047 | 36 | 0.1503 | 1.243488 | (36, 15902.4) | 0.1503 |
| 5 | 52.51674 | 45 | 0.2057 | 1.167385 | (45, 15980.4) | 0.2057 |
| 6 | 65.38594 | 54 | 0.1378 | 1.211355 | (54, 16019.2) | 0.1379 |
| 7 | 66.46056 | 63 | 0.3587 | 1.055108 | (63, 16039.1) | 0.3587 |
| 8 | 77.45666 | 72 | 0.3089 | 1.076035 | (72, 16049.0) | 0.3089 |
| 9 | 94.18737 | 81 | 0.1500 | 1.163354 | (81, 16053.0) | 0.1500 |
| 10 | 103.7849 | 90 | 0.1519 | 1.153728 | (90, 16053.3) | 0.1519 |
| 11 | 107.3781 | 99 | 0.2655 | 1.084974 | (99, 16051.2) | 0.2655 |
| 12 | 115.9959 | 108 | 0.2822 | 1.074366 | (108, 16047.4) | 0.2822 |
| 13 | 120.2595 | 117 | 0.3995 | 1.028023 | (117, 16042.5) | 0.3995 |
| 14 | 128.3091 | 126 | 0.4260 | 1.018458 | (126, 16036.7) | 0.4260 |
| 15 | 140.2345 | 135 | 0.3613 | 1.039002 | (135, 16030.3) | 0.3613 |
| 16 | 157.7607 | 144 | 0.2046 | 1.096091 | (144, 16023.5) | 0.2046 |
| 17 | 165.2465 | 153 | 0.2357 | 1.080514 | (153, 16016.3) | 0.2358 |
| 18 | 179.5768 | 162 | 0.1635 | 1.109166 | (162, 16008.7) | 0.1636 |
| 19 | 191.1652 | 171 | 0.1387 | 1.118687 | (171, 16001.0) | 0.1388 |
| 20 | 200.7180 | 180 | 0.1384 | 1.115878 | (180, 15993.1) | 0.1384 |
| 21 | 211.7756 | 189 | 0.1227 | 1.121358 | (189, 15985.0) | 0.1228 |
| 22 | 223.9533 | 198 | 0.0995 | 1.132049 | (198, 15976.8) | 0.0995 |
| 23 | 228.6592 | 207 | 0.1441 | 1.105434 | (207, 15968.5) | 0.1442 |
| 24 | 238.3011 | 216 | 0.1423 | 1.104066 | (216, 15960.1) | 0.1424 |
| 25 | 246.3048 | 225 | 0.1573 | 1.095467 | (225, 15951.7) | 0.1574 |
| 26 | 261.7458 | 234 | 0.1028 | 1.119591 | (234, 15943.1) | 0.1029 |
| 27 | 277.6947 | 243 | 0.0625 | 1.144065 | (243, 15934.6) | 0.0625 |
| 28 | 283.7904 | 252 | 0.0823 | 1.127319 | (252, 15925.9) | 0.0823 |
| 29 | 289.0387 | 261 | 0.1122 | 1.108444 | (261, 15917.3) | 0.1123 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 51: VAR Residual Serial Correlation LM Test – Oats**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:29
Sample: 3/31/2000 3/03/2022
Included observations: 5485

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 13.43124 | 9 | 0.1440 | 1.492724 | (9, 13159.4) | 0.1440 |
| 2 | 18.97718 | 9 | 0.0254 | 2.109536 | (9, 13159.4) | 0.0254 |
| 3 | 12.32751 | 9 | 0.1955 | 1.370000 | (9, 13159.4) | 0.1955 |
| 4 | 5.160463 | 9 | 0.8201 | 0.573345 | (9, 13159.4) | 0.8201 |
| 5 | 10.55478 | 9 | 0.3075 | 1.172912 | (9, 13159.4) | 0.3075 |
| 6 | 11.81645 | 9 | 0.2239 | 1.313179 | (9, 13159.4) | 0.2239 |
| 7 | 9.798231 | 9 | 0.3671 | 1.088808 | (9, 13159.4) | 0.3671 |
| 8 | 2.696248 | 9 | 0.9751 | 0.299534 | (9, 13159.4) | 0.9751 |
| 9 | 8.958602 | 9 | 0.4411 | 0.995474 | (9, 13159.4) | 0.4411 |
| 10 | 19.53024 | 9 | 0.0210 | 2.171060 | (9, 13159.4) | 0.0210 |
| 11 | 11.49127 | 9 | 0.2435 | 1.277026 | (9, 13159.4) | 0.2435 |
| 12 | 13.37315 | 9 | 0.1464 | 1.486266 | (9, 13159.4) | 0.1464 |
| 13 | 12.76891 | 9 | 0.1733 | 1.419079 | (9, 13159.4) | 0.1733 |
| 14 | 12.21261 | 9 | 0.2016 | 1.357225 | (9, 13159.4) | 0.2016 |
| 15 | 9.189854 | 9 | 0.4199 | 1.021180 | (9, 13159.4) | 0.4199 |
| 16 | 14.99285 | 9 | 0.0911 | 1.666378 | (9, 13159.4) | 0.0911 |
| 17 | 23.41937 | 9 | 0.0053 | 2.603776 | (9, 13159.4) | 0.0053 |
| 18 | 13.10428 | 9 | 0.1579 | 1.456369 | (9, 13159.4) | 0.1579 |
| 19 | 12.81523 | 9 | 0.1711 | 1.424229 | (9, 13159.4) | 0.1711 |
| 20 | 8.245546 | 9 | 0.5096 | 0.916215 | (9, 13159.4) | 0.5096 |
| 21 | 9.063251 | 9 | 0.4315 | 1.007107 | (9, 13159.4) | 0.4315 |
| 22 | 4.078382 | 9 | 0.9062 | 0.453103 | (9, 13159.4) | 0.9062 |
| 23 | 21.08501 | 9 | 0.0123 | 2.344032 | (9, 13159.4) | 0.0123 |
| 24 | 17.59003 | 9 | 0.0402 | 1.955234 | (9, 13159.4) | 0.0402 |
| 25 | 15.96633 | 9 | 0.0676 | 1.774642 | (9, 13159.4) | 0.0676 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 13.43124 | 9 | 0.1440 | 1.492724 | (9, 13159.4) | 0.1440 |
| 2 | 26.80170 | 18 | 0.0828 | 1.489509 | (18, 15285.3) | 0.0828 |
| 3 | 35.34922 | 27 | 0.1302 | 1.309659 | (27, 15774.3) | 0.1302 |
| 4 | 39.44248 | 36 | 0.3186 | 1.095811 | (36, 15949.7) | 0.3186 |
| 5 | 44.17159 | 45 | 0.5069 | 0.981626 | (45, 16028.0) | 0.5069 |
| 6 | 50.44247 | 54 | 0.6124 | 0.934074 | (54, 16066.8) | 0.6124 |
| 7 | 60.89666 | 63 | 0.5517 | 0.966609 | (63, 16086.9) | 0.5517 |
| 8 | 65.05849 | 72 | 0.7061 | 0.903450 | (72, 16096.8) | 0.7061 |
| 9 | 70.97589 | 81 | 0.7792 | 0.876026 | (81, 16100.8) | 0.7793 |
| 10 | 77.29176 | 90 | 0.8278 | 0.858510 | (90, 16101.2) | 0.8278 |
| 11 | 89.34483 | 99 | 0.7460 | 0.902256 | (99, 16099.1) | 0.7460 |
| 12 | 106.2362 | 108 | 0.5300 | 0.983672 | (108, 16095.3) | 0.5300 |
| 13 | 112.0749 | 117 | 0.6114 | 0.957814 | (117, 16090.4) | 0.6114 |
| 14 | 126.3969 | 126 | 0.4733 | 1.003220 | (126, 16084.7) | 0.4733 |
| 15 | 133.1134 | 135 | 0.5298 | 0.986023 | (135, 16078.3) | 0.5298 |
| 16 | 144.4938 | 144 | 0.4728 | 1.003501 | (144, 16071.4) | 0.4728 |
| 17 | 154.9172 | 153 | 0.4415 | 1.012646 | (153, 16064.2) | 0.4415 |
| 18 | 170.3039 | 162 | 0.3119 | 1.051586 | (162, 16056.7) | 0.3119 |
| 19 | 175.2078 | 171 | 0.3968 | 1.024795 | (171, 16049.0) | 0.3968 |
| 20 | 188.0120 | 180 | 0.3259 | 1.044825 | (180, 16041.0) | 0.3260 |
| 21 | 198.4975 | 189 | 0.3034 | 1.050615 | (189, 16033.0) | 0.3034 |
| 22 | 210.0329 | 198 | 0.2656 | 1.061222 | (198, 16024.8) | 0.2656 |
| 23 | 215.8321 | 207 | 0.3225 | 1.043004 | (207, 16016.5) | 0.3226 |
| 24 | 225.3146 | 216 | 0.3178 | 1.043475 | (216, 16008.1) | 0.3179 |
| 25 | 229.7053 | 225 | 0.4007 | 1.021109 | (225, 15999.6) | 0.4007 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 52: VAR Residual Serial Correlation LM Test – Rough Rice**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:36
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 5.392034 | 9 | 0.7989 | 0.599078 | (9, 13110.7) | 0.7989 |
| 2 | 6.310787 | 9 | 0.7085 | 0.701180 | (9, 13110.7) | 0.7085 |
| 3 | 6.658770 | 9 | 0.6726 | 0.739854 | (9, 13110.7) | 0.6726 |
| 4 | 6.677922 | 9 | 0.6706 | 0.741982 | (9, 13110.7) | 0.6706 |
| 5 | 10.19437 | 9 | 0.3350 | 1.132846 | (9, 13110.7) | 0.3350 |
| 6 | 8.768127 | 9 | 0.4589 | 0.974302 | (9, 13110.7) | 0.4589 |
| 7 | 10.43785 | 9 | 0.3162 | 1.159913 | (9, 13110.7) | 0.3162 |
| 8 | 4.484611 | 9 | 0.8767 | 0.498242 | (9, 13110.7) | 0.8767 |
| 9 | 7.093881 | 9 | 0.6273 | 0.788212 | (9, 13110.7) | 0.6273 |
| 10 | 7.658600 | 9 | 0.5689 | 0.850977 | (9, 13110.7) | 0.5689 |
| 11 | 14.57424 | 9 | 0.1033 | 1.619828 | (9, 13110.7) | 0.1033 |
| 12 | 3.199226 | 9 | 0.9559 | 0.355418 | (9, 13110.7) | 0.9559 |
| 13 | 10.31121 | 9 | 0.3259 | 1.145835 | (9, 13110.7) | 0.3259 |
| 14 | 15.75637 | 9 | 0.0721 | 1.751292 | (9, 13110.7) | 0.0721 |
| 15 | 23.06012 | 9 | 0.0061 | 2.563805 | (9, 13110.7) | 0.0061 |
| 16 | 10.42322 | 9 | 0.3173 | 1.158286 | (9, 13110.7) | 0.3173 |
| 17 | 5.647875 | 9 | 0.7746 | 0.627509 | (9, 13110.7) | 0.7746 |
| 18 | 11.07494 | 9 | 0.2706 | 1.230740 | (9, 13110.7) | 0.2706 |
| 19 | 8.331053 | 9 | 0.5012 | 0.925719 | (9, 13110.7) | 0.5012 |
| 20 | 5.301158 | 9 | 0.8073 | 0.588979 | (9, 13110.7) | 0.8073 |
| 21 | 9.164542 | 9 | 0.4222 | 1.018366 | (9, 13110.7) | 0.4222 |
| 22 | 11.73714 | 9 | 0.2285 | 1.304362 | (9, 13110.7) | 0.2285 |
| 23 | 7.720414 | 9 | 0.5625 | 0.857847 | (9, 13110.7) | 0.5625 |
| 24 | 13.61626 | 9 | 0.1366 | 1.513299 | (9, 13110.7) | 0.1366 |
| 25 | 12.42506 | 9 | 0.1904 | 1.380848 | (9, 13110.7) | 0.1904 |
| 26 | 9.817467 | 9 | 0.3655 | 1.090947 | (9, 13110.7) | 0.3655 |
| 27 | 6.948153 | 9 | 0.6425 | 0.772016 | (9, 13110.7) | 0.6425 |
| 28 | 7.946317 | 9 | 0.5396 | 0.882956 | (9, 13110.7) | 0.5396 |
| 29 | 9.128788 | 9 | 0.4255 | 1.014392 | (9, 13110.7) | 0.4255 |
| 30 | 5.663055 | 9 | 0.7731 | 0.629196 | (9, 13110.7) | 0.7731 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 5.392034 | 9 | 0.7989 | 0.599078 | (9, 13110.7) | 0.7989 |
| 2 | 11.45277 | 18 | 0.8742 | 0.636170 | (18, 15228.7) | 0.8742 |
| 3 | 15.76307 | 27 | 0.9573 | 0.583646 | (27, 15715.9) | 0.9573 |
| 4 | 27.37791 | 36 | 0.8486 | 0.760339 | (36, 15890.6) | 0.8486 |
| 5 | 33.55209 | 45 | 0.8954 | 0.745381 | (45, 15968.5) | 0.8954 |
| 6 | 43.62876 | 54 | 0.8425 | 0.807728 | (54, 16007.3) | 0.8425 |
| 7 | 51.82645 | 63 | 0.8416 | 0.822406 | (63, 16027.2) | 0.8416 |
| 8 | 69.80192 | 72 | 0.5515 | 0.969464 | (72, 16037.1) | 0.5515 |
| 9 | 77.71351 | 81 | 0.5829 | 0.959386 | (81, 16041.0) | 0.5829 |
| 10 | 92.46054 | 90 | 0.4085 | 1.027479 | (90, 16041.3) | 0.4085 |
| 11 | 105.8349 | 99 | 0.3008 | 1.069330 | (99, 16039.2) | 0.3008 |
| 12 | 115.9870 | 108 | 0.2824 | 1.074284 | (108, 16035... | 0.2824 |
| 13 | 126.1724 | 117 | 0.2650 | 1.078767 | (117, 16030... | 0.2650 |
| 14 | 134.8619 | 126 | 0.2785 | 1.070689 | (126, 16024... | 0.2785 |
| 15 | 146.6013 | 135 | 0.2336 | 1.086389 | (135, 16018... | 0.2336 |
| 16 | 150.0241 | 144 | 0.3485 | 1.042088 | (144, 16011... | 0.3485 |
| 17 | 154.8328 | 153 | 0.4434 | 1.012092 | (153, 16004... | 0.4434 |
| 18 | 166.0675 | 162 | 0.3970 | 1.025293 | (162, 15996... | 0.3970 |
| 19 | 170.0643 | 171 | 0.5058 | 0.994552 | (171, 15989... | 0.5059 |
| 20 | 175.2939 | 180 | 0.5851 | 0.973763 | (180, 15981... | 0.5852 |
| 21 | 179.2384 | 189 | 0.6832 | 0.948111 | (189, 15973... | 0.6832 |
| 22 | 185.0771 | 198 | 0.7358 | 0.934403 | (198, 15964... | 0.7358 |
| 23 | 195.8229 | 207 | 0.7008 | 0.945721 | (207, 15956... | 0.7008 |
| 24 | 202.8921 | 216 | 0.7296 | 0.938976 | (216, 15948... | 0.7297 |
| 25 | 218.4005 | 225 | 0.6113 | 0.970514 | (225, 15939... | 0.6114 |
| 26 | 228.1534 | 234 | 0.5955 | 0.974880 | (234, 15931... | 0.5955 |
| 27 | 230.4410 | 243 | 0.7086 | 0.947986 | (243, 15922... | 0.7087 |
| 28 | 232.9500 | 252 | 0.7998 | 0.923893 | (252, 15913... | 0.7999 |
| 29 | 236.6769 | 261 | 0.8577 | 0.906155 | (261, 15905... | 0.8578 |
| 30 | 244.7057 | 270 | 0.8634 | 0.905636 | (270, 15896... | 0.8634 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 53: VAR Residual Serial Correlation LM Test – Soybean**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:40
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.810653 | 9 | 0.5533 | 0.867877 | (9, 13178.8) | 0.5533 |
| 2 | 13.95855 | 9 | 0.1238 | 1.551360 | (9, 13178.8) | 0.1238 |
| 3 | 10.04661 | 9 | 0.3467 | 1.116419 | (9, 13178.8) | 0.3467 |
| 4 | 8.111254 | 9 | 0.5230 | 0.901288 | (9, 13178.8) | 0.5230 |
| 5 | 5.745053 | 9 | 0.7651 | 0.638309 | (9, 13178.8) | 0.7651 |
| 6 | 7.424235 | 9 | 0.5930 | 0.824928 | (9, 13178.8) | 0.5930 |
| 7 | 10.02894 | 9 | 0.3481 | 1.114454 | (9, 13178.8) | 0.3481 |
| 8 | 4.534201 | 9 | 0.8729 | 0.503753 | (9, 13178.8) | 0.8729 |
| 9 | 5.529428 | 9 | 0.7859 | 0.614347 | (9, 13178.8) | 0.7859 |
| 10 | 10.21474 | 9 | 0.3334 | 1.135109 | (9, 13178.8) | 0.3334 |
| 11 | 12.32844 | 9 | 0.1954 | 1.370104 | (9, 13178.8) | 0.1954 |
| 12 | 6.260401 | 9 | 0.7136 | 0.695581 | (9, 13178.8) | 0.7136 |
| 13 | 13.06448 | 9 | 0.1597 | 1.451943 | (9, 13178.8) | 0.1597 |
| 14 | 3.551406 | 9 | 0.9384 | 0.394549 | (9, 13178.8) | 0.9384 |
| 15 | 10.95929 | 9 | 0.2785 | 1.217881 | (9, 13178.8) | 0.2785 |
| 16 | 5.040491 | 9 | 0.8308 | 0.560013 | (9, 13178.8) | 0.8308 |
| 17 | 5.314047 | 9 | 0.8061 | 0.590412 | (9, 13178.8) | 0.8061 |
| 18 | 7.719351 | 9 | 0.5627 | 0.857729 | (9, 13178.8) | 0.5627 |
| 19 | 15.35372 | 9 | 0.0817 | 1.706509 | (9, 13178.8) | 0.0817 |
| 20 | 7.628010 | 9 | 0.5720 | 0.847577 | (9, 13178.8) | 0.5720 |
| 21 | 7.424679 | 9 | 0.5930 | 0.824978 | (9, 13178.8) | 0.5930 |
| 22 | 4.575527 | 9 | 0.8696 | 0.508345 | (9, 13178.8) | 0.8696 |
| 23 | 13.15637 | 9 | 0.1557 | 1.462161 | (9, 13178.8) | 0.1557 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.810653 | 9 | 0.5533 | 0.867877 | (9, 13178.8) | 0.5533 |
| 2 | 19.97222 | 18 | 0.3344 | 1.109712 | (18, 15307.9) | 0.3344 |
| 3 | 31.40166 | 27 | 0.2550 | 1.163260 | (27, 15797.7) | 0.2550 |
| 4 | 42.42750 | 36 | 0.2136 | 1.178852 | (36, 15973.4) | 0.2136 |
| 5 | 52.10376 | 45 | 0.2171 | 1.158189 | (45, 16051.7) | 0.2171 |
| 6 | 57.72983 | 54 | 0.3391 | 1.069260 | (54, 16090.7) | 0.3391 |
| 7 | 68.08668 | 63 | 0.3083 | 1.080977 | (63, 16110.8) | 0.3083 |
| 8 | 70.65485 | 72 | 0.5228 | 0.981336 | (72, 16120.7) | 0.5228 |
| 9 | 74.15059 | 81 | 0.6919 | 0.915300 | (81, 16124.8) | 0.6919 |
| 10 | 78.12539 | 90 | 0.8098 | 0.867792 | (90, 16125.1) | 0.8098 |
| 11 | 90.39472 | 99 | 0.7199 | 0.912889 | (99, 16123.0) | 0.7199 |
| 12 | 96.99981 | 108 | 0.7672 | 0.897893 | (108, 16119.3) | 0.7672 |
| 13 | 111.3449 | 117 | 0.6301 | 0.951554 | (117, 16114.4) | 0.6301 |
| 14 | 115.8160 | 126 | 0.7315 | 0.918937 | (126, 16108.6) | 0.7315 |
| 15 | 120.8392 | 135 | 0.8032 | 0.894763 | (135, 16102.3) | 0.8032 |
| 16 | 131.1886 | 144 | 0.7700 | 0.910721 | (144, 16095.4) | 0.7700 |
| 17 | 141.0894 | 153 | 0.7457 | 0.921863 | (153, 16088.2) | 0.7457 |
| 18 | 147.1862 | 162 | 0.7917 | 0.908189 | (162, 16080.7) | 0.7917 |
| 19 | 161.7158 | 171 | 0.6827 | 0.945484 | (171, 16073.0) | 0.6827 |
| 20 | 167.0701 | 180 | 0.7464 | 0.927843 | (180, 16065.0) | 0.7464 |
| 21 | 175.8332 | 189 | 0.7451 | 0.930002 | (189, 16057.0) | 0.7451 |
| 22 | 185.3197 | 198 | 0.7316 | 0.935636 | (198, 16048.8) | 0.7316 |
| 23 | 190.5558 | 207 | 0.7875 | 0.920135 | (207, 16040.5) | 0.7875 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 54: VAR Residual Serial Correlation LM Test – Soybean Oil**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:42
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.775204 | 9 | 0.6605 | 0.752794 | (9, 13178.8) | 0.6605 |
| 2 | 14.58941 | 9 | 0.1028 | 1.621512 | (9, 13178.8) | 0.1028 |
| 3 | 14.45270 | 9 | 0.1071 | 1.606310 | (9, 13178.8) | 0.1071 |
| 4 | 10.47172 | 9 | 0.3137 | 1.163678 | (9, 13178.8) | 0.3137 |
| 5 | 10.52082 | 9 | 0.3100 | 1.169136 | (9, 13178.8) | 0.3100 |
| 6 | 9.667889 | 9 | 0.3780 | 1.074319 | (9, 13178.8) | 0.3780 |
| 7 | 17.12751 | 9 | 0.0468 | 1.903788 | (9, 13178.8) | 0.0468 |
| 8 | 6.668317 | 9 | 0.6716 | 0.740915 | (9, 13178.8) | 0.6716 |
| 9 | 8.325128 | 9 | 0.5017 | 0.925061 | (9, 13178.8) | 0.5017 |
| 10 | 31.04596 | 9 | 0.0003 | 3.452699 | (9, 13178.8) | 0.0003 |
| 11 | 11.97508 | 9 | 0.2147 | 1.330816 | (9, 13178.8) | 0.2147 |
| 12 | 13.37846 | 9 | 0.1462 | 1.486856 | (9, 13178.8) | 0.1462 |
| 13 | 10.42198 | 9 | 0.3174 | 1.158148 | (9, 13178.8) | 0.3174 |
| 14 | 6.778151 | 9 | 0.6602 | 0.753122 | (9, 13178.8) | 0.6602 |
| 15 | 9.577207 | 9 | 0.3858 | 1.064238 | (9, 13178.8) | 0.3858 |
| 16 | 15.27142 | 9 | 0.0837 | 1.697357 | (9, 13178.8) | 0.0837 |
| 17 | 4.158080 | 9 | 0.9007 | 0.461959 | (9, 13178.8) | 0.9007 |
| 18 | 13.99359 | 9 | 0.1226 | 1.555256 | (9, 13178.8) | 0.1226 |
| 19 | 14.46959 | 9 | 0.1066 | 1.608188 | (9, 13178.8) | 0.1066 |
| 20 | 6.917406 | 9 | 0.6457 | 0.768598 | (9, 13178.8) | 0.6457 |
| 21 | 9.992616 | 9 | 0.3511 | 1.110417 | (9, 13178.8) | 0.3511 |
| 22 | 11.28236 | 9 | 0.2568 | 1.253800 | (9, 13178.8) | 0.2568 |
| 23 | 7.966832 | 9 | 0.5375 | 0.885236 | (9, 13178.8) | 0.5375 |

Null hypothesis: No serial correlation at lags 1 to h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 6.775204 | 9 | 0.6605 | 0.752794 | (9, 13178.8) | 0.6605 |
| 2 | 20.88240 | 18 | 0.2854 | 1.160318 | (18, 15307.9) | 0.2854 |
| 3 | 32.80976 | 27 | 0.2034 | 1.215476 | (27, 15797.7) | 0.2034 |
| 4 | 38.93465 | 36 | 0.3391 | 1.081685 | (36, 15973.4) | 0.3391 |
| 5 | 52.70423 | 45 | 0.2007 | 1.171558 | (45, 16051.7) | 0.2007 |
| 6 | 64.16420 | 54 | 0.1621 | 1.188674 | (54, 16090.7) | 0.1621 |
| 7 | 74.12085 | 63 | 0.1595 | 1.176999 | (63, 16110.8) | 0.1595 |
| 8 | 79.07105 | 72 | 0.2656 | 1.098516 | (72, 16120.7) | 0.2656 |
| 9 | 85.28142 | 81 | 0.3509 | 1.053060 | (81, 16124.8) | 0.3509 |
| 10 | 90.43767 | 90 | 0.4672 | 1.004936 | (90, 16125.1) | 0.4672 |
| 11 | 104.2907 | 99 | 0.3385 | 1.053676 | (99, 16123.0) | 0.3385 |
| 12 | 113.7517 | 108 | 0.3337 | 1.053505 | (108, 16119.3) | 0.3337 |
| 13 | 122.7348 | 117 | 0.3400 | 1.049262 | (117, 16114.4) | 0.3400 |
| 14 | 129.9177 | 126 | 0.3874 | 1.031276 | (126, 16108.6) | 0.3874 |
| 15 | 134.3096 | 135 | 0.5006 | 0.994921 | (135, 16102.3) | 0.5006 |
| 16 | 150.9696 | 144 | 0.3287 | 1.048685 | (144, 16095.4) | 0.3288 |
| 17 | 158.2484 | 153 | 0.3689 | 1.034528 | (153, 16088.2) | 0.3690 |
| 18 | 170.1730 | 162 | 0.3144 | 1.050773 | (162, 16080.7) | 0.3144 |
| 19 | 177.7583 | 171 | 0.3458 | 1.039795 | (171, 16073.0) | 0.3458 |
| 20 | 187.2846 | 180 | 0.3395 | 1.040759 | (180, 16065.0) | 0.3395 |
| 21 | 194.9112 | 189 | 0.3688 | 1.031518 | (189, 16057.0) | 0.3688 |
| 22 | 206.0596 | 198 | 0.3325 | 1.041017 | (198, 16048.8) | 0.3325 |
| 23 | 207.9128 | 207 | 0.4691 | 1.004487 | (207, 16040.5) | 0.4691 |

*Edgeworth expansion corrected likelihood ratio statistic.

**EViews Output 55: VAR Residual Serial Correlation LM Test – Wheat**

VAR Residual Serial Correlation LM Tests
Date: 05/27/22 Time: 20:50
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Null hypothesis: No serial correlation at lag h

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.719246 | 9 | 0.5627 | 0.857718 | (9, 13110.7) | 0.5627 |
| 2 | 4.201421 | 9 | 0.8977 | 0.466775 | (9, 13110.7) | 0.8977 |
| 3 | 4.577358 | 9 | 0.8695 | 0.508548 | (9, 13110.7) | 0.8695 |
| 4 | 13.58835 | 9 | 0.1377 | 1.510196 | (9, 13110.7) | 0.1377 |
| 5 | 8.430329 | 9 | 0.4914 | 0.936754 | (9, 13110.7) | 0.4914 |
| 6 | 14.37630 | 9 | 0.1096 | 1.597816 | (9, 13110.7) | 0.1096 |
| 7 | 4.876304 | 9 | 0.8450 | 0.541768 | (9, 13110.7) | 0.8450 |
| 8 | 5.841066 | 9 | 0.7557 | 0.648979 | (9, 13110.7) | 0.7557 |
| 9 | 9.203139 | 9 | 0.4187 | 1.022657 | (9, 13110.7) | 0.4187 |
| 10 | 13.03563 | 9 | 0.1610 | 1.448736 | (9, 13110.7) | 0.1610 |
| 11 | 9.609062 | 9 | 0.3831 | 1.067780 | (9, 13110.7) | 0.3831 |
| 12 | 4.948986 | 9 | 0.8387 | 0.549844 | (9, 13110.7) | 0.8387 |
| 13 | 4.107686 | 9 | 0.9042 | 0.456359 | (9, 13110.7) | 0.9042 |
| 14 | 11.79616 | 9 | 0.2250 | 1.310924 | (9, 13110.7) | 0.2250 |
| 15 | 11.49402 | 9 | 0.2434 | 1.277332 | (9, 13110.7) | 0.2434 |
| 16 | 6.655566 | 9 | 0.6729 | 0.739498 | (9, 13110.7) | 0.6729 |
| 17 | 3.976425 | 9 | 0.9130 | 0.441774 | (9, 13110.7) | 0.9130 |
| 18 | 9.777024 | 9 | 0.3688 | 1.086451 | (9, 13110.7) | 0.3688 |
| 19 | 2.941007 | 9 | 0.9666 | 0.326728 | (9, 13110.7) | 0.9666 |
| 20 | 3.248905 | 9 | 0.9536 | 0.360938 | (9, 13110.7) | 0.9536 |
| 21 | 4.562844 | 9 | 0.8706 | 0.506935 | (9, 13110.7) | 0.8706 |
| 22 | 12.81770 | 9 | 0.1710 | 1.424505 | (9, 13110.7) | 0.1710 |
| 23 | 15.83056 | 9 | 0.0705 | 1.759543 | (9, 13110.7) | 0.0705 |
| 24 | 13.59240 | 9 | 0.1376 | 1.510646 | (9, 13110.7) | 0.1376 |
| 25 | 8.426452 | 9 | 0.4918 | 0.936323 | (9, 13110.7) | 0.4918 |
| 26 | 2.660009 | 9 | 0.9763 | 0.295508 | (9, 13110.7) | 0.9763 |
| 27 | 4.842789 | 9 | 0.8478 | 0.538043 | (9, 13110.7) | 0.8478 |
| 28 | 6.346965 | 9 | 0.7048 | 0.705201 | (9, 13110.7) | 0.7048 |
| 29 | 7.026915 | 9 | 0.6343 | 0.780769 | (9, 13110.7) | 0.6343 |
| 30 | 8.730730 | 9 | 0.4625 | 0.970145 | (9, 13110.7) | 0.4625 |

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 7.719246 | 9 | 0.5627 | 0.857718 | (9, 13110.7) | 0.5627 |
| 2 | 13.01643 | 18 | 0.7906 | 0.723064 | (18, 15228.7) | 0.7906 |
| 3 | 18.82057 | 27 | 0.8764 | 0.696921 | (27, 15715.9) | 0.8764 |
| 4 | 28.40235 | 36 | 0.8126 | 0.788815 | (36, 15890.6) | 0.8126 |
| 5 | 36.15422 | 45 | 0.8238 | 0.803255 | (45, 15968.5) | 0.8238 |
| 6 | 43.43999 | 54 | 0.8475 | 0.804229 | (54, 16007.3) | 0.8475 |
| 7 | 49.98486 | 63 | 0.8830 | 0.793137 | (63, 16027.2) | 0.8830 |
| 8 | 68.64638 | 72 | 0.5902 | 0.953380 | (72, 16037.1) | 0.5902 |
| 9 | 81.12956 | 81 | 0.4751 | 1.001664 | (81, 16041.0) | 0.4751 |
| 10 | 89.51968 | 90 | 0.4945 | 0.994708 | (90, 16041.3) | 0.4945 |
| 11 | 94.71177 | 99 | 0.6032 | 0.956613 | (99, 16039.2) | 0.6032 |
| 12 | 97.04643 | 108 | 0.7662 | 0.898325 | (108, 16035.4) | 0.7662 |
| 13 | 102.2298 | 117 | 0.8328 | 0.873409 | (117, 16030.5) | 0.8328 |
| 14 | 115.0158 | 126 | 0.7488 | 0.912564 | (126, 16024.7) | 0.7488 |
| 15 | 122.3601 | 135 | 0.7745 | 0.906066 | (135, 16018.4) | 0.7745 |
| 16 | 130.1462 | 144 | 0.7894 | 0.903454 | (144, 16011.5) | 0.7895 |
| 17 | 131.4417 | 153 | 0.8956 | 0.858567 | (153, 16004.3) | 0.8956 |
| 18 | 134.8891 | 162 | 0.9408 | 0.831991 | (162, 15996.8) | 0.9409 |
| 19 | 145.9001 | 171 | 0.9183 | 0.852595 | (171, 15989.0) | 0.9183 |
| 20 | 155.2398 | 180 | 0.9090 | 0.861823 | (180, 15981.1) | 0.9090 |
| 21 | 164.2155 | 189 | 0.9033 | 0.868238 | (189, 15973.0) | 0.9033 |
| 22 | 172.4571 | 198 | 0.9048 | 0.870345 | (198, 15964.8) | 0.9048 |
| 23 | 182.5407 | 207 | 0.8887 | 0.881210 | (207, 15956.5) | 0.8888 |
| 24 | 186.5168 | 216 | 0.9273 | 0.862750 | (216, 15948.1) | 0.9274 |
| 25 | 196.2633 | 225 | 0.9170 | 0.871539 | (225, 15939.7) | 0.9170 |
| 26 | 198.7365 | 234 | 0.9544 | 0.848405 | (234, 15931.1) | 0.9544 |
| 27 | 210.4539 | 243 | 0.9354 | 0.865223 | (243, 15922.6) | 0.9354 |
| 28 | 222.0493 | 252 | 0.9132 | 0.880361 | (252, 15913.9) | 0.9133 |
| 29 | 234.3727 | 261 | 0.8806 | 0.897269 | (261, 15905.3) | 0.8807 |
| 30 | 238.7667 | 270 | 0.9148 | 0.883492 | (270, 15896.6) | 0.9148 |

*Edgeworth expansion corrected likelihood ratio statistic.

## Section III: VAR Estimates

**EViews Output 56: VAR Estimates – Cocoa**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:12
Sample (adjusted): 5/03/2000 5/13/2021
Included observations: 5487 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | COCOA_LA... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| COCOA_LAST_PRICE1... | 0.001470 | -0.002039 | -0.010642 |
| | (0.01358) | (0.01669) | (0.01411) |
| | [ 0.10825] | [-0.12216] | [-0.75445] |
| COCOA_LAST_PRICE1... | 0.026382 | 0.015269 | -0.002812 |
| | (0.01358) | (0.01668) | (0.01410) |
| | [ 1.94333] | [ 0.91516] | [-0.19941] |
| COCOA_LAST_PRICE1... | 0.024025 | 0.002365 | 0.009196 |
| | (0.01357) | (0.01668) | (0.01410) |
| | [ 1.77024] | [ 0.14180] | [ 0.65245] |
| COCOA_LAST_PRICE1... | -0.015564 | 0.004919 | 0.007712 |
| | (0.01357) | (0.01668) | (0.01410) |
| | [-1.14660] | [ 0.29484] | [ 0.54700] |
| COCOA_LAST_PRICE1... | -0.000811 | -0.021127 | -0.019847 |
| | (0.01357) | (0.01668) | (0.01409) |
| | [-0.05978] | [-1.26674] | [-1.40812] |
| COCOA_LAST_PRICE1... | -0.025829 | -0.010978 | 0.021335 |
| | (0.01357) | (0.01668) | (0.01410) |
| | [-1.90308] | [-0.65815] | [ 1.51351] |
| COCOA_LAST_PRICE1... | 0.011446 | -0.002258 | 0.015597 |
| | (0.01358) | (0.01669) | (0.01410) |
| | [ 0.84283] | [-0.13532] | [ 1.10581] |
| COCOA_LAST_PRICE1... | 0.005057 | -0.003661 | -0.013566 |
| | (0.01358) | (0.01669) | (0.01411) |
| | [ 0.37230] | [-0.21932] | [-0.96167] |
| COCOA_LAST_PRICE1... | -0.009502 | -0.009047 | 0.008796 |
| | (0.01358) | (0.01669) | (0.01410) |
| | [-0.69975] | [-0.54207] | [ 0.62365] |
| COCOA_LAST_PRICE1... | -0.027399 | -0.010226 | -0.011823 |
| | (0.01357) | (0.01667) | (0.01409) |
| | [-2.01971] | [-0.61336] | [-0.83912] |

| | | | |
|---|---|---|---|
| COCOA_LAST_PRICE1... | 0.005921 | 0.013793 | 0.035169 |
| | (0.01357) | (0.01668) | (0.01409) |
| | [ 0.43632] | [ 0.82707] | [ 2.49539] |
| COCOA_LAST_PRICE1... | -0.014008 | 0.011332 | 0.004543 |
| | (0.01358) | (0.01669) | (0.01410) |
| | [-1.03179] | [ 0.67916] | [ 0.32216] |
| COCOA_LAST_PRICE1... | -0.042305 | 0.018543 | 0.003019 |
| | (0.01358) | (0.01669) | (0.01410) |
| | [-3.11557] | [ 1.11115] | [ 0.21404] |
| COCOA_LAST_PRICE1... | -0.006621 | -0.005551 | 0.008378 |
| | (0.01359) | (0.01670) | (0.01412) |
| | [-0.48718] | [-0.33231] | [ 0.59355] |
| COCOA_LAST_PRICE1... | -0.024969 | -0.001107 | 0.007344 |
| | (0.01359) | (0.01670) | (0.01411) |
| | [-1.83738] | [-0.06626] | [ 0.52029] |
| COCOA_LAST_PRICE1... | -0.011777 | 0.000274 | -0.009116 |
| | (0.01359) | (0.01671) | (0.01412) |
| | [-0.86643] | [ 0.01642] | [-0.64574] |
| COCOA_LAST_PRICE1... | -0.000700 | 0.009417 | 0.006652 |
| | (0.01359) | (0.01670) | (0.01411) |
| | [-0.05153] | [ 0.56399] | [ 0.47141] |
| COCOA_LAST_PRICE1... | -0.005184 | -0.025195 | -0.006811 |
| | (0.01359) | (0.01670) | (0.01411) |
| | [-0.38159] | [-1.50895] | [-0.48269] |
| COCOA_LAST_PRICE1... | -0.005620 | -0.004067 | -0.014020 |
| | (0.01358) | (0.01670) | (0.01411) |
| | [-0.41369] | [-0.24359] | [-0.99365] |
| COCOA_LAST_PRICE1... | -0.040004 | 0.001829 | 0.018147 |
| | (0.01358) | (0.01669) | (0.01411) |
| | [-2.94507] | [ 0.10956] | [ 1.28632] |
| COCOA_LAST_PRICE1... | -0.017804 | -0.022814 | -0.020156 |
| | (0.01359) | (0.01670) | (0.01411) |
| | [-1.31013] | [-1.36596] | [-1.42805] |
| COCOA_LAST_PRICE1... | -0.017126 | 0.003031 | 0.049013 |
| | (0.01360) | (0.01671) | (0.01412) |
| | [-1.25964] | [ 0.18138] | [ 3.47101] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-1) | 0.006313 | 0.484467 | 0.058133 |
| | (0.01146) | (0.01408) | (0.01190) |
| | [ 0.55107] | [ 34.4073] | [ 4.88554] |
| GPRD_ACT(-2) | 0.010578 | 0.197475 | 0.009687 |
| | (0.01266) | (0.01556) | (0.01315) |
| | [ 0.83566] | [ 12.6938] | [ 0.73683] |
| GPRD_ACT(-3) | -0.022086 | 0.089769 | 0.009648 |
| | (0.01286) | (0.01580) | (0.01336) |
| | [-1.71766] | [ 5.68038] | [ 0.72245] |
| GPRD_ACT(-4) | 0.009922 | 0.052100 | 0.022946 |
| | (0.01291) | (0.01587) | (0.01341) |
| | [ 0.76827] | [ 3.28248] | [ 1.71070] |
| GPRD_ACT(-5) | -0.016183 | 0.080016 | 0.005619 |
| | (0.01293) | (0.01589) | (0.01343) |
| | [-1.25168] | [ 5.03563] | [ 0.41847] |
| GPRD_ACT(-6) | 0.021879 | 0.009656 | 0.009449 |
| | (0.01296) | (0.01592) | (0.01346) |
| | [ 1.68887] | [ 0.60645] | [ 0.70225] |
| GPRD_ACT(-7) | -0.002143 | -0.019712 | -0.019454 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-0.16539] | [-1.23771] | [-1.44538] |
| GPRD_ACT(-8) | -0.016873 | -0.007351 | -0.018172 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-1.30189] | [-0.46150] | [-1.34998] |
| GPRD_ACT(-9) | -0.004710 | -0.014216 | -0.022185 |
| | (0.01297) | (0.01593) | (0.01347) |
| | [-0.36329] | [-0.89217] | [-1.64755] |
| GPRD_ACT(-10) | -0.000750 | 0.031964 | -0.008541 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-0.05787] | [ 2.00697] | [-0.63460] |
| GPRD_ACT(-11) | 0.002444 | 0.029741 | 0.009737 |
| | (0.01296) | (0.01593) | (0.01347) |
| | [ 0.18851] | [ 1.86649] | [ 0.72308] |
| GPRD_ACT(-12) | 0.019228 | -0.012396 | -0.014777 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [ 1.48339] | [-0.77815] | [-1.09764] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-13) | -0.008547 | 0.006295 | -0.015084 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-0.65949] | [ 0.39522] | [-1.12058] |
| GPRD_ACT(-14) | -0.003966 | -0.004359 | 0.000595 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-0.30598] | [-0.27361] | [ 0.04422] |
| GPRD_ACT(-15) | -0.005743 | 0.015882 | -0.012282 |
| | (0.01296) | (0.01593) | (0.01346) |
| | [-0.44306] | [ 0.99686] | [-0.91228] |
| GPRD_ACT(-16) | 0.001077 | -0.006934 | -0.014502 |
| | (0.01298) | (0.01595) | (0.01348) |
| | [ 0.08296] | [-0.43467] | [-1.07572] |
| GPRD_ACT(-17) | 0.026483 | -0.030691 | -0.015131 |
| | (0.01299) | (0.01597) | (0.01349) |
| | [ 2.03841] | [-1.92209] | [-1.12136] |
| GPRD_ACT(-18) | -0.014612 | 0.005805 | 0.008360 |
| | (0.01298) | (0.01595) | (0.01348) |
| | [-1.12566] | [ 0.36390] | [ 0.62009] |
| GPRD_ACT(-19) | 0.013096 | 0.007519 | 0.003006 |
| | (0.01297) | (0.01594) | (0.01347) |
| | [ 1.00977] | [ 0.47175] | [ 0.22315] |
| GPRD_ACT(-20) | -0.012149 | 0.011768 | 0.016823 |
| | (0.01293) | (0.01589) | (0.01343) |
| | [-0.93946] | [ 0.74040] | [ 1.25248] |
| GPRD_ACT(-21) | 0.004366 | 0.050794 | 0.016336 |
| | (0.01275) | (0.01567) | (0.01324) |
| | [ 0.34242] | [ 3.24156] | [ 1.23366] |
| GPRD_ACT(-22) | -0.002959 | -0.043272 | -0.034855 |
| | (0.01156) | (0.01421) | (0.01201) |
| | [-0.25587] | [-3.04463] | [-2.90203] |
| GPRD_THREAT(-1) | 0.003446 | 0.009127 | 0.337150 |
| | (0.01354) | (0.01664) | (0.01406) |
| | [ 0.25456] | [ 0.54853] | [ 23.9767] |
| GPRD_THREAT(-2) | -0.016116 | 0.043004 | 0.171786 |
| | (0.01428) | (0.01756) | (0.01484) |
| | [-1.12820] | [ 2.44956] | [ 11.5788] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-3) | 0.020280 | -0.021013 | 0.065541 |
| | (0.01444) | (0.01775) | (0.01500) |
| | [ 1.40402] | [-1.18371] | [ 4.36885] |
| GPRD_THREAT(-4) | -0.017142 | -0.017897 | 0.030312 |
| | (0.01448) | (0.01780) | (0.01504) |
| | [-1.18388] | [-1.00567] | [ 2.01554] |
| GPRD_THREAT(-5) | 0.006213 | 0.042754 | 0.081044 |
| | (0.01449) | (0.01781) | (0.01505) |
| | [ 0.42870] | [ 2.40047] | [ 5.38451] |
| GPRD_THREAT(-6) | 0.003929 | -0.015419 | 0.033380 |
| | (0.01453) | (0.01786) | (0.01509) |
| | [ 0.27038] | [-0.86340] | [ 2.21176] |
| GPRD_THREAT(-7) | 0.006800 | -0.004037 | 0.015938 |
| | (0.01454) | (0.01787) | (0.01510) |
| | [ 0.46777] | [-0.22597] | [ 1.05563] |
| GPRD_THREAT(-8) | 0.016801 | -0.000966 | -0.003046 |
| | (0.01452) | (0.01785) | (0.01508) |
| | [ 1.15695] | [-0.05414] | [-0.20196] |
| GPRD_THREAT(-9) | -0.003950 | 0.028508 | 0.022375 |
| | (0.01456) | (0.01789) | (0.01512) |
| | [-0.27135] | [ 1.59355] | [ 1.48001] |
| GPRD_THREAT(-10) | -0.006827 | 0.003067 | 0.045112 |
| | (0.01456) | (0.01790) | (0.01513) |
| | [-0.46875] | [ 0.17134] | [ 2.98215] |
| GPRD_THREAT(-11) | -0.002491 | -0.035365 | 0.012839 |
| | (0.01457) | (0.01791) | (0.01513) |
| | [-0.17093] | [-1.97472] | [ 0.84831] |
| GPRD_THREAT(-12) | 0.009401 | -0.011302 | -0.027518 |
| | (0.01461) | (0.01796) | (0.01518) |
| | [ 0.64345] | [-0.62938] | [-1.81333] |
| GPRD_THREAT(-13) | -0.005918 | -0.048049 | -0.021600 |
| | (0.01461) | (0.01795) | (0.01517) |
| | [-0.40520] | [-2.67677] | [-1.42391] |
| GPRD_THREAT(-14) | -0.018926 | 0.038007 | 0.012997 |
| | (0.01462) | (0.01797) | (0.01518) |
| | [-1.29467] | [ 2.11546] | [ 0.85604] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-15) | 0.019167 | 0.022428 | 0.051708 |
| | (0.01463) | (0.01798) | (0.01519) |
| | [ 1.31027] | [ 1.24746] | [ 3.40330] |
| GPRD_THREAT(-16) | -0.009583 | -0.002200 | 0.013021 |
| | (0.01466) | (0.01802) | (0.01523) |
| | [-0.65357] | [-0.12208] | [ 0.85496] |
| GPRD_THREAT(-17) | -0.004051 | -0.011738 | -0.002157 |
| | (0.01465) | (0.01801) | (0.01522) |
| | [-0.27645] | [-0.65183] | [-0.14171] |
| GPRD_THREAT(-18) | -0.016853 | -0.004060 | -0.001101 |
| | (0.01462) | (0.01797) | (0.01519) |
| | [-1.15231] | [-0.22588] | [-0.07248] |
| GPRD_THREAT(-19) | -0.023377 | -0.002786 | 0.017158 |
| | (0.01462) | (0.01797) | (0.01518) |
| | [-1.59908] | [-0.15504] | [ 1.13003] |
| GPRD_THREAT(-20) | 0.004250 | 0.012428 | 0.043205 |
| | (0.01459) | (0.01793) | (0.01515) |
| | [ 0.29134] | [ 0.69320] | [ 2.85154] |
| GPRD_THREAT(-21) | 0.025873 | -0.026959 | -0.016987 |
| | (0.01445) | (0.01775) | (0.01500) |
| | [ 1.79111] | [-1.51855] | [-1.13223] |
| GPRD_THREAT(-22) | -0.004080 | 0.024518 | 0.040756 |
| | (0.01381) | (0.01697) | (0.01434) |
| | [-0.29545] | [ 1.44464] | [ 2.84161] |
| C | 1.340443 | 5.094642 | 9.520030 |
| | (1.48698) | (1.82753) | (1.54440) |
| | [ 0.90145] | [ 2.78773] | [ 6.16421] |

| | | | |
|---|---|---|---|
| R-squared | 0.015482 | 0.767779 | 0.570577 |
| Adj. R-squared | 0.003494 | 0.764951 | 0.565348 |
| Sum sq. resids | 9893097. | 14943314 | 10671892 |
| S.E. equation | 42.72347 | 52.50780 | 44.37323 |
| F-statistic | 1.291433 | 271.5120 | 109.1148 |
| Log likelihood | -28354.31 | -29485.81 | -28562.21 |
| Akaike AIC | 10.35951 | 10.77194 | 10.43529 |
| Schwarz SC | 10.44022 | 10.85265 | 10.51600 |
| Mean dependent | 0.342264 | 114.2376 | 112.7700 |
| S.D. dependent | 42.79830 | 108.3040 | 67.30542 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 9.21E+09 |
| Determinant resid covariance | 8.88E+09 |
| Log likelihood | -86202.29 |
| Akaike information criterion | 31.49382 |
| Schwarz criterion | 31.73596 |
| Number of coefficients | 201 |

**EViews Output 57: VAR Estimates – Coffee**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:16
Sample (adjusted): 5/03/2000 5/13/2021
Included observations: 5487 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | COFFEE_LA... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| COFFEE_LAST_PRICE... | -0.014387 | 0.057438 | -0.140598 |
| | (0.01356) | (0.25242) | (0.21371) |
| | [-1.06063] | [ 0.22755] | [-0.65788] |
| COFFEE_LAST_PRICE... | -0.007234 | 0.333065 | 0.326033 |
| | (0.01356) | (0.25239) | (0.21369) |
| | [-0.53335] | [ 1.31965] | [ 1.52573] |
| COFFEE_LAST_PRICE... | 0.033388 | -0.046375 | -0.030527 |
| | (0.01356) | (0.25234) | (0.21365) |
| | [ 2.46203] | [-0.18378] | [-0.14288] |
| COFFEE_LAST_PRICE... | -0.007971 | 0.053632 | 0.347835 |
| | (0.01357) | (0.25250) | (0.21378) |
| | [-0.58741] | [ 0.21241] | [ 1.62706] |
| COFFEE_LAST_PRICE... | -0.015527 | -0.323297 | 0.112661 |
| | (0.01354) | (0.25187) | (0.21325) |
| | [-1.14710] | [-1.28359] | [ 0.52830] |
| COFFEE_LAST_PRICE... | 0.001908 | -0.526087 | 0.262787 |
| | (0.01354) | (0.25190) | (0.21327) |
| | [ 0.14095] | [-2.08851] | [ 1.23217] |
| COFFEE_LAST_PRICE... | -0.008971 | -0.065513 | 0.061030 |
| | (0.01354) | (0.25196) | (0.21333) |
| | [-0.66252] | [-0.26001] | [ 0.28608] |
| COFFEE_LAST_PRICE... | -0.001711 | 0.577081 | 0.217512 |
| | (0.01354) | (0.25191) | (0.21328) |
| | [-0.12642] | [ 2.29085] | [ 1.01983] |
| COFFEE_LAST_PRICE... | -0.012706 | 0.097084 | -0.076586 |
| | (0.01355) | (0.25205) | (0.21341) |
| | [-0.93800] | [ 0.38517] | [-0.35888] |
| COFFEE_LAST_PRICE... | 0.004220 | 0.007939 | 0.025685 |
| | (0.01355) | (0.25209) | (0.21344) |
| | [ 0.31153] | [ 0.03149] | [ 0.12034] |

| | | | |
|---|---|---|---|
| COFFEE_LAST_PRICE... | 0.006454 | -0.306164 | 0.253885 |
| | (0.01355) | (0.25205) | (0.21341) |
| | [ 0.47645] | [-1.21468] | [ 1.18968] |
| COFFEE_LAST_PRICE... | -0.007539 | 0.145157 | 0.316843 |
| | (0.01355) | (0.25222) | (0.21355) |
| | [-0.55620] | [ 0.57552] | [ 1.48372] |
| COFFEE_LAST_PRICE... | -0.001225 | 0.034596 | 0.417608 |
| | (0.01356) | (0.25228) | (0.21360) |
| | [-0.09035] | [ 0.13714] | [ 1.95512] |
| COFFEE_LAST_PRICE... | -0.005824 | -0.030046 | 0.340819 |
| | (0.01356) | (0.25233) | (0.21364) |
| | [-0.42947] | [-0.11907] | [ 1.59531] |
| COFFEE_LAST_PRICE... | -0.008579 | 0.068054 | 0.197676 |
| | (0.01356) | (0.25232) | (0.21363) |
| | [-0.63266] | [ 0.26971] | [ 0.92532] |
| COFFEE_LAST_PRICE... | -0.025357 | 0.131700 | 0.106468 |
| | (0.01356) | (0.25239) | (0.21369) |
| | [-1.86951] | [ 0.52181] | [ 0.49823] |
| COFFEE_LAST_PRICE... | -0.014158 | -0.102721 | -0.020675 |
| | (0.01357) | (0.25243) | (0.21372) |
| | [-1.04365] | [-0.40693] | [-0.09674] |
| COFFEE_LAST_PRICE... | -0.056194 | -0.198977 | 0.196620 |
| | (0.01358) | (0.25266) | (0.21392) |
| | [-4.13869] | [-0.78754] | [ 0.91915] |
| COFFEE_LAST_PRICE... | 0.021926 | 0.177846 | 0.091587 |
| | (0.01360) | (0.25305) | (0.21425) |
| | [ 1.61231] | [ 0.70281] | [ 0.42748] |
| COFFEE_LAST_PRICE... | -0.021695 | -0.256749 | 0.384557 |
| | (0.01359) | (0.25295) | (0.21417) |
| | [-1.59595] | [-1.01501] | [ 1.79559] |
| COFFEE_LAST_PRICE... | -0.033143 | 0.000595 | -0.212829 |
| | (0.01361) | (0.25320) | (0.21438) |
| | [-2.43572] | [ 0.00235] | [-0.99277] |
| COFFEE_LAST_PRICE... | -0.032126 | -0.439350 | -0.102784 |
| | (0.01361) | (0.25326) | (0.21442) |
| | [-2.36044] | [-1.73480] | [-0.47935] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-1) | 0.000721 | 0.484501 | 0.058259 |
| | (0.00076) | (0.01408) | (0.01192) |
| | [ 0.95258] | [ 34.4038] | [ 4.88608] |
| GPRD_ACT(-2) | -0.000362 | 0.198053 | 0.010342 |
| | (0.00084) | (0.01556) | (0.01317) |
| | [-0.43322] | [ 12.7286] | [ 0.78506] |
| GPRD_ACT(-3) | -0.001116 | 0.090804 | 0.009217 |
| | (0.00085) | (0.01580) | (0.01338) |
| | [-1.31449] | [ 5.74534] | [ 0.68877] |
| GPRD_ACT(-4) | 0.000943 | 0.051743 | 0.021605 |
| | (0.00085) | (0.01587) | (0.01344) |
| | [ 1.10547] | [ 3.25999] | [ 1.60772] |
| GPRD_ACT(-5) | 7.21E-05 | 0.078918 | 0.006644 |
| | (0.00085) | (0.01589) | (0.01345) |
| | [ 0.08442] | [ 4.96622] | [ 0.49380] |
| GPRD_ACT(-6) | 9.48E-05 | 0.008306 | 0.009207 |
| | (0.00086) | (0.01592) | (0.01348) |
| | [ 0.11084] | [ 0.52166] | [ 0.68299] |
| GPRD_ACT(-7) | 9.74E-05 | -0.020323 | -0.017554 |
| | (0.00086) | (0.01592) | (0.01348) |
| | [ 0.11389] | [-1.27653] | [-1.30224] |
| GPRD_ACT(-8) | -0.002044 | -0.007234 | -0.017943 |
| | (0.00086) | (0.01592) | (0.01348) |
| | [-2.38874] | [-0.45431] | [-1.33098] |
| GPRD_ACT(-9) | 0.000607 | -0.013856 | -0.021091 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [ 0.70925] | [-0.86975] | [-1.56360] |
| GPRD_ACT(-10) | 0.000314 | 0.033871 | -0.008700 |
| | (0.00086) | (0.01593) | (0.01348) |
| | [ 0.36642] | [ 2.12673] | [-0.64520] |
| GPRD_ACT(-11) | 0.001373 | 0.029204 | 0.008690 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [ 1.60304] | [ 1.83279] | [ 0.64416] |
| GPRD_ACT(-12) | -0.001144 | -0.012074 | -0.015306 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [-1.33563] | [-0.75781] | [-1.13470] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-13) | 0.000787 | 0.006149 | -0.013524 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [ 0.91916] | [ 0.38603] | [-1.00276] |
| GPRD_ACT(-14) | -0.000591 | -0.005095 | 0.000223 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [-0.69031] | [-0.31982] | [ 0.01653] |
| GPRD_ACT(-15) | 9.44E-05 | 0.015775 | -0.013099 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [ 0.11025] | [ 0.99038] | [-0.97131] |
| GPRD_ACT(-16) | 0.000106 | -0.006113 | -0.015370 |
| | (0.00086) | (0.01595) | (0.01350) |
| | [ 0.12402] | [-0.38340] | [-1.13848] |
| GPRD_ACT(-17) | 0.000573 | -0.031111 | -0.016584 |
| | (0.00086) | (0.01595) | (0.01351) |
| | [ 0.66894] | [-1.95025] | [-1.22788] |
| GPRD_ACT(-18) | -0.000121 | 0.006358 | 0.009482 |
| | (0.00086) | (0.01593) | (0.01349) |
| | [-0.14189] | [ 0.39906] | [ 0.70291] |
| GPRD_ACT(-19) | 0.000382 | 0.006803 | 0.001768 |
| | (0.00086) | (0.01592) | (0.01348) |
| | [ 0.44655] | [ 0.42738] | [ 0.13115] |
| GPRD_ACT(-20) | 0.000517 | 0.011563 | 0.017988 |
| | (0.00085) | (0.01587) | (0.01344) |
| | [ 0.60592] | [ 0.72853] | [ 1.33863] |
| GPRD_ACT(-21) | -0.000659 | 0.051168 | 0.016627 |
| | (0.00084) | (0.01564) | (0.01325) |
| | [-0.78370] | [ 3.27060] | [ 1.25522] |
| GPRD_ACT(-22) | -0.000728 | -0.043414 | -0.035390 |
| | (0.00076) | (0.01419) | (0.01202) |
| | [-0.95461] | [-3.05866] | [-2.94483] |
| GPRD_THREAT(-1) | -0.002311 | 0.008580 | 0.332904 |
| | (0.00089) | (0.01663) | (0.01408) |
| | [-2.58514] | [ 0.51579] | [ 23.6377] |
| GPRD_THREAT(-2) | 0.000481 | 0.044569 | 0.171377 |
| | (0.00094) | (0.01754) | (0.01485) |
| | [ 0.51016] | [ 2.54094] | [ 11.5399] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-3) | 0.000886 | -0.021374 | 0.067075 |
| | (0.00095) | (0.01773) | (0.01501) |
| | [ 0.93003] | [-1.20579] | [ 4.46924] |
| GPRD_THREAT(-4) | 0.000571 | -0.018605 | 0.029223 |
| | (0.00096) | (0.01777) | (0.01505) |
| | [ 0.59789] | [-1.04680] | [ 1.94201] |
| GPRD_THREAT(-5) | 0.001022 | 0.043904 | 0.082343 |
| | (0.00096) | (0.01778) | (0.01506) |
| | [ 1.06915] | [ 2.46870] | [ 5.46860] |
| GPRD_THREAT(-6) | -0.001742 | -0.016462 | 0.031654 |
| | (0.00096) | (0.01783) | (0.01510) |
| | [-1.81778] | [-0.92300] | [ 2.09623] |
| GPRD_THREAT(-7) | 0.000121 | -0.004574 | 0.015422 |
| | (0.00096) | (0.01785) | (0.01511) |
| | [ 0.12645] | [-0.25629] | [ 1.02061] |
| GPRD_THREAT(-8) | 0.000989 | 0.000233 | -0.002517 |
| | (0.00096) | (0.01783) | (0.01509) |
| | [ 1.03214] | [ 0.01308] | [-0.16674] |
| GPRD_THREAT(-9) | -0.000310 | 0.030792 | 0.022173 |
| | (0.00096) | (0.01787) | (0.01513) |
| | [-0.32261] | [ 1.72351] | [ 1.46585] |
| GPRD_THREAT(-10) | -0.000911 | 0.002632 | 0.043652 |
| | (0.00096) | (0.01788) | (0.01514) |
| | [-0.94858] | [ 0.14722] | [ 2.88409] |
| GPRD_THREAT(-11) | -4.98E-05 | -0.035601 | 0.015460 |
| | (0.00096) | (0.01788) | (0.01514) |
| | [-0.05179] | [-1.99060] | [ 1.02097] |
| GPRD_THREAT(-12) | -6.78E-05 | -0.013710 | -0.027702 |
| | (0.00096) | (0.01794) | (0.01519) |
| | [-0.07030] | [-0.76435] | [-1.82411] |
| GPRD_THREAT(-13) | -0.001236 | -0.047854 | -0.021545 |
| | (0.00096) | (0.01793) | (0.01518) |
| | [-1.28215] | [-2.66851] | [-1.41902] |
| GPRD_THREAT(-14) | 0.001688 | 0.039976 | 0.014760 |
| | (0.00096) | (0.01795) | (0.01520) |
| | [ 1.75023] | [ 2.22716] | [ 0.97126] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-15) | 0.000490 | 0.021046 | 0.052663 |
| | (0.00097) | (0.01797) | (0.01521) |
| | [ 0.50766] | [ 1.17138] | [ 3.46190] |
| GPRD_THREAT(-16) | -0.000544 | -0.002011 | 0.013709 |
| | (0.00097) | (0.01801) | (0.01525) |
| | [-0.56220] | [-0.11169] | [ 0.89899] |
| GPRD_THREAT(-17) | 0.002153 | -0.012838 | -0.002274 |
| | (0.00097) | (0.01800) | (0.01524) |
| | [ 2.22622] | [-0.71334] | [-0.14921] |
| GPRD_THREAT(-18) | -0.003132 | -0.003687 | -0.000611 |
| | (0.00097) | (0.01798) | (0.01522) |
| | [-3.24131] | [-0.20510] | [-0.04013] |
| GPRD_THREAT(-19) | -0.001635 | -0.003505 | 0.018098 |
| | (0.00097) | (0.01798) | (0.01523) |
| | [-1.69131] | [-0.19487] | [ 1.18852] |
| GPRD_THREAT(-20) | 0.000101 | 0.015248 | 0.042988 |
| | (0.00096) | (0.01795) | (0.01519) |
| | [ 0.10490] | [ 0.84968] | [ 2.82930] |
| GPRD_THREAT(-21) | 0.000580 | -0.027967 | -0.016336 |
| | (0.00096) | (0.01777) | (0.01505) |
| | [ 0.60751] | [-1.57374] | [-1.08573] |
| GPRD_THREAT(-22) | 0.002561 | 0.024233 | 0.039885 |
| | (0.00091) | (0.01698) | (0.01438) |
| | [ 2.80609] | [ 1.42704] | [ 2.77409] |
| C | 0.073194 | 5.025028 | 9.409274 |
| | (0.09813) | (1.82597) | (1.54599) |
| | [ 0.74590] | [ 2.75198] | [ 6.08625] |

| | | | |
|---|---|---|---|
| R-squared | 0.019868 | 0.768206 | 0.569752 |
| Adj. R-squared | 0.007932 | 0.765384 | 0.564513 |
| Sum sq. resids | 43077.25 | 14915790 | 10692376 |
| S.E. equation | 2.819190 | 52.45942 | 44.41580 |
| F-statistic | 1.664616 | 272.1646 | 108.7485 |
| Log likelihood | -13439.01 | -29480.75 | -28567.47 |
| Akaike AIC | 4.922912 | 10.77009 | 10.43720 |
| Schwarz SC | 5.003626 | 10.85081 | 10.51792 |
| Mean dependent | 0.024048 | 114.2376 | 112.7700 |
| S.D. dependent | 2.830438 | 108.3040 | 67.30542 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 40085533 |
| Determinant resid covariance | 38634976 |
| Log likelihood | -71285.18 |
| Akaike information criterion | 26.05656 |
| Schwarz criterion | 26.29871 |
| Number of coefficients | 201 |

**EViews Output 58: VAR Estimates – Corn**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:21
Sample (adjusted): 5/03/2000 5/13/2021
Included observations: 5487 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | CORN_LAS... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| CORN_LAST_PRICE1(-1) | 0.027926 | 0.093925 | 0.108948 |
| | (0.01359) | (0.08481) | (0.07179) |
| | [ 2.05536] | [ 1.10746] | [ 1.51755] |
| CORN_LAST_PRICE1(-2) | -0.028820 | 0.005207 | -0.004093 |
| | (0.01360) | (0.08487) | (0.07184) |
| | [-2.11961] | [ 0.06136] | [-0.05698] |
| CORN_LAST_PRICE1(-3) | 0.013558 | 0.049289 | 0.080795 |
| | (0.01360) | (0.08489) | (0.07185) |
| | [ 0.99701] | [ 0.58066] | [ 1.12442] |
| CORN_LAST_PRICE1(-4) | -0.018883 | -0.090355 | -0.000149 |
| | (0.01359) | (0.08485) | (0.07182) |
| | [-1.38921] | [-1.06492] | [-0.00208] |
| CORN_LAST_PRICE1(-5) | 0.009403 | -0.000822 | -0.062592 |
| | (0.01359) | (0.08482) | (0.07180) |
| | [ 0.69196] | [-0.00969] | [-0.87176] |
| CORN_LAST_PRICE1(-6) | -0.000172 | -0.089967 | -0.082241 |
| | (0.01359) | (0.08480) | (0.07178) |
| | [-0.01267] | [-1.06093] | [-1.14569] |
| CORN_LAST_PRICE1(-7) | 0.033743 | 0.029309 | 0.013828 |
| | (0.01359) | (0.08481) | (0.07179) |
| | [ 2.48346] | [ 0.34558] | [ 0.19261] |
| CORN_LAST_PRICE1(-8) | -0.005724 | 0.029508 | 0.054022 |
| | (0.01359) | (0.08481) | (0.07179) |
| | [-0.42127] | [ 0.34793] | [ 0.75248] |
| CORN_LAST_PRICE1(-9) | 0.028214 | 0.044854 | 0.043537 |
| | (0.01359) | (0.08483) | (0.07181) |
| | [ 2.07614] | [ 0.52876] | [ 0.60631] |
| CORN_LAST_PRICE1(-... | 0.004015 | -0.031538 | -0.011405 |
| | (0.01359) | (0.08485) | (0.07182) |
| | [ 0.29537] | [-0.37170] | [-0.15879] |

| | | | |
|---|---|---|---|
| CORN_LAST_PRICE1(-... | -0.001772 | -0.059828 | 0.013633 |
| | (0.01358) | (0.08478) | (0.07177) |
| | [-0.13048] | [-0.70566] | [ 0.18996] |
| CORN_LAST_PRICE1(-... | -0.055401 | 0.025795 | 0.103941 |
| | (0.01360) | (0.08488) | (0.07185) |
| | [-4.07407] | [ 0.30390] | [ 1.44659] |
| CORN_LAST_PRICE1(-... | 0.014858 | -0.001163 | 0.114274 |
| | (0.01364) | (0.08513) | (0.07206) |
| | [ 1.08949] | [-0.01366] | [ 1.58585] |
| CORN_LAST_PRICE1(-... | 0.013908 | 0.143450 | 0.093668 |
| | (0.01366) | (0.08528) | (0.07219) |
| | [ 1.01799] | [ 1.68209] | [ 1.29752] |
| CORN_LAST_PRICE1(-... | 0.033942 | -0.036669 | -0.002334 |
| | (0.01367) | (0.08530) | (0.07221) |
| | [ 2.48372] | [-0.42987] | [-0.03232] |
| CORN_LAST_PRICE1(-... | 0.009381 | -0.040469 | -0.019448 |
| | (0.01367) | (0.08533) | (0.07223) |
| | [ 0.68623] | [-0.47425] | [-0.26923] |
| CORN_LAST_PRICE1(-... | -0.029048 | -0.131832 | 0.084876 |
| | (0.01368) | (0.08536) | (0.07226) |
| | [-2.12419] | [-1.54442] | [ 1.17465] |
| CORN_LAST_PRICE1(-... | -0.034240 | 0.012619 | -0.016967 |
| | (0.01369) | (0.08543) | (0.07231) |
| | [-2.50184] | [ 0.14772] | [-0.23463] |
| CORN_LAST_PRICE1(-... | 0.023871 | -0.062373 | -0.071693 |
| | (0.01369) | (0.08544) | (0.07233) |
| | [ 1.74395] | [-0.73001] | [-0.99125] |
| CORN_LAST_PRICE1(-... | -0.030654 | 0.022190 | 0.030984 |
| | (0.01369) | (0.08542) | (0.07231) |
| | [-2.23991] | [ 0.25976] | [ 0.42849] |
| CORN_LAST_PRICE1(-... | 0.004834 | 0.033084 | 0.078459 |
| | (0.01368) | (0.08542) | (0.07231) |
| | [ 0.35320] | [ 0.38730] | [ 1.08505] |
| CORN_LAST_PRICE1(-... | -0.023198 | -0.021444 | -0.013486 |
| | (0.01367) | (0.08534) | (0.07224) |
| | [-1.69685] | [-0.25129] | [-0.18668] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-1) | -0.000705 | 0.484888 | 0.057703 |
| | (0.00226) | (0.01408) | (0.01192) |
| | [-0.31250] | [ 34.4388] | [ 4.84149] |
| GPRD_ACT(-2) | 0.002948 | 0.196964 | 0.009418 |
| | (0.00249) | (0.01556) | (0.01317) |
| | [ 1.18270] | [ 12.6592] | [ 0.71507] |
| GPRD_ACT(-3) | -0.001396 | 0.090767 | 0.009872 |
| | (0.00253) | (0.01581) | (0.01338) |
| | [-0.55117] | [ 5.74285] | [ 0.73785] |
| GPRD_ACT(-4) | -0.006322 | 0.051950 | 0.023175 |
| | (0.00254) | (0.01587) | (0.01343) |
| | [-2.48631] | [ 3.27327] | [ 1.72504] |
| GPRD_ACT(-5) | 0.001966 | 0.079561 | 0.006688 |
| | (0.00255) | (0.01590) | (0.01346) |
| | [ 0.77210] | [ 5.00450] | [ 0.49694] |
| GPRD_ACT(-6) | 0.001015 | 0.008568 | 0.008633 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [ 0.39777] | [ 0.53803] | [ 0.64038] |
| GPRD_ACT(-7) | -0.001606 | -0.020396 | -0.018762 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [-0.62930] | [-1.28069] | [-1.39170] |
| GPRD_ACT(-8) | 0.003405 | -0.006757 | -0.018148 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [ 1.33451] | [-0.42420] | [-1.34597] |
| GPRD_ACT(-9) | -0.002507 | -0.014042 | -0.022161 |
| | (0.00255) | (0.01593) | (0.01349) |
| | [-0.98233] | [-0.88141] | [-1.64327] |
| GPRD_ACT(-10) | 0.001565 | 0.032366 | -0.008140 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [ 0.61311] | [ 2.03198] | [-0.60370] |
| GPRD_ACT(-11) | 0.002684 | 0.029216 | 0.009371 |
| | (0.00255) | (0.01594) | (0.01349) |
| | [ 1.05135] | [ 1.83329] | [ 0.69467] |
| GPRD_ACT(-12) | -0.001304 | -0.011500 | -0.015448 |
| | (0.00255) | (0.01593) | (0.01349) |
| | [-0.51081] | [-0.72179] | [-1.14541] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-13) | -0.002002 | 0.006522 | -0.013484 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [-0.78465] | [ 0.40943] | [-1.00005] |
| GPRD_ACT(-14) | 1.50E-05 | -0.003728 | -0.001399 |
| | (0.00255) | (0.01593) | (0.01349) |
| | [ 0.00589] | [-0.23403] | [-0.10371] |
| GPRD_ACT(-15) | -0.000136 | 0.015869 | -0.011883 |
| | (0.00255) | (0.01593) | (0.01349) |
| | [-0.05348] | [ 0.99615] | [-0.88119] |
| GPRD_ACT(-16) | 0.000817 | -0.007494 | -0.014577 |
| | (0.00256) | (0.01595) | (0.01350) |
| | [ 0.31985] | [-0.46981] | [-1.07954] |
| GPRD_ACT(-17) | 0.000410 | -0.030381 | -0.014624 |
| | (0.00256) | (0.01597) | (0.01352) |
| | [ 0.16016] | [-1.90280] | [-1.08203] |
| GPRD_ACT(-18) | -0.001506 | 0.006544 | 0.009752 |
| | (0.00255) | (0.01594) | (0.01350) |
| | [-0.58958] | [ 0.41045] | [ 0.72265] |
| GPRD_ACT(-19) | 0.000278 | 0.007913 | 0.001520 |
| | (0.00255) | (0.01593) | (0.01348) |
| | [ 0.10898] | [ 0.49678] | [ 0.11271] |
| GPRD_ACT(-20) | -0.001070 | 0.009850 | 0.016716 |
| | (0.00254) | (0.01588) | (0.01344) |
| | [-0.42067] | [ 0.62021] | [ 1.24341] |
| GPRD_ACT(-21) | 0.001204 | 0.051758 | 0.018103 |
| | (0.00251) | (0.01565) | (0.01325) |
| | [ 0.48007] | [ 3.30646] | [ 1.36616] |
| GPRD_ACT(-22) | 0.000370 | -0.044526 | -0.035723 |
| | (0.00228) | (0.01420) | (0.01202) |
| | [ 0.16279] | [-3.13501] | [-2.97133] |
| GPRD_THREAT(-1) | 0.006470 | 0.008325 | 0.334473 |
| | (0.00267) | (0.01664) | (0.01408) |
| | [ 2.42752] | [ 0.50039] | [ 23.7497] |
| GPRD_THREAT(-2) | -0.003426 | 0.043952 | 0.173298 |
| | (0.00281) | (0.01756) | (0.01486) |
| | [-1.21811] | [ 2.50331] | [ 11.6603] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-3) | 0.005241 | -0.020434 | 0.066592 |
| | (0.00284) | (0.01776) | (0.01503) |
| | [ 1.84235] | [-1.15073] | [ 4.43013] |
| GPRD_THREAT(-4) | -0.000501 | -0.019292 | 0.027657 |
| | (0.00285) | (0.01781) | (0.01507) |
| | [-0.17548] | [-1.08339] | [ 1.83479] |
| GPRD_THREAT(-5) | -0.003181 | 0.044761 | 0.081857 |
| | (0.00285) | (0.01782) | (0.01508) |
| | [-1.11415] | [ 2.51195] | [ 5.42673] |
| GPRD_THREAT(-6) | 0.002349 | -0.016566 | 0.032782 |
| | (0.00286) | (0.01786) | (0.01512) |
| | [ 0.82067] | [-0.92734] | [ 2.16786] |
| GPRD_THREAT(-7) | 0.001034 | -0.003553 | 0.017143 |
| | (0.00286) | (0.01787) | (0.01513) |
| | [ 0.36116] | [-0.19877] | [ 1.13309] |
| GPRD_THREAT(-8) | -0.004547 | -0.000397 | -0.002228 |
| | (0.00286) | (0.01786) | (0.01512) |
| | [-1.58939] | [-0.02222] | [-0.14738] |
| GPRD_THREAT(-9) | 0.005386 | 0.029482 | 0.022559 |
| | (0.00287) | (0.01790) | (0.01515) |
| | [ 1.87836] | [ 1.64731] | [ 1.48906] |
| GPRD_THREAT(-10) | -0.000811 | 0.001520 | 0.042025 |
| | (0.00287) | (0.01791) | (0.01516) |
| | [-0.28247] | [ 0.08485] | [ 2.77195] |
| GPRD_THREAT(-11) | -0.000352 | -0.036484 | 0.015347 |
| | (0.00287) | (0.01792) | (0.01517) |
| | [-0.12277] | [-2.03628] | [ 1.01189] |
| GPRD_THREAT(-12) | 0.000719 | -0.012727 | -0.028281 |
| | (0.00288) | (0.01797) | (0.01521) |
| | [ 0.24976] | [-0.70833] | [-1.85946] |
| GPRD_THREAT(-13) | -0.003559 | -0.047238 | -0.023052 |
| | (0.00288) | (0.01796) | (0.01520) |
| | [-1.23689] | [-2.62999] | [-1.51617] |
| GPRD_THREAT(-14) | 0.003490 | 0.039364 | 0.014073 |
| | (0.00288) | (0.01798) | (0.01522) |
| | [ 1.21171] | [ 2.18963] | [ 0.92479] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-15) | -0.000666 | 0.020190 | 0.050517 |
| | (0.00288) | (0.01799) | (0.01523) |
| | [-0.23101] | [ 1.12203] | [ 3.31653] |
| GPRD_THREAT(-16) | -0.003397 | -0.000723 | 0.014489 |
| | (0.00289) | (0.01804) | (0.01527) |
| | [-1.17557] | [-0.04008] | [ 0.94905] |
| GPRD_THREAT(-17) | 0.003704 | -0.013198 | -0.002984 |
| | (0.00289) | (0.01802) | (0.01526) |
| | [ 1.28301] | [-0.73234] | [-0.19562] |
| GPRD_THREAT(-18) | 0.001091 | -0.003134 | -0.002125 |
| | (0.00288) | (0.01800) | (0.01523) |
| | [ 0.37835] | [-0.17417] | [-0.13948] |
| GPRD_THREAT(-19) | -0.006255 | -0.002631 | 0.018422 |
| | (0.00288) | (0.01799) | (0.01523) |
| | [-2.17066] | [-0.14628] | [ 1.20994] |
| GPRD_THREAT(-20) | -0.000105 | 0.014441 | 0.042819 |
| | (0.00288) | (0.01795) | (0.01520) |
| | [-0.03651] | [ 0.80440] | [ 2.81766] |
| GPRD_THREAT(-21) | -0.000652 | -0.028128 | -0.017232 |
| | (0.00285) | (0.01778) | (0.01505) |
| | [-0.22881] | [-1.58182] | [-1.14479] |
| GPRD_THREAT(-22) | 0.002010 | 0.025562 | 0.040118 |
| | (0.00272) | (0.01698) | (0.01437) |
| | [ 0.73895] | [ 1.50575] | [ 2.79172] |
| C | -0.150968 | 5.020542 | 9.763290 |
| | (0.29297) | (1.82874) | (1.54802) |
| | [-0.51530] | [ 2.74535] | [ 6.30697] |

| | | | |
|---|---|---|---|
| R-squared | 0.020350 | 0.767810 | 0.569196 |
| Adj. R-squared | 0.008421 | 0.764982 | 0.563950 |
| Sum sq. resids | 383473.9 | 14941317 | 10706194 |
| S.E. equation | 8.411400 | 52.50429 | 44.44449 |
| F-statistic | 1.705916 | 271.5592 | 108.5021 |
| Log likelihood | -19437.06 | -29485.44 | -28571.01 |
| Akaike AIC | 7.109188 | 10.77180 | 10.43849 |
| Schwarz SC | 7.189903 | 10.85252 | 10.51921 |
| Mean dependent | 0.092400 | 114.2376 | 112.7700 |
| S.D. dependent | 8.447042 | 108.3040 | 67.30542 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 3.58E+08 |
| Determinant resid covariance | 3.45E+08 |
| Log likelihood | -77291.59 |
| Akaike information criterion | 28.24589 |
| Schwarz criterion | 28.48803 |
| Number of coefficients | 201 |

**EViews Output 59: VAR Estimates – Cotton**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:25
Sample (adjusted): 5/12/2000 5/13/2021
Included observations: 5480 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | COTTON_L... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| COTTON_LAST_PRICE... | 0.129912 | 0.046225 | -0.519869 |
| | (0.01363) | (0.48262) | (0.40890) |
| | [ 9.53256] | [ 0.09578] | [-1.27138] |
| COTTON_LAST_PRICE... | 0.008420 | -0.190864 | 0.462244 |
| | (0.01375) | (0.48691) | (0.41254) |
| | [ 0.61243] | [-0.39199] | [ 1.12049] |
| COTTON_LAST_PRICE... | -0.032456 | -0.208985 | 0.049220 |
| | (0.01375) | (0.48709) | (0.41269) |
| | [-2.35965] | [-0.42905] | [ 0.11927] |
| COTTON_LAST_PRICE... | 0.003847 | -0.576282 | -0.126871 |
| | (0.01376) | (0.48738) | (0.41293) |
| | [ 0.27953] | [-1.18241] | [-0.30724] |
| COTTON_LAST_PRICE... | 0.028603 | 0.389584 | 0.167454 |
| | (0.01377) | (0.48770) | (0.41321) |
| | [ 2.07693] | [ 0.79882] | [ 0.40525] |
| COTTON_LAST_PRICE... | -0.035708 | -0.133624 | 0.129229 |
| | (0.01377) | (0.48762) | (0.41314) |
| | [-2.59328] | [-0.27403] | [ 0.31280] |
| COTTON_LAST_PRICE... | 0.017703 | 0.346648 | 0.326880 |
| | (0.01378) | (0.48784) | (0.41333) |
| | [ 1.28507] | [ 0.71057] | [ 0.79085] |
| COTTON_LAST_PRICE... | -0.029696 | -0.341231 | -0.599625 |
| | (0.01377) | (0.48776) | (0.41325) |
| | [-2.15601] | [-0.69959] | [-1.45098] |
| COTTON_LAST_PRICE... | 0.005106 | 0.412483 | 0.233169 |
| | (0.01376) | (0.48735) | (0.41291) |
| | [ 0.37102] | [ 0.84637] | [ 0.56469] |
| COTTON_LAST_PRICE... | 0.000231 | -0.035318 | -0.208472 |
| | (0.01377) | (0.48752) | (0.41305) |
| | [ 0.01679] | [-0.07244] | [-0.50471] |

| | | | |
|---|---|---|---|
| COTTON_LAST_PRICE... | 0.001838 | -0.229885 | -0.698441 |
| | (0.01377) | (0.48756) | (0.41308) |
| | [ 0.13351] | [-0.47151] | [-1.69080] |
| COTTON_LAST_PRICE... | -0.017760 | -0.450542 | 0.442006 |
| | (0.01376) | (0.48732) | (0.41288) |
| | [-1.29063] | [-0.92453] | [ 1.07054] |
| COTTON_LAST_PRICE... | -0.006344 | 1.086461 | 0.528384 |
| | (0.01375) | (0.48692) | (0.41254) |
| | [-0.46142] | [ 2.23130] | [ 1.28080] |
| COTTON_LAST_PRICE... | 0.041702 | -0.082661 | 0.152499 |
| | (0.01375) | (0.48710) | (0.41270) |
| | [ 3.03184] | [-0.16970] | [ 0.36952] |
| COTTON_LAST_PRICE... | -0.023756 | 0.287318 | 0.030568 |
| | (0.01378) | (0.48786) | (0.41334) |
| | [-1.72440] | [ 0.58893] | [ 0.07395] |
| COTTON_LAST_PRICE... | 0.029108 | -0.510614 | 0.031659 |
| | (0.01379) | (0.48820) | (0.41363) |
| | [ 2.11146] | [-1.04591] | [ 0.07654] |
| COTTON_LAST_PRICE... | -0.045144 | 0.461273 | 0.150471 |
| | (0.01379) | (0.48841) | (0.41380) |
| | [-3.27331] | [ 0.94444] | [ 0.36363] |
| COTTON_LAST_PRICE... | -0.030697 | -0.279882 | -0.310009 |
| | (0.01380) | (0.48883) | (0.41416) |
| | [-2.22386] | [-0.57256] | [-0.74853] |
| COTTON_LAST_PRICE... | -0.002385 | 0.222728 | 0.161782 |
| | (0.01380) | (0.48884) | (0.41417) |
| | [-0.17276] | [ 0.45562] | [ 0.39061] |
| COTTON_LAST_PRICE... | -0.001200 | -0.316624 | 0.231617 |
| | (0.01381) | (0.48905) | (0.41435) |
| | [-0.08686] | [-0.64743] | [ 0.55899] |
| COTTON_LAST_PRICE... | 0.059554 | -0.784700 | -0.208263 |
| | (0.01381) | (0.48907) | (0.41437) |
| | [ 4.31223] | [-1.60447] | [-0.50261] |
| COTTON_LAST_PRICE... | -0.025894 | 0.325913 | 0.271440 |
| | (0.01384) | (0.49014) | (0.41527) |
| | [-1.87084] | [ 0.66494] | [ 0.65364] |

| | | | |
|---|---|---|---|
| COTTON_LAST_PRICE... | 0.015518 | -0.392209 | -0.021944 |
| | (0.01385) | (0.49042) | (0.41551) |
| | [ 1.12057] | [-0.79974] | [-0.05281] |
| COTTON_LAST_PRICE... | 0.031585 | 0.065626 | 0.597148 |
| | (0.01384) | (0.49014) | (0.41527) |
| | [ 2.28203] | [ 0.13389] | [ 1.43797] |
| COTTON_LAST_PRICE... | -0.003482 | 0.053545 | -0.094014 |
| | (0.01384) | (0.49017) | (0.41530) |
| | [-0.25158] | [ 0.10924] | [-0.22638] |
| COTTON_LAST_PRICE... | -0.000554 | 0.101633 | 0.103090 |
| | (0.01384) | (0.49014) | (0.41527) |
| | [-0.04006] | [ 0.20735] | [ 0.24825] |
| COTTON_LAST_PRICE... | 0.016570 | -0.106339 | 0.413079 |
| | (0.01383) | (0.48994) | (0.41510) |
| | [ 1.19770] | [-0.21705] | [ 0.99513] |
| COTTON_LAST_PRICE... | 0.009967 | -0.163244 | -0.673416 |
| | (0.01384) | (0.49011) | (0.41525) |
| | [ 0.72017] | [-0.33307] | [-1.62171] |
| COTTON_LAST_PRICE... | 0.010551 | -0.427697 | 0.865477 |
| | (0.01372) | (0.48574) | (0.41154) |
| | [ 0.76926] | [-0.88051] | [ 2.10301] |
| GPRD_ACT(-1) | -0.000335 | 0.487525 | 0.058890 |
| | (0.00040) | (0.01412) | (0.01196) |
| | [-0.83954] | [ 34.5251] | [ 4.92233] |
| GPRD_ACT(-2) | 0.000478 | 0.193349 | 0.009845 |
| | (0.00044) | (0.01563) | (0.01324) |
| | [ 1.08232] | [ 12.3683] | [ 0.74334] |
| GPRD_ACT(-3) | -0.000365 | 0.091845 | 0.011315 |
| | (0.00045) | (0.01587) | (0.01344) |
| | [-0.81521] | [ 5.78794] | [ 0.84164] |
| GPRD_ACT(-4) | -0.000388 | 0.050443 | 0.020552 |
| | (0.00045) | (0.01593) | (0.01350) |
| | [-0.86298] | [ 3.16663] | [ 1.52279] |
| GPRD_ACT(-5) | 0.000696 | 0.078907 | 0.006274 |
| | (0.00045) | (0.01595) | (0.01351) |
| | [ 1.54530] | [ 4.94864] | [ 0.46444] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-6) | 0.000326 | 0.009571 | 0.009067 |
| | (0.00045) | (0.01597) | (0.01353) |
| | [ 0.72263] | [ 0.59930] | [ 0.67015] |
| GPRD_ACT(-7) | -0.001361 | -0.021063 | -0.019621 |
| | (0.00045) | (0.01596) | (0.01353) |
| | [-3.01852] | [-1.31939] | [-1.45066] |
| GPRD_ACT(-8) | 0.000389 | -0.008332 | -0.017196 |
| | (0.00045) | (0.01597) | (0.01353) |
| | [ 0.86305] | [-0.52155] | [-1.27048] |
| GPRD_ACT(-9) | 0.000701 | -0.012968 | -0.021013 |
| | (0.00045) | (0.01597) | (0.01353) |
| | [ 1.55492] | [-0.81218] | [-1.55325] |
| GPRD_ACT(-10) | -0.000722 | 0.031184 | -0.006462 |
| | (0.00045) | (0.01598) | (0.01354) |
| | [-1.60055] | [ 1.95175] | [-0.47735] |
| GPRD_ACT(-11) | 0.001100 | 0.030370 | 0.008141 |
| | (0.00045) | (0.01599) | (0.01355) |
| | [ 2.43660] | [ 1.89968] | [ 0.60103] |
| GPRD_ACT(-12) | -0.000425 | -0.012423 | -0.014864 |
| | (0.00045) | (0.01600) | (0.01356) |
| | [-0.94057] | [-0.77632] | [-1.09635] |
| GPRD_ACT(-13) | -0.000284 | 0.006227 | -0.012906 |
| | (0.00045) | (0.01600) | (0.01356) |
| | [-0.62759] | [ 0.38919] | [-0.95215] |
| GPRD_ACT(-14) | -0.000480 | -0.004054 | -0.003115 |
| | (0.00045) | (0.01600) | (0.01356) |
| | [-1.06243] | [-0.25335] | [-0.22976] |
| GPRD_ACT(-15) | 0.000482 | 0.015813 | -0.011028 |
| | (0.00045) | (0.01600) | (0.01356) |
| | [ 1.06585] | [ 0.98832] | [-0.81355] |
| GPRD_ACT(-16) | 9.20E-05 | -0.008355 | -0.014153 |
| | (0.00045) | (0.01602) | (0.01357) |
| | [ 0.20343] | [-0.52160] | [-1.04292] |
| GPRD_ACT(-17) | 0.000337 | -0.029534 | -0.014489 |
| | (0.00045) | (0.01602) | (0.01358) |
| | [ 0.74541] | [-1.84328] | [-1.06731] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-18) | -0.000391 | 0.002185 | 0.008535 |
| | (0.00045) | (0.01604) | (0.01359) |
| | [-0.86396] | [ 0.13618] | [ 0.62787] |
| GPRD_ACT(-19) | -0.000104 | 0.008922 | 0.002351 |
| | (0.00045) | (0.01604) | (0.01359) |
| | [-0.22990] | [ 0.55620] | [ 0.17295] |
| GPRD_ACT(-20) | 4.68E-06 | 0.010213 | 0.016260 |
| | (0.00045) | (0.01603) | (0.01358) |
| | [ 0.01033] | [ 0.63698] | [ 1.19698] |
| GPRD_ACT(-21) | -0.000157 | 0.050742 | 0.016849 |
| | (0.00045) | (0.01604) | (0.01359) |
| | [-0.34760] | [ 3.16316] | [ 1.23968] |
| GPRD_ACT(-22) | 0.000130 | -0.047458 | -0.034850 |
| | (0.00045) | (0.01607) | (0.01361) |
| | [ 0.28703] | [-2.95398] | [-2.56027] |
| GPRD_ACT(-23) | -0.000161 | 0.026466 | -0.012860 |
| | (0.00045) | (0.01608) | (0.01363) |
| | [-0.35529] | [ 1.64565] | [-0.94383] |
| GPRD_ACT(-24) | -0.000346 | -0.042624 | 0.010667 |
| | (0.00045) | (0.01609) | (0.01363) |
| | [-0.76210] | [-2.64963] | [ 0.78262] |
| GPRD_ACT(-25) | 0.000109 | 0.028625 | 0.013469 |
| | (0.00045) | (0.01607) | (0.01361) |
| | [ 0.23931] | [ 1.78132] | [ 0.98929] |
| GPRD_ACT(-26) | 8.10E-05 | -0.002738 | -0.015088 |
| | (0.00045) | (0.01605) | (0.01360) |
| | [ 0.17862] | [-0.17056] | [-1.10922] |
| GPRD_ACT(-27) | 9.23E-05 | -0.011671 | 0.002075 |
| | (0.00045) | (0.01601) | (0.01357) |
| | [ 0.20422] | [-0.72887] | [ 0.15292] |
| GPRD_ACT(-28) | -0.000226 | -0.005216 | -0.004968 |
| | (0.00045) | (0.01579) | (0.01338) |
| | [-0.50773] | [-0.33042] | [-0.37147] |
| GPRD_ACT(-29) | 0.000535 | 0.021887 | 0.002703 |
| | (0.00040) | (0.01429) | (0.01211) |
| | [ 1.32587] | [ 1.53176] | [ 0.22327] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-1) | 0.000164 | 0.008306 | 0.334991 |
| | (0.00047) | (0.01667) | (0.01412) |
| | [ 0.34846] | [ 0.49834] | [ 23.7212] |
| GPRD_THREAT(-2) | -0.000180 | 0.044810 | 0.174008 |
| | (0.00050) | (0.01758) | (0.01489) |
| | [-0.36332] | [ 2.54895] | [ 11.6826] |
| GPRD_THREAT(-3) | 0.000124 | -0.021050 | 0.063582 |
| | (0.00050) | (0.01780) | (0.01508) |
| | [ 0.24721] | [-1.18255] | [ 4.21598] |
| GPRD_THREAT(-4) | -1.56E-06 | -0.014539 | 0.030761 |
| | (0.00050) | (0.01784) | (0.01512) |
| | [-0.00309] | [-0.81485] | [ 2.03476] |
| GPRD_THREAT(-5) | -0.000408 | 0.042648 | 0.081330 |
| | (0.00050) | (0.01785) | (0.01513) |
| | [-0.80866] | [ 2.38888] | [ 5.37691] |
| GPRD_THREAT(-6) | -1.09E-05 | -0.012866 | 0.030967 |
| | (0.00051) | (0.01789) | (0.01516) |
| | [-0.02155] | [-0.71905] | [ 2.04276] |
| GPRD_THREAT(-7) | 0.000276 | -0.002631 | 0.013576 |
| | (0.00051) | (0.01790) | (0.01516) |
| | [ 0.54650] | [-0.14701] | [ 0.89529] |
| GPRD_THREAT(-8) | -0.000108 | -0.001344 | -0.001940 |
| | (0.00051) | (0.01789) | (0.01516) |
| | [-0.21289] | [-0.07516] | [-0.12797] |
| GPRD_THREAT(-9) | -0.000302 | 0.030388 | 0.021928 |
| | (0.00051) | (0.01793) | (0.01519) |
| | [-0.59587] | [ 1.69443] | [ 1.44312] |
| GPRD_THREAT(-10) | 0.000355 | 0.003663 | 0.039848 |
| | (0.00051) | (0.01793) | (0.01519) |
| | [ 0.70067] | [ 0.20430] | [ 2.62280] |
| GPRD_THREAT(-11) | -0.000397 | -0.035283 | 0.014988 |
| | (0.00051) | (0.01794) | (0.01520) |
| | [-0.78347] | [-1.96630] | [ 0.98590] |
| GPRD_THREAT(-12) | 0.000449 | -0.012217 | -0.029342 |
| | (0.00051) | (0.01800) | (0.01525) |
| | [ 0.88362] | [-0.67882] | [-1.92423] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-13) | 0.000383 | -0.048428 | -0.022969 |
| | (0.00051) | (0.01800) | (0.01525) |
| | [ 0.75300] | [-2.68976] | [-1.50576] |
| GPRD_THREAT(-14) | -0.000273 | 0.040076 | 0.013906 |
| | (0.00051) | (0.01802) | (0.01527) |
| | [-0.53572] | [ 2.22374] | [ 0.91075] |
| GPRD_THREAT(-15) | 0.000461 | 0.021897 | 0.051229 |
| | (0.00051) | (0.01802) | (0.01527) |
| | [ 0.90670] | [ 1.21512] | [ 3.35539] |
| GPRD_THREAT(-16) | -0.000144 | 0.001506 | 0.015993 |
| | (0.00051) | (0.01807) | (0.01531) |
| | [-0.28239] | [ 0.08335] | [ 1.04488] |
| GPRD_THREAT(-17) | 0.000795 | -0.013164 | -0.005320 |
| | (0.00051) | (0.01806) | (0.01530) |
| | [ 1.55901] | [-0.72888] | [-0.34769] |
| GPRD_THREAT(-18) | -0.000618 | -0.002470 | 0.000575 |
| | (0.00051) | (0.01806) | (0.01530) |
| | [-1.21171] | [-0.13678] | [ 0.03758] |
| GPRD_THREAT(-19) | -0.000159 | 0.001053 | 0.017758 |
| | (0.00051) | (0.01805) | (0.01530) |
| | [-0.31221] | [ 0.05835] | [ 1.16102] |
| GPRD_THREAT(-20) | 0.000877 | 0.016087 | 0.039641 |
| | (0.00051) | (0.01805) | (0.01529) |
| | [ 1.72097] | [ 0.89137] | [ 2.59242] |
| GPRD_THREAT(-21) | -2.79E-05 | -0.021399 | -0.016388 |
| | (0.00051) | (0.01806) | (0.01530) |
| | [-0.05475] | [-1.18506] | [-1.07118] |
| GPRD_THREAT(-22) | 0.000145 | 0.029640 | 0.037553 |
| | (0.00051) | (0.01809) | (0.01532) |
| | [ 0.28364] | [ 1.63868] | [ 2.45050] |
| GPRD_THREAT(-23) | -0.000202 | 0.006822 | 0.005046 |
| | (0.00051) | (0.01813) | (0.01536) |
| | [-0.39463] | [ 0.37635] | [ 0.32858] |
| GPRD_THREAT(-24) | -0.000206 | -0.007769 | -0.032618 |
| | (0.00051) | (0.01811) | (0.01534) |
| | [-0.40242] | [-0.42897] | [-2.12580] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-25) | 0.000528 | 0.002814 | 0.005288 |
| | (0.00051) | (0.01814) | (0.01537) |
| | [ 1.03137] | [ 0.15508] | [ 0.34399] |
| GPRD_THREAT(-26) | -0.000577 | -0.034950 | 0.012431 |
| | (0.00051) | (0.01813) | (0.01536) |
| | [-1.12767] | [-1.92741] | [ 0.80913] |
| GPRD_THREAT(-27) | -0.000737 | -0.005849 | -0.004507 |
| | (0.00051) | (0.01815) | (0.01538) |
| | [-1.43699] | [-0.32221] | [-0.29307] |
| GPRD_THREAT(-28) | 0.000718 | 0.026977 | 0.019264 |
| | (0.00051) | (0.01800) | (0.01525) |
| | [ 1.41234] | [ 1.49897] | [ 1.26337] |
| GPRD_THREAT(-29) | -0.000454 | -0.031093 | 0.020032 |
| | (0.00049) | (0.01720) | (0.01457) |
| | [-0.93520] | [-1.80785] | [ 1.37470] |
| C | -0.019883 | 5.808746 | 8.588016 |
| | (0.05450) | (1.93008) | (1.63527) |
| | [-0.36481] | [ 3.00958] | [ 5.25175] |
| R-squared | 0.040685 | 0.769058 | 0.570617 |
| Adj. R-squared | 0.025206 | 0.765331 | 0.563689 |
| Sum sq. resids | 11849.83 | 14860793 | 10667596 |
| S.E. equation | 1.482454 | 52.49840 | 44.47934 |
| F-statistic | 2.628442 | 206.3886 | 82.36272 |
| Log likelihood | -9888.895 | -29436.52 | -28528.16 |
| Akaike AIC | 3.641203 | 10.77537 | 10.44385 |
| Schwarz SC | 3.747330 | 10.88150 | 10.54998 |
| Mean dependent | 0.013405 | 114.2487 | 112.8077 |
| S.D. dependent | 1.501498 | 108.3724 | 67.33801 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 11125960 |
| Determinant resid covariance | 10598526 |
| Log likelihood | -67650.21 |
| Akaike information criterion | 24.78621 |
| Schwarz criterion | 25.10459 |
| Number of coefficients | 264 |

**EViews Output 60: VAR Estimates – No.11 Sugar**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:45
Sample (adjusted): 5/11/2000 5/13/2021
Included observations: 5481 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | SUGAR_LA... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| SUGAR_LAST_PRICE1(... | -0.008710 | 0.410824 | -0.710394 |
| | (0.01359) | (2.09700) | (1.77832) |
| | [-0.64109] | [ 0.19591] | [-0.39947] |
| SUGAR_LAST_PRICE1(... | -0.008972 | 1.070154 | -0.142843 |
| | (0.01358) | (2.09661) | (1.77799) |
| | [-0.66047] | [ 0.51042] | [-0.08034] |
| SUGAR_LAST_PRICE1(... | 0.025228 | 1.044580 | -1.100485 |
| | (0.01359) | (2.09682) | (1.77817) |
| | [ 1.85693] | [ 0.49817] | [-0.61889] |
| SUGAR_LAST_PRICE1(... | -0.011144 | -0.264734 | -0.010506 |
| | (0.01359) | (2.09756) | (1.77879) |
| | [-0.81999] | [-0.12621] | [-0.00591] |
| SUGAR_LAST_PRICE1(... | -0.046813 | -0.803883 | -3.153750 |
| | (0.01359) | (2.09726) | (1.77854) |
| | [-3.44500] | [-0.38330] | [-1.77323] |
| SUGAR_LAST_PRICE1(... | -0.012024 | -2.372895 | -0.781568 |
| | (0.01361) | (2.10002) | (1.78088) |
| | [-0.88366] | [-1.12994] | [-0.43887] |
| SUGAR_LAST_PRICE1(... | 0.007901 | -1.588901 | 1.186136 |
| | (0.01361) | (2.09996) | (1.78083) |
| | [ 0.58068] | [-0.75663] | [ 0.66606] |
| SUGAR_LAST_PRICE1(... | 0.012638 | 1.882364 | 1.192255 |
| | (0.01360) | (2.09881) | (1.77985) |
| | [ 0.92938] | [ 0.89687] | [ 0.66986] |
| SUGAR_LAST_PRICE1(... | -0.037547 | 0.067320 | 0.809502 |
| | (0.01360) | (2.09887) | (1.77990) |
| | [-2.76103] | [ 0.03207] | [ 0.45480] |
| SUGAR_LAST_PRICE1(... | 0.033768 | 0.680477 | 0.186869 |
| | (0.01361) | (2.10044) | (1.78124) |
| | [ 2.48127] | [ 0.32397] | [ 0.10491] |

| | | | |
|---|---|---|---|
| SUGAR_LAST_PRICE1(... | -0.017546 | 0.234214 | 1.997393 |
| | (0.01361) | (2.10099) | (1.78170) |
| | [-1.28895] | [ 0.11148] | [ 1.12106] |
| SUGAR_LAST_PRICE1(... | 0.002162 | 0.141433 | -0.140917 |
| | (0.01362) | (2.10152) | (1.78215) |
| | [ 0.15878] | [ 0.06730] | [-0.07907] |
| SUGAR_LAST_PRICE1(... | 0.016400 | 0.662339 | 0.954959 |
| | (0.01360) | (2.09920) | (1.78019) |
| | [ 1.20578] | [ 0.31552] | [ 0.53644] |
| SUGAR_LAST_PRICE1(... | 0.004737 | -2.779223 | -1.515524 |
| | (0.01360) | (2.09929) | (1.78026) |
| | [ 0.34829] | [-1.32389] | [-0.85129] |
| SUGAR_LAST_PRICE1(... | -0.004651 | 0.832810 | -1.209920 |
| | (0.01360) | (2.09887) | (1.77991) |
| | [-0.34204] | [ 0.39679] | [-0.67977] |
| SUGAR_LAST_PRICE1(... | 0.006706 | 1.454168 | -2.097273 |
| | (0.01360) | (2.09839) | (1.77949) |
| | [ 0.49323] | [ 0.69299] | [-1.17858] |
| SUGAR_LAST_PRICE1(... | -0.058250 | -0.875938 | 0.602682 |
| | (0.01360) | (2.09919) | (1.78017) |
| | [-4.28272] | [-0.41728] | [ 0.33855] |
| GPRD_ACT(-1) | 7.69E-05 | 0.487018 | 0.059124 |
| | (9.1E-05) | (0.01412) | (0.01197) |
| | [ 0.84009] | [ 34.4902] | [ 4.93743] |
| GPRD_ACT(-2) | -0.000150 | 0.194344 | 0.009006 |
| | (0.00010) | (0.01563) | (0.01325) |
| | [-1.48160] | [ 12.4364] | [ 0.67960] |
| GPRD_ACT(-3) | 4.21E-05 | 0.092535 | 0.010398 |
| | (0.00010) | (0.01586) | (0.01345) |
| | [ 0.40918] | [ 5.83337] | [ 0.77299] |
| GPRD_ACT(-4) | -8.85E-06 | 0.051348 | 0.021284 |
| | (0.00010) | (0.01593) | (0.01351) |
| | [-0.08577] | [ 3.22365] | [ 1.57568] |
| GPRD_ACT(-5) | -5.55E-05 | 0.077937 | 0.006170 |
| | (0.00010) | (0.01593) | (0.01351) |
| | [-0.53764] | [ 4.89152] | [ 0.45666] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-6) | 0.000165 | 0.010855 | 0.009299 |
| | (0.00010) | (0.01596) | (0.01354) |
| | [ 1.59541] | [ 0.68002] | [ 0.68691] |
| GPRD_ACT(-7) | -3.65E-05 | -0.023591 | -0.019136 |
| | (0.00010) | (0.01596) | (0.01353) |
| | [-0.35284] | [-1.47823] | [-1.41396] |
| GPRD_ACT(-8) | -0.000235 | -0.006226 | -0.016557 |
| | (0.00010) | (0.01595) | (0.01353) |
| | [-2.27083] | [-0.39034] | [-1.22407] |
| GPRD_ACT(-9) | 8.41E-05 | -0.013990 | -0.022386 |
| | (0.00010) | (0.01596) | (0.01354) |
| | [ 0.81345] | [-0.87648] | [-1.65386] |
| GPRD_ACT(-10) | 0.000126 | 0.031903 | -0.007401 |
| | (0.00010) | (0.01596) | (0.01354) |
| | [ 1.21846] | [ 1.99830] | [-0.54666] |
| GPRD_ACT(-11) | -1.19E-06 | 0.030071 | 0.009033 |
| | (0.00010) | (0.01597) | (0.01354) |
| | [-0.01154] | [ 1.88325] | [ 0.66708] |
| GPRD_ACT(-12) | -0.000138 | -0.012403 | -0.014580 |
| | (0.00010) | (0.01597) | (0.01354) |
| | [-1.33603] | [-0.77677] | [-1.07672] |
| GPRD_ACT(-13) | 1.58E-05 | 0.007124 | -0.015103 |
| | (0.00010) | (0.01597) | (0.01354) |
| | [ 0.15307] | [ 0.44615] | [-1.11537] |
| GPRD_ACT(-14) | -6.02E-05 | -0.004963 | -0.001820 |
| | (0.00010) | (0.01596) | (0.01354) |
| | [-0.58234] | [-0.31091] | [-0.13443] |
| GPRD_ACT(-15) | 7.59E-05 | 0.015489 | -0.009246 |
| | (0.00010) | (0.01596) | (0.01353) |
| | [ 0.73426] | [ 0.97070] | [-0.68333] |
| GPRD_ACT(-16) | 0.000113 | -0.007351 | -0.015459 |
| | (0.00010) | (0.01597) | (0.01354) |
| | [ 1.08811] | [-0.46038] | [-1.14168] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-17) | -1.70E-05 | -0.029234 | -0.014493 |
| | (0.00010) | (0.01599) | (0.01356) |
| | [-0.16457] | [-1.82863] | [-1.06901] |
| GPRD_ACT(-18) | -5.86E-05 | 0.002498 | 0.008658 |
| | (0.00010) | (0.01600) | (0.01357) |
| | [-0.56552] | [ 0.15614] | [ 0.63808] |
| GPRD_ACT(-19) | 4.04E-05 | 0.009258 | 0.001550 |
| | (0.00010) | (0.01600) | (0.01357) |
| | [ 0.38972] | [ 0.57870] | [ 0.11427] |
| GPRD_ACT(-20) | 0.000156 | 0.008737 | 0.015902 |
| | (0.00010) | (0.01600) | (0.01357) |
| | [ 1.50455] | [ 0.54615] | [ 1.17224] |
| GPRD_ACT(-21) | -0.000127 | 0.050142 | 0.016710 |
| | (0.00010) | (0.01601) | (0.01358) |
| | [-1.22708] | [ 3.13171] | [ 1.23069] |
| GPRD_ACT(-22) | -7.01E-05 | -0.045070 | -0.033643 |
| | (0.00010) | (0.01603) | (0.01360) |
| | [-0.67488] | [-2.81088] | [-2.47427] |
| GPRD_ACT(-23) | 0.000135 | 0.026669 | -0.013604 |
| | (0.00010) | (0.01605) | (0.01361) |
| | [ 1.29860] | [ 1.66198] | [-0.99972] |
| GPRD_ACT(-24) | -3.54E-05 | -0.041223 | 0.012743 |
| | (0.00010) | (0.01601) | (0.01358) |
| | [-0.34082] | [-2.57494] | [ 0.93859] |
| GPRD_ACT(-25) | -1.64E-06 | 0.028779 | 0.013413 |
| | (0.00010) | (0.01602) | (0.01359) |
| | [-0.01576] | [ 1.79616] | [ 0.98716] |
| GPRD_ACT(-26) | 2.33E-05 | 3.72E-05 | -0.015594 |
| | (0.00010) | (0.01598) | (0.01355) |
| | [ 0.22505] | [ 0.00233] | [-1.15058] |
| GPRD_ACT(-27) | -9.73E-05 | -0.009153 | 0.001858 |
| | (0.00010) | (0.01576) | (0.01336) |
| | [-0.95332] | [-0.58096] | [ 0.13908] |
| GPRD_ACT(-28) | 1.96E-05 | 0.004806 | -0.001958 |
| | (9.2E-05) | (0.01427) | (0.01210) |
| | [ 0.21180] | [ 0.33678] | [-0.16177] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-1) | 5.85E-06 | 0.008632 | 0.334324 |
| | (0.00011) | (0.01665) | (0.01412) |
| | [ 0.05421] | [ 0.51844] | [ 23.6782] |
| GPRD_THREAT(-2) | 8.19E-05 | 0.043290 | 0.174411 |
| | (0.00011) | (0.01756) | (0.01489) |
| | [ 0.72000] | [ 2.46556] | [ 11.7137] |
| GPRD_THREAT(-3) | 2.87E-05 | -0.021415 | 0.065161 |
| | (0.00012) | (0.01778) | (0.01508) |
| | [ 0.24953] | [-1.20457] | [ 4.32213] |
| GPRD_THREAT(-4) | -0.000112 | -0.015273 | 0.031083 |
| | (0.00012) | (0.01782) | (0.01512) |
| | [-0.97036] | [-0.85685] | [ 2.05631] |
| GPRD_THREAT(-5) | 6.21E-06 | 0.042670 | 0.080908 |
| | (0.00012) | (0.01783) | (0.01512) |
| | [ 0.05378] | [ 2.39351] | [ 5.35170] |
| GPRD_THREAT(-6) | -0.000105 | -0.012898 | 0.030547 |
| | (0.00012) | (0.01787) | (0.01516) |
| | [-0.90809] | [-0.72168] | [ 2.01541] |
| GPRD_THREAT(-7) | 8.60E-05 | -0.002458 | 0.015253 |
| | (0.00012) | (0.01787) | (0.01516) |
| | [ 0.74235] | [-0.13754] | [ 1.00642] |
| GPRD_THREAT(-8) | 8.37E-05 | -0.001239 | -0.003697 |
| | (0.00012) | (0.01787) | (0.01516) |
| | [ 0.72274] | [-0.06932] | [-0.24392] |
| GPRD_THREAT(-9) | -0.000208 | 0.029974 | 0.022489 |
| | (0.00012) | (0.01790) | (0.01518) |
| | [-1.79593] | [ 1.67416] | [ 1.48118] |
| GPRD_THREAT(-10) | 0.000182 | 0.004280 | 0.042205 |
| | (0.00012) | (0.01792) | (0.01520) |
| | [ 1.56370] | [ 0.23883] | [ 2.77742] |
| GPRD_THREAT(-11) | 9.60E-05 | -0.036606 | 0.013564 |
| | (0.00012) | (0.01794) | (0.01521) |
| | [ 0.82614] | [-2.04078] | [ 0.89173] |
| GPRD_THREAT(-12) | 1.46E-05 | -0.013668 | -0.028823 |
| | (0.00012) | (0.01799) | (0.01525) |
| | [ 0.12501] | [-0.75982] | [-1.88943] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-13) | -0.000155 | -0.048428 | -0.022471 |
| | (0.00012) | (0.01799) | (0.01526) |
| | [-1.33166] | [-2.69206] | [-1.47297] |
| GPRD_THREAT(-14) | 9.85E-05 | 0.039239 | 0.014140 |
| | (0.00012) | (0.01799) | (0.01526) |
| | [ 0.84525] | [ 2.18067] | [ 0.92667] |
| GPRD_THREAT(-15) | -0.000183 | 0.021296 | 0.051632 |
| | (0.00012) | (0.01801) | (0.01527) |
| | [-1.57176] | [ 1.18258] | [ 3.38097] |
| GPRD_THREAT(-16) | 7.91E-05 | 0.001695 | 0.015244 |
| | (0.00012) | (0.01805) | (0.01531) |
| | [ 0.67639] | [ 0.09389] | [ 0.99567] |
| GPRD_THREAT(-17) | 8.77E-05 | -0.011539 | -0.004399 |
| | (0.00012) | (0.01804) | (0.01530) |
| | [ 0.75043] | [-0.63950] | [-0.28747] |
| GPRD_THREAT(-18) | -7.27E-05 | -0.003015 | -0.000996 |
| | (0.00012) | (0.01805) | (0.01531) |
| | [-0.62199] | [-0.16700] | [-0.06508] |
| GPRD_THREAT(-19) | -7.84E-05 | -0.000765 | 0.019396 |
| | (0.00012) | (0.01804) | (0.01530) |
| | [-0.67049] | [-0.04237] | [ 1.26765] |
| GPRD_THREAT(-20) | 0.000124 | 0.014595 | 0.039637 |
| | (0.00012) | (0.01804) | (0.01530) |
| | [ 1.05853] | [ 0.80893] | [ 2.59063] |
| GPRD_THREAT(-21) | -0.000144 | -0.021757 | -0.017294 |
| | (0.00012) | (0.01805) | (0.01531) |
| | [-1.23086] | [-1.20544] | [-1.12988] |
| GPRD_THREAT(-22) | 6.37E-05 | 0.028116 | 0.037467 |
| | (0.00012) | (0.01808) | (0.01533) |
| | [ 0.54380] | [ 1.55492] | [ 2.44341] |
| GPRD_THREAT(-23) | -5.24E-05 | 0.006053 | 0.005879 |
| | (0.00012) | (0.01811) | (0.01536) |
| | [-0.44618] | [ 0.33427] | [ 0.38282] |
| GPRD_THREAT(-24) | 0.000137 | -0.008843 | -0.030876 |
| | (0.00012) | (0.01807) | (0.01533) |
| | [ 1.17079] | [-0.48932] | [-2.01464] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-25) | 2.00E-06 | 0.001157 | 0.005593 |
| | (0.00012) | (0.01813) | (0.01537) |
| | [ 0.01705] | [ 0.06379] | [ 0.36376] |
| GPRD_THREAT(-26) | -0.000198 | -0.036175 | 0.012528 |
| | (0.00012) | (0.01809) | (0.01534) |
| | [-1.68677] | [-1.99942] | [ 0.81651] |
| GPRD_THREAT(-27) | 0.000271 | -0.010579 | 0.001080 |
| | (0.00012) | (0.01800) | (0.01526) |
| | [ 2.31985] | [-0.58785] | [ 0.07080] |
| GPRD_THREAT(-28) | -0.000174 | 0.018579 | 0.024983 |
| | (0.00011) | (0.01719) | (0.01457) |
| | [-1.55919] | [ 1.08105] | [ 1.71412] |
| C | 0.008486 | 5.608811 | 8.933978 |
| | (0.01244) | (1.91955) | (1.62783) |
| | [ 0.68227] | [ 2.92194] | [ 5.48826] |
| R-squared | 0.025230 | 0.769159 | 0.570036 |
| Adj. R-squared | 0.010055 | 0.765565 | 0.563343 |
| Sum sq. resids | 623.5875 | 14854289 | 10682545 |
| S.E. equation | 0.339948 | 52.46745 | 44.49399 |
| F-statistic | 1.662656 | 214.0404 | 85.16527 |
| Log likelihood | -1820.578 | -29440.19 | -28536.71 |
| Akaike AIC | 0.695340 | 10.77365 | 10.44397 |
| Schwarz SC | 0.797833 | 10.87614 | 10.54647 |
| Mean dependent | 0.002346 | 114.2470 | 112.8015 |
| S.D. dependent | 0.341670 | 108.3625 | 67.33346 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 585362.2 |
| Determinant resid covariance | 558548.7 |
| Log likelihood | -59596.91 |
| Akaike information criterion | 21.83978 |
| Schwarz criterion | 22.14726 |
| Number of coefficients | 255 |

**EViews Output 61: VAR Estimates – Oats**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:29
Sample (adjusted): 5/05/2000 5/13/2021
Included observations: 5485 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | OATS_LAST... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| OATS_LAST_PRICE1(-1) | 0.083745 | -0.132708 | -0.112072 |
| | (0.01361) | (0.10611) | (0.08973) |
| | [ 6.15536] | [-1.25066] | [-1.24897] |
| OATS_LAST_PRICE1(-2) | -0.040671 | -0.024846 | 0.045186 |
| | (0.01366) | (0.10654) | (0.09010) |
| | [-2.97721] | [-0.23320] | [ 0.50152] |
| OATS_LAST_PRICE1(-3) | -0.041380 | -0.038230 | -0.047964 |
| | (0.01370) | (0.10686) | (0.09037) |
| | [-3.02006] | [-0.35774] | [-0.53076] |
| OATS_LAST_PRICE1(-4) | -0.017768 | 0.014235 | 0.003025 |
| | (0.01371) | (0.10693) | (0.09043) |
| | [-1.29591] | [ 0.13312] | [ 0.03345] |
| OATS_LAST_PRICE1(-5) | -0.005168 | 0.041002 | -0.165888 |
| | (0.01374) | (0.10713) | (0.09059) |
| | [-0.37626] | [ 0.38274] | [-1.83117] |
| OATS_LAST_PRICE1(-6) | 0.023686 | 0.060579 | 0.043444 |
| | (0.01374) | (0.10718) | (0.09063) |
| | [ 1.72365] | [ 0.56523] | [ 0.47934] |
| OATS_LAST_PRICE1(-7) | 0.010247 | -0.162736 | -0.016560 |
| | (0.01374) | (0.10716) | (0.09062) |
| | [ 0.74578] | [-1.51865] | [-0.18275] |
| OATS_LAST_PRICE1(-8) | -0.019273 | 0.172257 | -0.130094 |
| | (0.01374) | (0.10715) | (0.09061) |
| | [-1.40284] | [ 1.60761] | [-1.43573] |
| OATS_LAST_PRICE1(-9) | -0.005242 | 0.037459 | 0.017504 |
| | (0.01377) | (0.10740) | (0.09082) |
| | [-0.38066] | [ 0.34878] | [ 0.19272] |
| OATS_LAST_PRICE1(-10) | -0.030943 | -0.009693 | 0.079059 |
| | (0.01377) | (0.10742) | (0.09084) |
| | [-2.24671] | [-0.09024] | [ 0.87035] |

| | | | |
|---|---|---|---|
| OATS_LAST_PRICE1(-11) | -0.028205 | -0.119872 | 0.197921 |
| | (0.01379) | (0.10753) | (0.09093) |
| | [-2.04573] | [-1.11475] | [ 2.17654] |
| OATS_LAST_PRICE1(-12) | -0.003857 | 0.117941 | 0.124698 |
| | (0.01379) | (0.10758) | (0.09098) |
| | [-0.27962] | [ 1.09627] | [ 1.37064] |
| OATS_LAST_PRICE1(-13) | -0.037389 | -0.072913 | 0.006963 |
| | (0.01388) | (0.10824) | (0.09153) |
| | [-2.69402] | [-0.67361] | [ 0.07606] |
| OATS_LAST_PRICE1(-14) | 0.009869 | -0.017753 | 0.229305 |
| | (0.01388) | (0.10827) | (0.09156) |
| | [ 0.71089] | [-0.16397] | [ 2.50446] |
| OATS_LAST_PRICE1(-15) | -0.002693 | 0.020400 | 0.060131 |
| | (0.01388) | (0.10822) | (0.09152) |
| | [-0.19409] | [ 0.18850] | [ 0.65703] |
| OATS_LAST_PRICE1(-16) | 0.018488 | -0.054728 | -0.014661 |
| | (0.01388) | (0.10828) | (0.09157) |
| | [ 1.33172] | [-0.50544] | [-0.16012] |
| OATS_LAST_PRICE1(-17) | -0.026566 | -0.022934 | -0.032550 |
| | (0.01388) | (0.10827) | (0.09156) |
| | [-1.91367] | [-0.21182] | [-0.35551] |
| OATS_LAST_PRICE1(-18) | 0.002179 | 0.032710 | 0.090792 |
| | (0.01389) | (0.10831) | (0.09159) |
| | [ 0.15693] | [ 0.30201] | [ 0.99129] |
| OATS_LAST_PRICE1(-19) | 0.018770 | 0.091531 | 0.109658 |
| | (0.01389) | (0.10834) | (0.09162) |
| | [ 1.35124] | [ 0.84485] | [ 1.19692] |
| OATS_LAST_PRICE1(-20) | -0.035666 | -0.052751 | 0.057772 |
| | (0.01389) | (0.10831) | (0.09159) |
| | [-2.56831] | [-0.48705] | [ 0.63078] |
| OATS_LAST_PRICE1(-21) | -0.044426 | 0.058323 | -0.059804 |
| | (0.01389) | (0.10833) | (0.09161) |
| | [-3.19842] | [ 0.53837] | [-0.65282] |

| | | | |
|---|---|---|---|
| OATS_LAST_PRICE1(-22) | 0.015216 | -0.011560 | -0.008156 |
| | (0.01390) | (0.10840) | (0.09167) |
| | [ 1.09471] | [-0.10663] | [-0.08898] |
| OATS_LAST_PRICE1(-23) | -0.002634 | 0.115483 | 0.115359 |
| | (0.01392) | (0.10860) | (0.09183) |
| | [-0.18914] | [ 1.06342] | [ 1.25617] |
| OATS_LAST_PRICE1(-24) | 0.020879 | -0.075925 | 0.253804 |
| | (0.01393) | (0.10864) | (0.09187) |
| | [ 1.49892] | [-0.69886] | [ 2.76259] |
| GPRD_ACT(-1) | -0.003291 | 0.487117 | 0.057712 |
| | (0.00181) | (0.01411) | (0.01193) |
| | [-1.81956] | [ 34.5331] | [ 4.83820] |
| GPRD_ACT(-2) | 0.005379 | 0.194594 | 0.009400 |
| | (0.00200) | (0.01561) | (0.01320) |
| | [ 2.68665] | [ 12.4623] | [ 0.71186] |
| GPRD_ACT(-3) | -0.002070 | 0.091565 | 0.010206 |
| | (0.00203) | (0.01585) | (0.01340) |
| | [-1.01863] | [ 5.77646] | [ 0.76135] |
| GPRD_ACT(-4) | -0.001614 | 0.050915 | 0.022764 |
| | (0.00204) | (0.01591) | (0.01345) |
| | [-0.79131] | [ 3.20119] | [ 1.69247] |
| GPRD_ACT(-5) | -0.003583 | 0.079863 | 0.006299 |
| | (0.00204) | (0.01592) | (0.01346) |
| | [-1.75517] | [ 5.01586] | [ 0.46783] |
| GPRD_ACT(-6) | 0.002426 | 0.008050 | 0.006034 |
| | (0.00205) | (0.01596) | (0.01350) |
| | [ 1.18526] | [ 0.50425] | [ 0.44693] |
| GPRD_ACT(-7) | 0.000187 | -0.019847 | -0.016671 |
| | (0.00205) | (0.01597) | (0.01350) |
| | [ 0.09159] | [-1.24306] | [-1.23473] |
| GPRD_ACT(-8) | 0.004711 | -0.008692 | -0.017518 |
| | (0.00205) | (0.01596) | (0.01350) |
| | [ 2.30158] | [-0.54450] | [-1.29768] |
| GPRD_ACT(-9) | -0.000726 | -0.010807 | -0.021408 |
| | (0.00205) | (0.01598) | (0.01351) |
| | [-0.35439] | [-0.67634] | [-1.58440] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-10) | -0.005849 | 0.031267 | -0.008729 |
| | (0.00205) | (0.01598) | (0.01351) |
| | [-2.85495] | [ 1.95676] | [-0.64597] |
| GPRD_ACT(-11) | 0.005328 | 0.029486 | 0.007972 |
| | (0.00205) | (0.01599) | (0.01353) |
| | [ 2.59800] | [ 1.84351] | [ 0.58943] |
| GPRD_ACT(-12) | 2.15E-05 | -0.013483 | -0.014338 |
| | (0.00205) | (0.01600) | (0.01353) |
| | [ 0.01047] | [-0.84277] | [-1.05977] |
| GPRD_ACT(-13) | 0.000159 | 0.008388 | -0.013352 |
| | (0.00205) | (0.01600) | (0.01353) |
| | [ 0.07759] | [ 0.52426] | [-0.98680] |
| GPRD_ACT(-14) | 0.001182 | -0.004043 | -0.003453 |
| | (0.00205) | (0.01599) | (0.01353) |
| | [ 0.57657] | [-0.25279] | [-0.25527] |
| GPRD_ACT(-15) | -0.000577 | 0.017183 | -0.011603 |
| | (0.00205) | (0.01599) | (0.01352) |
| | [-0.28147] | [ 1.07490] | [-0.85830] |
| GPRD_ACT(-16) | 0.000161 | -0.007394 | -0.013802 |
| | (0.00205) | (0.01600) | (0.01353) |
| | [ 0.07846] | [-0.46216] | [-1.02012] |
| GPRD_ACT(-17) | 0.000466 | -0.032865 | -0.014345 |
| | (0.00205) | (0.01601) | (0.01354) |
| | [ 0.22717] | [-2.05227] | [-1.05928] |
| GPRD_ACT(-18) | -0.001477 | 0.005547 | 0.008125 |
| | (0.00205) | (0.01603) | (0.01355) |
| | [-0.71879] | [ 0.34611] | [ 0.59953] |
| GPRD_ACT(-19) | 0.000166 | 0.010293 | 0.002386 |
| | (0.00205) | (0.01603) | (0.01355) |
| | [ 0.08078] | [ 0.64230] | [ 0.17603] |
| GPRD_ACT(-20) | -0.001838 | 0.010480 | 0.015577 |
| | (0.00205) | (0.01598) | (0.01351) |
| | [-0.89683] | [ 0.65581] | [ 1.15272] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-21) | -0.000826 | 0.048835 | 0.017380 |
| | (0.00205) | (0.01597) | (0.01351) |
| | [-0.40313] | [ 3.05707] | [ 1.28656] |
| GPRD_ACT(-22) | 0.001119 | -0.043539 | -0.035672 |
| | (0.00205) | (0.01595) | (0.01349) |
| | [ 0.54713] | [-2.72928] | [-2.64432] |
| GPRD_ACT(-23) | -0.002105 | 0.030450 | -0.012304 |
| | (0.00202) | (0.01574) | (0.01331) |
| | [-1.04294] | [ 1.93417] | [-0.92422] |
| GPRD_ACT(-24) | 0.002569 | -0.029250 | 0.015229 |
| | (0.00183) | (0.01426) | (0.01206) |
| | [ 1.40537] | [-2.05161] | [ 1.26312] |
| GPRD_THREAT(-1) | 0.005660 | 0.008130 | 0.332146 |
| | (0.00214) | (0.01668) | (0.01410) |
| | [ 2.64725] | [ 0.48753] | [ 23.5535] |
| GPRD_THREAT(-2) | -0.004236 | 0.044425 | 0.175626 |
| | (0.00226) | (0.01759) | (0.01488) |
| | [-1.87817] | [ 2.52538] | [ 11.8060] |
| GPRD_THREAT(-3) | 0.002896 | -0.022750 | 0.065311 |
| | (0.00228) | (0.01781) | (0.01506) |
| | [ 1.26825] | [-1.27759] | [ 4.33719] |
| GPRD_THREAT(-4) | 0.003402 | -0.015244 | 0.028933 |
| | (0.00229) | (0.01785) | (0.01510) |
| | [ 1.48617] | [-0.85387] | [ 1.91648] |
| GPRD_THREAT(-5) | -0.003812 | 0.045092 | 0.081088 |
| | (0.00229) | (0.01785) | (0.01509) |
| | [-1.66580] | [ 2.52672] | [ 5.37309] |
| GPRD_THREAT(-6) | 0.002232 | -0.015591 | 0.034769 |
| | (0.00229) | (0.01789) | (0.01513) |
| | [ 0.97276] | [-0.87129] | [ 2.29768] |
| GPRD_THREAT(-7) | 0.000614 | -0.005402 | 0.016617 |
| | (0.00230) | (0.01791) | (0.01514) |
| | [ 0.26733] | [-0.30167] | [ 1.09729] |
| GPRD_THREAT(-8) | -0.000693 | 0.000450 | -0.003178 |
| | (0.00230) | (0.01791) | (0.01514) |
| | [-0.30191] | [ 0.02512] | [-0.20988] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-9) | -0.000412 | 0.027329 | 0.024717 |
| | (0.00230) | (0.01796) | (0.01518) |
| | [-0.17884] | [ 1.52196] | [ 1.62778] |
| GPRD_THREAT(-10) | 0.000331 | 0.004328 | 0.043818 |
| | (0.00230) | (0.01795) | (0.01518) |
| | [ 0.14390] | [ 0.24114] | [ 2.88724] |
| GPRD_THREAT(-11) | -0.002083 | -0.035959 | 0.017061 |
| | (0.00230) | (0.01795) | (0.01518) |
| | [-0.90520] | [-2.00338] | [ 1.12405] |
| GPRD_THREAT(-12) | -0.003485 | -0.014869 | -0.030403 |
| | (0.00231) | (0.01800) | (0.01522) |
| | [-1.51038] | [-0.82619] | [-1.99776] |
| GPRD_THREAT(-13) | -0.002376 | -0.047736 | -0.024309 |
| | (0.00231) | (0.01800) | (0.01523) |
| | [-1.02944] | [-2.65136] | [-1.59659] |
| GPRD_THREAT(-14) | 0.001670 | 0.040294 | 0.016934 |
| | (0.00231) | (0.01803) | (0.01524) |
| | [ 0.72276] | [ 2.23543] | [ 1.11093] |
| GPRD_THREAT(-15) | 0.001664 | 0.021052 | 0.051491 |
| | (0.00231) | (0.01803) | (0.01525) |
| | [ 0.71987] | [ 1.16753] | [ 3.37689] |
| GPRD_THREAT(-16) | -9.35E-05 | -0.004046 | 0.014329 |
| | (0.00232) | (0.01806) | (0.01528) |
| | [-0.04038] | [-0.22399] | [ 0.93799] |
| GPRD_THREAT(-17) | 0.004611 | -0.010697 | -0.005240 |
| | (0.00231) | (0.01805) | (0.01527) |
| | [ 1.99233] | [-0.59255] | [-0.34324] |
| GPRD_THREAT(-18) | -0.002767 | -0.001193 | -0.000611 |
| | (0.00232) | (0.01806) | (0.01527) |
| | [-1.19515] | [-0.06605] | [-0.04001] |
| GPRD_THREAT(-19) | -0.005949 | -0.001046 | 0.020970 |
| | (0.00231) | (0.01805) | (0.01526) |
| | [-2.57086] | [-0.05799] | [ 1.37407] |
| GPRD_THREAT(-20) | 0.003071 | 0.013072 | 0.041890 |
| | (0.00231) | (0.01802) | (0.01524) |
| | [ 1.32885] | [ 0.72530] | [ 2.74857] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-19) | -0.005949 | -0.001046 | 0.020970 |
| | (0.00231) | (0.01805) | (0.01526) |
| | [-2.57086] | [-0.05799] | [ 1.37407] |
| GPRD_THREAT(-20) | 0.003071 | 0.013072 | 0.041890 |
| | (0.00231) | (0.01802) | (0.01524) |
| | [ 1.32885] | [ 0.72530] | [ 2.74857] |
| GPRD_THREAT(-21) | -0.002542 | -0.024720 | -0.016856 |
| | (0.00231) | (0.01802) | (0.01524) |
| | [-1.10003] | [-1.37160] | [-1.10593] |
| GPRD_THREAT(-22) | 0.001138 | 0.027854 | 0.042121 |
| | (0.00231) | (0.01803) | (0.01524) |
| | [ 0.49233] | [ 1.54515] | [ 2.76308] |
| GPRD_THREAT(-23) | 0.002349 | 0.002378 | 0.012686 |
| | (0.00230) | (0.01792) | (0.01515) |
| | [ 1.02248] | [ 0.13269] | [ 0.83720] |
| GPRD_THREAT(-24) | -0.001049 | -0.016353 | -0.020067 |
| | (0.00219) | (0.01710) | (0.01446) |
| | [-0.47854] | [-0.95620] | [-1.38753] |
| C | 0.114601 | 5.451575 | 9.628978 |
| | (0.23796) | (1.85595) | (1.56947) |
| | [ 0.48159] | [ 2.93735] | [ 6.13519] |
| R-squared | 0.033689 | 0.768263 | 0.570821 |
| Adj. R-squared | 0.020833 | 0.765180 | 0.565111 |
| Sum sq. resids | 245147.6 | 14912037 | 10663730 |
| S.E. equation | 6.730308 | 52.49157 | 44.38903 |
| F-statistic | 2.620541 | 249.1954 | 99.97382 |
| Log likelihood | -18203.95 | -29470.31 | -28550.70 |
| Akaike AIC | 6.664338 | 10.77240 | 10.43708 |
| Schwarz SC | 6.752308 | 10.86037 | 10.52505 |
| Mean dependent | 0.109025 | 114.2411 | 112.7874 |
| S.D. dependent | 6.801529 | 108.3234 | 67.31107 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 2.28E+08 |
| Determinant resid covariance | 2.19E+08 |
| Log likelihood | -76014.11 |
| Akaike information criterion | 27.79694 |
| Schwarz criterion | 28.06085 |
| Number of coefficients | 219 |

**EViews Output 62: VAR Estimates – Rough Rice**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:37
Sample (adjusted): 5/12/2000 5/13/2021
Included observations: 5480 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | ROUGH_RI... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| ROUGH_RICE_LAST_P... | 0.128277 | 1.498717 | 3.902282 |
| | (0.01361) | (3.48517) | (2.95340) |
| | [ 9.42646] | [ 0.43003] | [ 1.32128] |
| ROUGH_RICE_LAST_P... | -0.001155 | 4.704457 | 2.577643 |
| | (0.01372) | (3.51388) | (2.97772) |
| | [-0.08416] | [ 1.33882] | [ 0.86564] |
| ROUGH_RICE_LAST_P... | -0.003926 | -5.012800 | -1.586746 |
| | (0.01371) | (3.51249) | (2.97655) |
| | [-0.28626] | [-1.42713] | [-0.53308] |
| ROUGH_RICE_LAST_P... | -0.024897 | 0.073744 | -2.034631 |
| | (0.01371) | (3.51199) | (2.97612) |
| | [-1.81556] | [ 0.02100] | [-0.68365] |
| ROUGH_RICE_LAST_P... | -0.027249 | 4.535361 | -4.406107 |
| | (0.01371) | (3.51198) | (2.97612) |
| | [-1.98710] | [ 1.29140] | [-1.48049] |
| ROUGH_RICE_LAST_P... | 0.012622 | -5.228257 | 0.738796 |
| | (0.01371) | (3.51058) | (2.97493) |
| | [ 0.92080] | [-1.48929] | [ 0.24834] |
| ROUGH_RICE_LAST_P... | -0.000668 | 4.687108 | 4.486344 |
| | (0.01371) | (3.51138) | (2.97561) |
| | [-0.04873] | [ 1.33483] | [ 1.50771] |
| ROUGH_RICE_LAST_P... | -0.001020 | -3.485591 | -2.860888 |
| | (0.01371) | (3.51201) | (2.97614) |
| | [-0.07435] | [-0.99248] | [-0.96127] |
| ROUGH_RICE_LAST_P... | -0.032883 | -0.781478 | -4.878294 |
| | (0.01371) | (3.51001) | (2.97445) |
| | [-2.39928] | [-0.22264] | [-1.64007] |
| ROUGH_RICE_LAST_P... | -0.054521 | 0.297108 | 1.662389 |
| | (0.01372) | (3.51271) | (2.97673) |
| | [-3.97506] | [ 0.08458] | [ 0.55846] |

| | | | |
|---|---|---|---|
| ROUGH_RICE_LAST_P... | 0.017179 | -4.306572 | 1.971724 |
| | (0.01373) | (3.51722) | (2.98055) |
| | [ 1.25091] | [-1.22443] | [ 0.66153] |
| ROUGH_RICE_LAST_P... | -0.015308 | 1.646525 | 2.013462 |
| | (0.01374) | (3.51985) | (2.98278) |
| | [-1.11381] | [ 0.46778] | [ 0.67503] |
| ROUGH_RICE_LAST_P... | -0.004045 | -2.703759 | -0.500265 |
| | (0.01376) | (3.52290) | (2.98537) |
| | [-0.29405] | [-0.76748] | [-0.16757] |
| ROUGH_RICE_LAST_P... | -0.011368 | -1.241455 | 1.501796 |
| | (0.01375) | (3.52099) | (2.98375) |
| | [-0.82688] | [-0.35259] | [ 0.50332] |
| ROUGH_RICE_LAST_P... | -0.033648 | -1.314071 | 3.305718 |
| | (0.01373) | (3.51729) | (2.98062) |
| | [-2.45008] | [-0.37360] | [ 1.10907] |
| ROUGH_RICE_LAST_P... | 0.008086 | 0.550004 | 0.475038 |
| | (0.01374) | (3.51927) | (2.98229) |
| | [ 0.58841] | [ 0.15628] | [ 0.15929] |
| ROUGH_RICE_LAST_P... | -0.010117 | -0.708312 | 0.347998 |
| | (0.01374) | (3.51912) | (2.98217) |
| | [-0.73630] | [-0.20128] | [ 0.11669] |
| ROUGH_RICE_LAST_P... | 0.000546 | 1.453935 | 1.547880 |
| | (0.01374) | (3.51900) | (2.98207) |
| | [ 0.03974] | [ 0.41317] | [ 0.51906] |
| ROUGH_RICE_LAST_P... | 0.014402 | -0.891578 | 2.473864 |
| | (0.01374) | (3.51838) | (2.98154) |
| | [ 1.04834] | [-0.25341] | [ 0.82973] |
| ROUGH_RICE_LAST_P... | -0.001414 | 0.659658 | -0.250367 |
| | (0.01372) | (3.51339) | (2.97731) |
| | [-0.10309] | [ 0.18776] | [-0.08409] |
| ROUGH_RICE_LAST_P... | -0.032570 | -3.030142 | -3.217403 |
| | (0.01371) | (3.51008) | (2.97451) |
| | [-2.37641] | [-0.86327] | [-1.08166] |
| ROUGH_RICE_LAST_P... | -0.014422 | 1.276721 | 3.897939 |
| | (0.01371) | (3.51226) | (2.97636) |
| | [-1.05162] | [ 0.36350] | [ 1.30964] |

| | | | |
|---|---|---|---|
| ROUGH_RICE_LAST_P... | 0.004665 | 0.939899 | -2.685765 |
| | (0.01373) | (3.51527) | (2.97891) |
| | [ 0.33989] | [ 0.26738] | [-0.90159] |
| ROUGH_RICE_LAST_P... | 0.039676 | -6.412620 | -0.529266 |
| | (0.01373) | (3.51551) | (2.97911) |
| | [ 2.89047] | [-1.82409] | [-0.17766] |
| ROUGH_RICE_LAST_P... | 0.017949 | -1.367548 | -1.056308 |
| | (0.01373) | (3.51760) | (2.98088) |
| | [ 1.30684] | [-0.38877] | [-0.35436] |
| ROUGH_RICE_LAST_P... | 0.009311 | -2.948438 | 1.890931 |
| | (0.01373) | (3.51621) | (2.97970) |
| | [ 0.67816] | [-0.83853] | [ 0.63460] |
| ROUGH_RICE_LAST_P... | 0.030134 | 1.598993 | -1.135360 |
| | (0.01373) | (3.51657) | (2.98001) |
| | [ 2.19464] | [ 0.45470] | [-0.38099] |
| ROUGH_RICE_LAST_P... | 0.010434 | 0.146726 | -2.138455 |
| | (0.01374) | (3.51820) | (2.98139) |
| | [ 0.75957] | [ 0.04170] | [-0.71727] |
| ROUGH_RICE_LAST_P... | -0.042060 | -0.111485 | -0.276261 |
| | (0.01363) | (3.49076) | (2.95814) |
| | [-3.08583] | [-0.03194] | [-0.09339] |
| GPRD_ACT(-1) | -7.54E-05 | 0.487794 | 0.058671 |
| | (5.5E-05) | (0.01413) | (0.01197) |
| | [-1.36737] | [ 34.5299] | [ 4.90100] |
| GPRD_ACT(-2) | 5.37E-05 | 0.193101 | 0.009806 |
| | (6.1E-05) | (0.01564) | (0.01326) |
| | [ 0.87932] | [ 12.3438] | [ 0.73972] |
| GPRD_ACT(-3) | -3.92E-05 | 0.090853 | 0.011018 |
| | (6.2E-05) | (0.01588) | (0.01346) |
| | [-0.63186] | [ 5.72160] | [ 0.81878] |
| GPRD_ACT(-4) | 0.000100 | 0.052254 | 0.021923 |
| | (6.2E-05) | (0.01594) | (0.01351) |
| | [ 1.61278] | [ 3.27820] | [ 1.62302] |
| GPRD_ACT(-5) | -4.18E-05 | 0.077349 | 0.006053 |
| | (6.2E-05) | (0.01596) | (0.01352) |
| | [-0.67084] | [ 4.84674] | [ 0.44759] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-6) | 1.18E-05 | 0.010597 | 0.007214 |
| | (6.2E-05) | (0.01598) | (0.01354) |
| | [ 0.18957] | [ 0.66329] | [ 0.53281] |
| GPRD_ACT(-7) | 9.22E-06 | -0.021400 | -0.017766 |
| | (6.2E-05) | (0.01597) | (0.01353) |
| | [ 0.14795] | [-1.34015] | [-1.31289] |
| GPRD_ACT(-8) | -1.55E-05 | -0.007572 | -0.017287 |
| | (6.2E-05) | (0.01596) | (0.01353) |
| | [-0.24880] | [-0.47430] | [-1.27785] |
| GPRD_ACT(-9) | -3.50E-06 | -0.013605 | -0.021244 |
| | (6.2E-05) | (0.01596) | (0.01352) |
| | [-0.05621] | [-0.85268] | [-1.57114] |
| GPRD_ACT(-10) | -4.73E-05 | 0.031170 | -0.008660 |
| | (6.2E-05) | (0.01596) | (0.01353) |
| | [-0.75852] | [ 1.95297] | [-0.64026] |
| GPRD_ACT(-11) | 7.50E-05 | 0.029439 | 0.009670 |
| | (6.2E-05) | (0.01597) | (0.01353) |
| | [ 1.20221] | [ 1.84362] | [ 0.71466] |
| GPRD_ACT(-12) | -1.70E-05 | -0.011663 | -0.014800 |
| | (6.2E-05) | (0.01598) | (0.01354) |
| | [-0.27229] | [-0.73002] | [-1.09319] |
| GPRD_ACT(-13) | -1.55E-05 | 0.004871 | -0.013672 |
| | (6.2E-05) | (0.01597) | (0.01354) |
| | [-0.24919] | [ 0.30495] | [-1.01007] |
| GPRD_ACT(-14) | 7.36E-05 | -0.003929 | -0.002790 |
| | (6.2E-05) | (0.01598) | (0.01354) |
| | [ 1.18039] | [-0.24590] | [-0.20604] |
| GPRD_ACT(-15) | -1.29E-05 | 0.016548 | -0.010775 |
| | (6.2E-05) | (0.01598) | (0.01354) |
| | [-0.20638] | [ 1.03584] | [-0.79589] |
| GPRD_ACT(-16) | -5.95E-05 | -0.009401 | -0.013819 |
| | (6.2E-05) | (0.01599) | (0.01355) |
| | [-0.95269] | [-0.58791] | [-1.01982] |
| GPRD_ACT(-17) | 3.30E-05 | -0.028006 | -0.015708 |
| | (6.2E-05) | (0.01600) | (0.01356) |
| | [ 0.52753] | [-1.75042] | [-1.15852] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-18) | 5.47E-06 | 0.002251 | 0.009762 |
| | (6.3E-05) | (0.01602) | (0.01358) |
| | [ 0.08744] | [ 0.14050] | [ 0.71894] |
| GPRD_ACT(-19) | -3.62E-05 | 0.009635 | 0.001914 |
| | (6.3E-05) | (0.01602) | (0.01357) |
| | [-0.57854] | [ 0.60158] | [ 0.14105] |
| GPRD_ACT(-20) | -2.46E-05 | 0.008909 | 0.016128 |
| | (6.3E-05) | (0.01601) | (0.01357) |
| | [-0.39334] | [ 0.55652] | [ 1.18882] |
| GPRD_ACT(-21) | 1.53E-05 | 0.050714 | 0.016428 |
| | (6.3E-05) | (0.01602) | (0.01357) |
| | [ 0.24433] | [ 3.16594] | [ 1.21020] |
| GPRD_ACT(-22) | 6.68E-05 | -0.046606 | -0.034265 |
| | (6.3E-05) | (0.01604) | (0.01360) |
| | [ 1.06551] | [-2.90479] | [-2.52017] |
| GPRD_ACT(-23) | -5.52E-05 | 0.025415 | -0.012623 |
| | (6.3E-05) | (0.01606) | (0.01361) |
| | [-0.88057] | [ 1.58245] | [-0.92752] |
| GPRD_ACT(-24) | -2.03E-05 | -0.040757 | 0.010695 |
| | (6.3E-05) | (0.01606) | (0.01361) |
| | [-0.32308] | [-2.53749] | [ 0.78573] |
| GPRD_ACT(-25) | -8.07E-05 | 0.028999 | 0.014258 |
| | (6.3E-05) | (0.01604) | (0.01359) |
| | [-1.28913] | [ 1.80808] | [ 1.04908] |
| GPRD_ACT(-26) | 0.000158 | -0.002358 | -0.015726 |
| | (6.3E-05) | (0.01603) | (0.01358) |
| | [ 2.52628] | [-0.14711] | [-1.15781] |
| GPRD_ACT(-27) | -6.13E-05 | -0.014252 | 0.001318 |
| | (6.2E-05) | (0.01599) | (0.01355) |
| | [-0.98106] | [-0.89115] | [ 0.09722] |
| GPRD_ACT(-28) | 4.95E-06 | -0.002531 | -0.005322 |
| | (6.2E-05) | (0.01577) | (0.01336) |
| | [ 0.08037] | [-0.16048] | [-0.39827] |
| GPRD_ACT(-29) | -2.03E-05 | 0.020345 | 0.003592 |
| | (5.6E-05) | (0.01428) | (0.01210) |
| | [-0.36496] | [ 1.42514] | [ 0.29689] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-1) | 3.33E-05 | 0.007936 | 0.333428 |
| | (6.5E-05) | (0.01668) | (0.01413) |
| | [ 0.51156] | [ 0.47592] | [ 23.5952] |
| GPRD_THREAT(-2) | -0.000105 | 0.045594 | 0.176257 |
| | (6.9E-05) | (0.01759) | (0.01490) |
| | [-1.52800] | [ 2.59269] | [ 11.8276] |
| GPRD_THREAT(-3) | 6.41E-05 | -0.021949 | 0.064654 |
| | (7.0E-05) | (0.01781) | (0.01510) |
| | [ 0.92196] | [-1.23203] | [ 4.28268] |
| GPRD_THREAT(-4) | 2.64E-05 | -0.014902 | 0.028178 |
| | (7.0E-05) | (0.01786) | (0.01513) |
| | [ 0.37835] | [-0.83440] | [ 1.86192] |
| GPRD_THREAT(-5) | 1.69E-05 | 0.042681 | 0.080862 |
| | (7.0E-05) | (0.01787) | (0.01514) |
| | [ 0.24223] | [ 2.38861] | [ 5.34017] |
| GPRD_THREAT(-6) | 1.50E-05 | -0.013975 | 0.031679 |
| | (7.0E-05) | (0.01791) | (0.01518) |
| | [ 0.21381] | [-0.78038] | [ 2.08747] |
| GPRD_THREAT(-7) | -7.40E-06 | -0.000203 | 0.015375 |
| | (7.0E-05) | (0.01791) | (0.01518) |
| | [-0.10580] | [-0.01133] | [ 1.01288] |
| GPRD_THREAT(-8) | 4.23E-05 | -0.003180 | -0.003477 |
| | (7.0E-05) | (0.01790) | (0.01517) |
| | [ 0.60570] | [-0.17765] | [-0.22923] |
| GPRD_THREAT(-9) | -0.000126 | 0.031391 | 0.022503 |
| | (7.0E-05) | (0.01795) | (0.01521) |
| | [-1.80083] | [ 1.74921] | [ 1.47970] |
| GPRD_THREAT(-10) | 8.44E-05 | 0.005045 | 0.043113 |
| | (7.0E-05) | (0.01795) | (0.01521) |
| | [ 1.20460] | [ 0.28111] | [ 2.83459] |
| GPRD_THREAT(-11) | -5.39E-05 | -0.034645 | 0.013180 |
| | (7.0E-05) | (0.01796) | (0.01522) |
| | [-0.76863] | [-1.92899] | [ 0.86601] |
| GPRD_THREAT(-12) | -3.32E-05 | -0.013110 | -0.030111 |
| | (7.0E-05) | (0.01801) | (0.01526) |
| | [-0.47269] | [-0.72782] | [-1.97258] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-13) | -2.84E-05 | -0.047079 | -0.021912 |
| | (7.0E-05) | (0.01802) | (0.01527) |
| | [-0.40368] | [-2.61257] | [-1.43491] |
| GPRD_THREAT(-14) | -4.54E-06 | 0.040542 | 0.014585 |
| | (7.0E-05) | (0.01803) | (0.01528) |
| | [-0.06442] | [ 2.24799] | [ 0.95436] |
| GPRD_THREAT(-15) | 0.000168 | 0.019695 | 0.050872 |
| | (7.0E-05) | (0.01803) | (0.01528) |
| | [ 2.38912] | [ 1.09224] | [ 3.32929] |
| GPRD_THREAT(-16) | -0.000167 | 0.000311 | 0.014420 |
| | (7.1E-05) | (0.01809) | (0.01533) |
| | [-2.35755] | [ 0.01721] | [ 0.94075] |
| GPRD_THREAT(-17) | 8.74E-05 | -0.013486 | -0.003099 |
| | (7.1E-05) | (0.01809) | (0.01533) |
| | [ 1.23777] | [-0.74539] | [-0.20214] |
| GPRD_THREAT(-18) | -2.84E-05 | -0.000412 | -0.002106 |
| | (7.1E-05) | (0.01809) | (0.01533) |
| | [-0.40264] | [-0.02276] | [-0.13735] |
| GPRD_THREAT(-19) | -3.96E-05 | -0.000534 | 0.018160 |
| | (7.1E-05) | (0.01809) | (0.01533) |
| | [-0.56023] | [-0.02950] | [ 1.18461] |
| GPRD_THREAT(-20) | -3.07E-05 | 0.016354 | 0.041299 |
| | (7.1E-05) | (0.01809) | (0.01533) |
| | [-0.43417] | [ 0.90415] | [ 2.69441] |
| GPRD_THREAT(-21) | 8.43E-05 | -0.021146 | -0.018068 |
| | (7.1E-05) | (0.01808) | (0.01532) |
| | [ 1.19381] | [-1.16930] | [-1.17897] |
| GPRD_THREAT(-22) | 7.56E-06 | 0.028512 | 0.037547 |
| | (7.1E-05) | (0.01812) | (0.01536) |
| | [ 0.10691] | [ 1.57348] | [ 2.44521] |
| GPRD_THREAT(-23) | 5.73E-05 | 0.007330 | 0.003765 |
| | (7.1E-05) | (0.01815) | (0.01538) |
| | [ 0.80881] | [ 0.40378] | [ 0.24475] |
| GPRD_THREAT(-24) | -0.000170 | -0.009005 | -0.030959 |
| | (7.1E-05) | (0.01814) | (0.01537) |
| | [-2.40122] | [-0.49649] | [-2.01422] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-25) | 0.000135 | 0.003427 | 0.003692 |
| | (7.1E-05) | (0.01818) | (0.01540) |
| | [ 1.90147] | [ 0.18854] | [ 0.23970] |
| GPRD_THREAT(-26) | -1.04E-05 | -0.034453 | 0.013629 |
| | (7.1E-05) | (0.01817) | (0.01540) |
| | [-0.14670] | [-1.89588] | [ 0.88499] |
| GPRD_THREAT(-27) | 9.58E-06 | -0.007280 | -0.002998 |
| | (7.1E-05) | (0.01819) | (0.01542) |
| | [ 0.13489] | [-0.40017] | [-0.19447] |
| GPRD_THREAT(-28) | 8.40E-05 | 0.026500 | 0.017794 |
| | (7.0E-05) | (0.01804) | (0.01529) |
| | [ 1.19192] | [ 1.46883] | [ 1.16385] |
| GPRD_THREAT(-29) | -4.82E-05 | -0.029074 | 0.019745 |
| | (6.7E-05) | (0.01723) | (0.01460) |
| | [-0.71564] | [-1.68716] | [ 1.35207] |
| C | -0.002831 | 5.864424 | 8.597220 |
| | (0.00753) | (1.92973) | (1.63529) |
| | [-0.37569] | [ 3.03899] | [ 5.25731] |
| R-squared | 0.040661 | 0.769081 | 0.570491 |
| Adj. R-squared | 0.025182 | 0.765355 | 0.563561 |
| Sum sq. resids | 226.5431 | 14859291 | 10670717 |
| S.E. equation | 0.204975 | 52.49575 | 44.48585 |
| F-statistic | 2.626879 | 206.4158 | 82.32050 |
| Log likelihood | 953.6523 | -29436.24 | -28528.96 |
| Akaike AIC | -0.315931 | 10.77527 | 10.44415 |
| Schwarz SC | -0.209804 | 10.88140 | 10.55028 |
| Mean dependent | 0.001991 | 114.2487 | 112.8077 |
| S.D. dependent | 0.207605 | 108.3724 | 67.33801 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 212720.5 |
| Determinant resid covariance | 202636.4 |
| Log likelihood | -56807.87 |
| Akaike information criterion | 20.82915 |
| Schwarz criterion | 21.14753 |
| Number of coefficients | 264 |

**EViews Output 63: VAR Estimates – Soybean**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:40
Sample (adjusted): 5/03/2000 5/13/2021
Included observations: 5487 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | SOYBEAN_L... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| SOYBEAN_LAST_PRIC... | 0.017119 | 0.050120 | 0.030390 |
| | (0.01359) | (0.04380) | (0.03704) |
| | [ 1.25962] | [ 1.14431] | [ 0.82043] |
| SOYBEAN_LAST_PRIC... | 0.005334 | 0.018993 | 0.021209 |
| | (0.01359) | (0.04379) | (0.03704) |
| | [ 0.39253] | [ 0.43368] | [ 0.57264] |
| SOYBEAN_LAST_PRIC... | 0.013697 | -0.001891 | -0.006858 |
| | (0.01358) | (0.04378) | (0.03702) |
| | [ 1.00829] | [-0.04320] | [-0.18524] |
| SOYBEAN_LAST_PRIC... | -0.015172 | -0.067395 | 0.009721 |
| | (0.01359) | (0.04381) | (0.03705) |
| | [-1.11619] | [-1.53846] | [ 0.26239] |
| SOYBEAN_LAST_PRIC... | -0.022913 | -0.001176 | -0.012461 |
| | (0.01359) | (0.04380) | (0.03704) |
| | [-1.68593] | [-0.02686] | [-0.33641] |
| SOYBEAN_LAST_PRIC... | -0.019186 | -0.057474 | -0.039398 |
| | (0.01359) | (0.04379) | (0.03704) |
| | [-1.41198] | [-1.31242] | [-1.06378] |
| SOYBEAN_LAST_PRIC... | 0.012811 | -0.018392 | -0.015028 |
| | (0.01359) | (0.04381) | (0.03705) |
| | [ 0.94251] | [-0.41985] | [-0.40565] |
| SOYBEAN_LAST_PRIC... | 0.047202 | -0.050906 | -0.085540 |
| | (0.01358) | (0.04378) | (0.03703) |
| | [ 3.47466] | [-1.16275] | [-2.31031] |
| SOYBEAN_LAST_PRIC... | 0.036828 | 0.035625 | 0.107065 |
| | (0.01361) | (0.04386) | (0.03709) |
| | [ 2.70613] | [ 0.81227] | [ 2.88650] |
| SOYBEAN_LAST_PRIC... | 0.000575 | -0.048889 | -0.023262 |
| | (0.01363) | (0.04391) | (0.03714) |
| | [ 0.04217] | [-1.11337] | [-0.62641] |

| | | | |
|---|---|---|---|
| SOYBEAN_LAST_PRIC... | -0.022787 | -0.035605 | -0.012094 |
| | (0.01363) | (0.04392) | (0.03714) |
| | [-1.67219] | [-0.81073] | [-0.32562] |
| SOYBEAN_LAST_PRIC... | -0.003217 | 0.003978 | 0.018733 |
| | (0.01363) | (0.04392) | (0.03714) |
| | [-0.23606] | [ 0.09057] | [ 0.50439] |
| SOYBEAN_LAST_PRIC... | -0.018208 | -0.000399 | 0.046493 |
| | (0.01363) | (0.04393) | (0.03715) |
| | [-1.33589] | [-0.00909] | [ 1.25159] |
| SOYBEAN_LAST_PRIC... | 0.003758 | 0.074470 | 0.071500 |
| | (0.01362) | (0.04390) | (0.03713) |
| | [ 0.27586] | [ 1.69631] | [ 1.92578] |
| SOYBEAN_LAST_PRIC... | 0.028164 | -0.050076 | 0.033706 |
| | (0.01361) | (0.04387) | (0.03710) |
| | [ 2.06911] | [-1.14152] | [ 0.90853] |
| SOYBEAN_LAST_PRIC... | 0.003910 | 0.000601 | 0.024800 |
| | (0.01362) | (0.04389) | (0.03712) |
| | [ 0.28713] | [ 0.01370] | [ 0.66817] |
| SOYBEAN_LAST_PRIC... | -0.024878 | -0.017070 | 0.053300 |
| | (0.01361) | (0.04386) | (0.03710) |
| | [-1.82782] | [-0.38915] | [ 1.43682] |
| SOYBEAN_LAST_PRIC... | -0.027859 | -0.016976 | 0.003922 |
| | (0.01361) | (0.04388) | (0.03711) |
| | [-2.04619] | [-0.38689] | [ 0.10568] |
| SOYBEAN_LAST_PRIC... | 0.011944 | 0.008678 | 0.064207 |
| | (0.01361) | (0.04387) | (0.03710) |
| | [ 0.87746] | [ 0.19783] | [ 1.73063] |
| SOYBEAN_LAST_PRIC... | 0.017766 | 0.027981 | 0.021271 |
| | (0.01361) | (0.04388) | (0.03711) |
| | [ 1.30493] | [ 0.63773] | [ 0.57326] |
| SOYBEAN_LAST_PRIC... | 0.026254 | -0.011811 | 0.024839 |
| | (0.01362) | (0.04388) | (0.03711) |
| | [ 1.92827] | [-0.26917] | [ 0.66935] |
| SOYBEAN_LAST_PRIC... | -0.000282 | -0.010680 | 0.031288 |
| | (0.01362) | (0.04389) | (0.03712) |
| | [-0.02073] | [-0.24333] | [ 0.84287] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-1) | -0.005724 | 0.484780 | 0.057838 |
| | (0.00437) | (0.01408) | (0.01191) |
| | [-1.31036] | [ 34.4367] | [ 4.85816] |
| GPRD_ACT(-2) | 0.008597 | 0.196983 | 0.009824 |
| | (0.00483) | (0.01556) | (0.01316) |
| | [ 1.78095] | [ 12.6622] | [ 0.74673] |
| GPRD_ACT(-3) | -0.002960 | 0.090179 | 0.010766 |
| | (0.00490) | (0.01580) | (0.01337) |
| | [-0.60352] | [ 5.70603] | [ 0.80550] |
| GPRD_ACT(-4) | -0.009513 | 0.051842 | 0.022340 |
| | (0.00492) | (0.01587) | (0.01342) |
| | [-1.93205] | [ 3.26709] | [ 1.66475] |
| GPRD_ACT(-5) | -0.000259 | 0.079574 | 0.007336 |
| | (0.00493) | (0.01589) | (0.01344) |
| | [-0.05251] | [ 5.00711] | [ 0.54586] |
| GPRD_ACT(-6) | 0.010664 | 0.009758 | 0.009276 |
| | (0.00494) | (0.01592) | (0.01347) |
| | [ 2.15841] | [ 0.61284] | [ 0.68885] |
| GPRD_ACT(-7) | -0.005023 | -0.021522 | -0.019178 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [-1.01620] | [-1.35104] | [-1.42350] |
| GPRD_ACT(-8) | 0.002102 | -0.006755 | -0.018593 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [ 0.42515] | [-0.42394] | [-1.37983] |
| GPRD_ACT(-9) | -0.005433 | -0.013721 | -0.020780 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [-1.09887] | [-0.86116] | [-1.54217] |
| GPRD_ACT(-10) | 0.003207 | 0.033388 | -0.007644 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [ 0.64890] | [ 2.09607] | [-0.56742] |
| GPRD_ACT(-11) | 0.001268 | 0.028029 | 0.008599 |
| | (0.00495) | (0.01594) | (0.01348) |
| | [ 0.25648] | [ 1.75871] | [ 0.63802] |
| GPRD_ACT(-12) | 0.001289 | -0.012004 | -0.016310 |
| | (0.00494) | (0.01593) | (0.01348) |
| | [ 0.26081] | [-0.75337] | [-1.21041] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-13) | -0.001442 | 0.007281 | -0.012248 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [-0.29181] | [ 0.45707] | [-0.90921] |
| GPRD_ACT(-14) | 0.001826 | -0.003650 | -0.000943 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [ 0.36939] | [-0.22911] | [-0.06999] |
| GPRD_ACT(-15) | -0.003567 | 0.015129 | -0.013756 |
| | (0.00494) | (0.01593) | (0.01347) |
| | [-0.72168] | [ 0.94967] | [-1.02105] |
| GPRD_ACT(-16) | 0.003995 | -0.007191 | -0.014768 |
| | (0.00495) | (0.01595) | (0.01349) |
| | [ 0.80716] | [-0.45074] | [-1.09460] |
| GPRD_ACT(-17) | -0.001706 | -0.030848 | -0.016063 |
| | (0.00496) | (0.01597) | (0.01351) |
| | [-0.34426] | [-1.93154] | [-1.18932] |
| GPRD_ACT(-18) | -0.000478 | 0.007212 | 0.011207 |
| | (0.00495) | (0.01595) | (0.01349) |
| | [-0.09657] | [ 0.45226] | [ 0.83098] |
| GPRD_ACT(-19) | -0.005162 | 0.006769 | 0.001270 |
| | (0.00494) | (0.01593) | (0.01348) |
| | [-1.04412] | [ 0.42484] | [ 0.09425] |
| GPRD_ACT(-20) | 0.000475 | 0.011064 | 0.017109 |
| | (0.00493) | (0.01589) | (0.01344) |
| | [ 0.09638] | [ 0.69633] | [ 1.27329] |
| GPRD_ACT(-21) | 0.005055 | 0.051962 | 0.016790 |
| | (0.00486) | (0.01566) | (0.01324) |
| | [ 1.04030] | [ 3.31793] | [ 1.26772] |
| GPRD_ACT(-22) | 0.000855 | -0.044820 | -0.034692 |
| | (0.00441) | (0.01421) | (0.01202) |
| | [ 0.19395] | [-3.15477] | [-2.88739] |
| GPRD_THREAT(-1) | 0.008143 | 0.009227 | 0.334531 |
| | (0.00516) | (0.01664) | (0.01408) |
| | [ 1.57665] | [ 0.55433] | [ 23.7656] |
| GPRD_THREAT(-2) | 0.004235 | 0.043978 | 0.171574 |
| | (0.00545) | (0.01756) | (0.01485) |
| | [ 0.77728] | [ 2.50478] | [ 11.5549] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-3) | 0.004082 | -0.022418 | 0.064943 |
| | (0.00551) | (0.01775) | (0.01501) |
| | [ 0.74105] | [-1.26272] | [ 4.32533] |
| GPRD_THREAT(-4) | -0.001553 | -0.018437 | 0.029170 |
| | (0.00552) | (0.01780) | (0.01505) |
| | [-0.28123] | [-1.03606] | [ 1.93829] |
| GPRD_THREAT(-5) | -0.008916 | 0.043265 | 0.080809 |
| | (0.00553) | (0.01781) | (0.01506) |
| | [-1.61366] | [ 2.42975] | [ 5.36614] |
| GPRD_THREAT(-6) | 0.004303 | -0.013211 | 0.033527 |
| | (0.00554) | (0.01786) | (0.01510) |
| | [ 0.77658] | [-0.73982] | [ 2.22011] |
| GPRD_THREAT(-7) | 0.002944 | -0.004944 | 0.016929 |
| | (0.00554) | (0.01787) | (0.01511) |
| | [ 0.53106] | [-0.27671] | [ 1.12049] |
| GPRD_THREAT(-8) | -0.002865 | -0.000370 | -0.003148 |
| | (0.00554) | (0.01785) | (0.01509) |
| | [-0.51741] | [-0.02075] | [-0.20856] |
| GPRD_THREAT(-9) | 0.007018 | 0.029277 | 0.025213 |
| | (0.00555) | (0.01789) | (0.01513) |
| | [ 1.26424] | [ 1.63644] | [ 1.66644] |
| GPRD_THREAT(-10) | -0.000775 | 0.002176 | 0.042254 |
| | (0.00556) | (0.01791) | (0.01514) |
| | [-0.13944] | [ 0.12151] | [ 2.79027] |
| GPRD_THREAT(-11) | -0.004381 | -0.036304 | 0.015116 |
| | (0.00556) | (0.01791) | (0.01515) |
| | [-0.78822] | [-2.02666] | [ 0.99780] |
| GPRD_THREAT(-12) | -0.004778 | -0.011649 | -0.028471 |
| | (0.00558) | (0.01797) | (0.01520) |
| | [-0.85707] | [-0.64835] | [-1.87368] |
| GPRD_THREAT(-13) | -0.003120 | -0.046736 | -0.022637 |
| | (0.00557) | (0.01796) | (0.01519) |
| | [-0.55975] | [-2.60163] | [-1.48998] |
| GPRD_THREAT(-14) | -0.001902 | 0.039427 | 0.015980 |
| | (0.00558) | (0.01797) | (0.01520) |
| | [-0.34120] | [ 2.19419] | [ 1.05156] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-15) | 0.012322 | 0.020058 | 0.050197 |
| | (0.00558) | (0.01797) | (0.01520) |
| | [ 2.21010] | [ 1.11637] | [ 3.30344] |
| GPRD_THREAT(-16) | -0.011497 | -0.002702 | 0.012691 |
| | (0.00559) | (0.01802) | (0.01524) |
| | [-2.05662] | [-0.15000] | [ 0.83300] |
| GPRD_THREAT(-17) | 0.011265 | -0.010973 | -0.002310 |
| | (0.00559) | (0.01801) | (0.01523) |
| | [ 2.01609] | [-0.60934] | [-0.15167] |
| GPRD_THREAT(-18) | -0.004163 | -0.005166 | -0.002160 |
| | (0.00558) | (0.01799) | (0.01521) |
| | [-0.74587] | [-0.28721] | [-0.14199] |
| GPRD_THREAT(-19) | -0.004086 | -0.000459 | 0.018318 |
| | (0.00558) | (0.01798) | (0.01520) |
| | [-0.73250] | [-0.02555] | [ 1.20484] |
| GPRD_THREAT(-20) | 0.002007 | 0.011657 | 0.041722 |
| | (0.00557) | (0.01794) | (0.01517) |
| | [ 0.36069] | [ 0.64987] | [ 2.75039] |
| GPRD_THREAT(-21) | -0.009930 | -0.026681 | -0.016982 |
| | (0.00551) | (0.01777) | (0.01502) |
| | [-1.80140] | [-1.50187] | [-1.13032] |
| GPRD_THREAT(-22) | 0.003075 | 0.024517 | 0.040175 |
| | (0.00527) | (0.01697) | (0.01435) |
| | [ 0.58382] | [ 1.44453] | [ 2.79900] |
| C | 0.229472 | 5.052859 | 9.741348 |
| | (0.56650) | (1.82569) | (1.54400) |
| | [ 0.40507] | [ 2.76764] | [ 6.30917] |

| | | | |
|---|---|---|---|
| R-squared | 0.017962 | 0.767937 | 0.570232 |
| Adj. R-squared | 0.006004 | 0.765111 | 0.564999 |
| Sum sq. resids | 1437769. | 14933129 | 10680457 |
| S.E. equation | 16.28714 | 52.48990 | 44.39104 |
| F-statistic | 1.502052 | 271.7532 | 108.9615 |
| Log likelihood | -23062.80 | -29483.94 | -28564.41 |
| Akaike AIC | 8.430764 | 10.77125 | 10.43609 |
| Schwarz SC | 8.511479 | 10.85197 | 10.51680 |
| Mean dependent | 0.192728 | 114.2376 | 112.7700 |
| S.D. dependent | 16.33625 | 108.3040 | 67.30542 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 1.34E+09 |
| Determinant resid covariance | 1.29E+09 |
| Log likelihood | -80911.58 |
| Akaike information criterion | 29.56537 |
| Schwarz criterion | 29.80751 |
| Number of coefficients | 201 |

**EViews Output 64: VAR Estimates – Soybean Oil**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:42
Sample (adjusted): 5/03/2000 5/13/2021
Included observations: 5487 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | SOYBEAN_... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| SOYBEAN_OIL_LAST_P... | 0.040457 | 1.580436 | 2.003876 |
| | (0.01358) | (1.18335) | (1.00035) |
| | [ 2.97856] | [ 1.33556] | [ 2.00318] |
| SOYBEAN_OIL_LAST_P... | 0.009774 | 0.063013 | 0.727594 |
| | (0.01360) | (1.18468) | (1.00147) |
| | [ 0.71880] | [ 0.05319] | [ 0.72653] |
| SOYBEAN_OIL_LAST_P... | -0.006380 | 0.413762 | 1.349807 |
| | (0.01360) | (1.18459) | (1.00139) |
| | [-0.46919] | [ 0.34929] | [ 1.34793] |
| SOYBEAN_OIL_LAST_P... | -0.006852 | -0.902465 | 1.033137 |
| | (0.01361) | (1.18567) | (1.00230) |
| | [-0.50351] | [-0.76115] | [ 1.03076] |
| SOYBEAN_OIL_LAST_P... | -0.001070 | 0.302664 | 0.094346 |
| | (0.01361) | (1.18592) | (1.00252) |
| | [-0.07864] | [ 0.25521] | [ 0.09411] |
| SOYBEAN_OIL_LAST_P... | 0.012938 | -0.811770 | -0.648012 |
| | (0.01361) | (1.18540) | (1.00208) |
| | [ 0.95087] | [-0.68481] | [-0.64667] |
| SOYBEAN_OIL_LAST_P... | 0.016257 | -0.811095 | -1.155861 |
| | (0.01361) | (1.18608) | (1.00265) |
| | [ 1.19414] | [-0.68385] | [-1.15280] |
| SOYBEAN_OIL_LAST_P... | 0.012755 | -1.560413 | -1.067085 |
| | (0.01361) | (1.18556) | (1.00221) |
| | [ 0.93729] | [-1.31618] | [-1.06473] |
| SOYBEAN_OIL_LAST_P... | -0.000715 | -0.326523 | 3.223548 |
| | (0.01362) | (1.18634) | (1.00287) |
| | [-0.05252] | [-0.27524] | [ 3.21431] |
| SOYBEAN_OIL_LAST_P... | 0.001141 | -1.749469 | -0.596604 |
| | (0.01365) | (1.18883) | (1.00497) |
| | [ 0.08359] | [-1.47159] | [-0.59365] |

| | | | |
|---|---|---|---|
| SOYBEAN_OIL_LAST_P... | -0.026860 | -0.467833 | 0.497514 |
| | (0.01365) | (1.18964) | (1.00566) |
| | [-1.96709] | [-0.39326] | [ 0.49471] |
| SOYBEAN_OIL_LAST_P... | 0.006833 | -0.094455 | 1.077080 |
| | (0.01365) | (1.18893) | (1.00506) |
| | [ 0.50072] | [-0.07945] | [ 1.07165] |
| SOYBEAN_OIL_LAST_P... | -0.026342 | 0.702863 | -0.942874 |
| | (0.01373) | (1.19625) | (1.01125) |
| | [-1.91844] | [ 0.58755] | [-0.93238] |
| SOYBEAN_OIL_LAST_P... | -0.010282 | 0.842998 | 1.260431 |
| | (0.01378) | (1.20023) | (1.01461) |
| | [-0.74638] | [ 0.70236] | [ 1.24228] |
| SOYBEAN_OIL_LAST_P... | 0.041903 | -1.293098 | -0.952080 |
| | (0.01378) | (1.20072) | (1.01503) |
| | [ 3.04038] | [-1.07693] | [-0.93798] |
| SOYBEAN_OIL_LAST_P... | 0.008750 | 0.341079 | 0.464952 |
| | (0.01379) | (1.20181) | (1.01595) |
| | [ 0.63433] | [ 0.28380] | [ 0.45765] |
| SOYBEAN_OIL_LAST_P... | -0.032705 | -0.790344 | 0.997329 |
| | (0.01379) | (1.20154) | (1.01572) |
| | [-2.37141] | [-0.65777] | [ 0.98189] |
| SOYBEAN_OIL_LAST_P... | -0.018112 | -1.267783 | -0.207353 |
| | (0.01381) | (1.20283) | (1.01682) |
| | [-1.31189] | [-1.05400] | [-0.20392] |
| SOYBEAN_OIL_LAST_P... | 0.031080 | -0.054363 | 1.428227 |
| | (0.01381) | (1.20293) | (1.01689) |
| | [ 2.25094] | [-0.04519] | [ 1.40450] |
| SOYBEAN_OIL_LAST_P... | -0.021463 | 0.719125 | 0.490407 |
| | (0.01382) | (1.20432) | (1.01807) |
| | [-1.55267] | [ 0.59712] | [ 0.48170] |
| SOYBEAN_OIL_LAST_P... | 0.022452 | 0.052118 | 1.061162 |
| | (0.01383) | (1.20518) | (1.01880) |
| | [ 1.62303] | [ 0.04324] | [ 1.04158] |
| SOYBEAN_OIL_LAST_P... | -0.051340 | 0.534263 | 1.460330 |
| | (0.01386) | (1.20710) | (1.02042) |
| | [-3.70545] | [ 0.44260] | [ 1.43110] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-1) | 4.92E-05 | 0.483941 | 0.058086 |
| | (0.00016) | (0.01408) | (0.01190) |
| | [ 0.30463] | [ 34.3688] | [ 4.87986] |
| GPRD_ACT(-2) | 0.000154 | 0.197064 | 0.009825 |
| | (0.00018) | (0.01555) | (0.01315) |
| | [ 0.86488] | [ 12.6706] | [ 0.74726] |
| GPRD_ACT(-3) | -8.09E-05 | 0.090106 | 0.009657 |
| | (0.00018) | (0.01580) | (0.01336) |
| | [-0.44610] | [ 5.70337] | [ 0.72306] |
| GPRD_ACT(-4) | -0.000331 | 0.052428 | 0.022563 |
| | (0.00018) | (0.01586) | (0.01341) |
| | [-1.81742] | [ 3.30495] | [ 1.68253] |
| GPRD_ACT(-5) | -0.000109 | 0.080001 | 0.006936 |
| | (0.00018) | (0.01589) | (0.01343) |
| | [-0.60043] | [ 5.03613] | [ 0.51654] |
| GPRD_ACT(-6) | 0.000206 | 0.009158 | 0.009173 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [ 1.12813] | [ 0.57536] | [ 0.68175] |
| GPRD_ACT(-7) | -0.000190 | -0.020893 | -0.018514 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [-1.03787] | [-1.31247] | [-1.37576] |
| GPRD_ACT(-8) | -3.87E-05 | -0.006779 | -0.018001 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [-0.21169] | [-0.42575] | [-1.33746] |
| GPRD_ACT(-9) | -5.39E-05 | -0.013249 | -0.020539 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [-0.29468] | [-0.83204] | [-1.52582] |
| GPRD_ACT(-10) | 6.14E-05 | 0.032561 | -0.008191 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [ 0.33600] | [ 2.04554] | [-0.60868] |
| GPRD_ACT(-11) | 8.68E-05 | 0.029282 | 0.009085 |
| | (0.00018) | (0.01593) | (0.01346) |
| | [ 0.47483] | [ 1.83869] | [ 0.67481] |
| GPRD_ACT(-12) | 6.48E-05 | -0.012529 | -0.015287 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [ 0.35463] | [-0.78686] | [-1.13566] |

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|---|---|---|---|
| GPRD_ACT(-13) | -4.26E-05 | 0.006968 | -0.012802 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [-0.23325] | [ 0.43775] | [-0.95141] |
| GPRD_ACT(-14) | 7.62E-05 | -0.004470 | -0.001186 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [ 0.41686] | [-0.28082] | [-0.08810] |
| GPRD_ACT(-15) | 2.24E-05 | 0.015129 | -0.013198 |
| | (0.00018) | (0.01592) | (0.01346) |
| | [ 0.12258] | [ 0.95041] | [-0.98075] |
| GPRD_ACT(-16) | -1.62E-05 | -0.007563 | -0.014874 |
| | (0.00018) | (0.01594) | (0.01348) |
| | [-0.08866] | [-0.47436] | [-1.10366] |
| GPRD_ACT(-17) | 6.95E-05 | -0.030500 | -0.016205 |
| | (0.00018) | (0.01596) | (0.01350) |
| | [ 0.37905] | [-1.91057] | [-1.20083] |
| GPRD_ACT(-18) | -0.000135 | 0.006349 | 0.010103 |
| | (0.00018) | (0.01594) | (0.01347) |
| | [-0.73547] | [ 0.39835] | [ 0.74978] |
| GPRD_ACT(-19) | 9.03E-05 | 0.007538 | 0.002301 |
| | (0.00018) | (0.01593) | (0.01346) |
| | [ 0.49398] | [ 0.47329] | [ 0.17094] |
| GPRD_ACT(-20) | 0.000103 | 0.011595 | 0.016499 |
| | (0.00018) | (0.01588) | (0.01342) |
| | [ 0.56580] | [ 0.73021] | [ 1.22909] |
| GPRD_ACT(-21) | 7.38E-05 | 0.051442 | 0.017240 |
| | (0.00018) | (0.01565) | (0.01323) |
| | [ 0.41059] | [ 3.28624] | [ 1.30281] |
| GPRD_ACT(-22) | -0.000152 | -0.044217 | -0.035133 |
| | (0.00016) | (0.01420) | (0.01201) |
| | [-0.93142] | [-3.11304] | [-2.92597] |
| GPRD_THREAT(-1) | 0.000197 | 0.009760 | 0.334883 |
| | (0.00019) | (0.01665) | (0.01408) |
| | [ 1.03167] | [ 0.58608] | [ 23.7883] |
| GPRD_THREAT(-2) | 9.64E-05 | 0.042839 | 0.171859 |
| | (0.00020) | (0.01756) | (0.01485) |
| | [ 0.47793] | [ 2.43894] | [ 11.5743] |

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|---|---|---|---|
| GPRD_THREAT(-3) | 0.000283 | -0.021680 | 0.065319 |
| | (0.00020) | (0.01776) | (0.01501) |
| | [ 1.38875] | [-1.22061] | [ 4.35040] |
| GPRD_THREAT(-4) | 0.000242 | -0.018844 | 0.030799 |
| | (0.00020) | (0.01780) | (0.01505) |
| | [ 1.18653] | [-1.05839] | [ 2.04635] |
| GPRD_THREAT(-5) | 0.000258 | 0.044107 | 0.079140 |
| | (0.00020) | (0.01782) | (0.01506) |
| | [ 1.26300] | [ 2.47524] | [ 5.25368] |
| GPRD_THREAT(-6) | -0.000109 | -0.014343 | 0.031920 |
| | (0.00021) | (0.01787) | (0.01510) |
| | [-0.52910] | [-0.80281] | [ 2.11344] |
| GPRD_THREAT(-7) | 4.11E-05 | -0.003918 | 0.015051 |
| | (0.00021) | (0.01787) | (0.01511) |
| | [ 0.20019] | [-0.21919] | [ 0.99612] |
| GPRD_THREAT(-8) | -7.09E-05 | -0.000969 | -0.004936 |
| | (0.00020) | (0.01785) | (0.01509) |
| | [-0.34577] | [-0.05426] | [-0.32708] |
| GPRD_THREAT(-9) | 0.000146 | 0.030408 | 0.024625 |
| | (0.00021) | (0.01789) | (0.01512) |
| | [ 0.71140] | [ 1.69975] | [ 1.62835] |
| GPRD_THREAT(-10) | -0.000260 | 0.001682 | 0.042563 |
| | (0.00021) | (0.01790) | (0.01513) |
| | [-1.26327] | [ 0.09396] | [ 2.81267] |
| GPRD_THREAT(-11) | -0.000476 | -0.035178 | 0.015939 |
| | (0.00021) | (0.01791) | (0.01514) |
| | [-2.31731] | [-1.96418] | [ 1.05277] |
| GPRD_THREAT(-12) | 8.34E-05 | -0.011034 | -0.026946 |
| | (0.00021) | (0.01797) | (0.01519) |
| | [ 0.40423] | [-0.61393] | [-1.77348] |
| GPRD_THREAT(-13) | -0.000242 | -0.046721 | -0.023665 |
| | (0.00021) | (0.01797) | (0.01519) |
| | [-1.17426] | [-2.59988] | [-1.55780] |
| GPRD_THREAT(-14) | -0.000315 | 0.039855 | 0.015706 |
| | (0.00021) | (0.01797) | (0.01519) |
| | [-1.52868] | [ 2.21795] | [ 1.03396] |

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|---|---|---|---|
| GPRD_THREAT(-15) | 0.000121 | 0.021491 | 0.052297 |
| | (0.00021) | (0.01798) | (0.01520) |
| | [ 0.58551] | [ 1.19513] | [ 3.44028] |
| GPRD_THREAT(-16) | -5.32E-05 | -0.001008 | 0.013481 |
| | (0.00021) | (0.01802) | (0.01523) |
| | [-0.25698] | [-0.05595] | [ 0.88493] |
| GPRD_THREAT(-17) | 0.000427 | -0.012314 | -0.002327 |
| | (0.00021) | (0.01801) | (0.01522) |
| | [ 2.06774] | [-0.68381] | [-0.15287] |
| GPRD_THREAT(-18) | 2.36E-05 | -0.006293 | -0.003596 |
| | (0.00021) | (0.01799) | (0.01520) |
| | [ 0.11433] | [-0.34989] | [-0.23650] |
| GPRD_THREAT(-19) | -0.000168 | -0.002100 | 0.018287 |
| | (0.00021) | (0.01798) | (0.01520) |
| | [-0.81422] | [-0.11681] | [ 1.20341] |
| GPRD_THREAT(-20) | -0.000119 | 0.012461 | 0.042195 |
| | (0.00021) | (0.01794) | (0.01516) |
| | [-0.57761] | [ 0.69476] | [ 2.78286] |
| GPRD_THREAT(-21) | -0.000113 | -0.028590 | -0.019018 |
| | (0.00020) | (0.01776) | (0.01502) |
| | [-0.55569] | [-1.60958] | [-1.26653] |
| GPRD_THREAT(-22) | 0.000155 | 0.024512 | 0.042110 |
| | (0.00019) | (0.01699) | (0.01436) |
| | [ 0.79526] | [ 1.44311] | [ 2.93262] |
| C | 0.002758 | 5.004669 | 9.878285 |
| | (0.02103) | (1.83203) | (1.54871) |
| | [ 0.13118] | [ 2.73176] | [ 6.37840] |

| | | | |
|---|---|---|---|
| R-squared | 0.019838 | 0.767844 | 0.570422 |
| Adj. R-squared | 0.007902 | 0.765017 | 0.565191 |
| Sum sq. resids | 1968.194 | 14939119 | 10675746 |
| S.E. equation | 0.602607 | 52.50043 | 44.38124 |
| F-statistic | 1.662053 | 271.6113 | 109.0458 |
| Log likelihood | -4972.901 | -29485.04 | -28563.20 |
| Akaike AIC | 1.837033 | 10.77166 | 10.43565 |
| Schwarz SC | 1.917748 | 10.85237 | 10.51636 |
| Mean dependent | 0.009428 | 114.2376 | 112.7700 |
| S.D. dependent | 0.605002 | 108.3040 | 67.30542 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 1832566. |
| Determinant resid covariance | 1766252. |
| Log likelihood | -62820.67 |
| Akaike information criterion | 22.97127 |
| Schwarz criterion | 23.21341 |
| Number of coefficients | 201 |

**EViews Output 65: VAR Estimates – Wheat**

Vector Autoregression Estimates
Date: 05/27/22 Time: 20:50
Sample (adjusted): 5/12/2000 5/13/2021
Included observations: 5480 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | WHEAT_LA... | GPRD_ACT | GPRD_THR... |
|---|---|---|---|
| WHEAT_LAST_PRICE1(... | 0.043687 | -0.010713 | 0.100144 |
| | (0.01361) | (0.05607) | (0.04752) |
| | [ 3.21092] | [-0.19108] | [ 2.10738] |
| WHEAT_LAST_PRICE1(... | 0.013390 | -0.024312 | 0.014898 |
| | (0.01363) | (0.05615) | (0.04759) |
| | [ 0.98275] | [-0.43301] | [ 0.31307] |
| WHEAT_LAST_PRICE1(... | -0.077919 | 0.094981 | 0.000287 |
| | (0.01363) | (0.05617) | (0.04760) |
| | [-5.71692] | [ 1.69111] | [ 0.00602] |
| WHEAT_LAST_PRICE1(... | -0.025064 | -0.036460 | -0.008959 |
| | (0.01368) | (0.05636) | (0.04777) |
| | [-1.83260] | [-0.64691] | [-0.18755] |
| WHEAT_LAST_PRICE1(... | -0.021449 | 0.051984 | 0.021386 |
| | (0.01369) | (0.05640) | (0.04780) |
| | [-1.56725] | [ 0.92177] | [ 0.44742] |
| WHEAT_LAST_PRICE1(... | 0.000877 | -0.096385 | -0.047645 |
| | (0.01369) | (0.05640) | (0.04780) |
| | [ 0.06411] | [-1.70896] | [-0.99670] |
| WHEAT_LAST_PRICE1(... | -0.023212 | 0.003266 | 0.102064 |
| | (0.01368) | (0.05635) | (0.04776) |
| | [-1.69734] | [ 0.05796] | [ 2.13683] |
| WHEAT_LAST_PRICE1(... | 0.014899 | 0.005220 | 0.006138 |
| | (0.01366) | (0.05629) | (0.04771) |
| | [ 1.09080] | [ 0.09275] | [ 0.12866] |
| WHEAT_LAST_PRICE1(... | 0.003784 | 0.068768 | 0.089271 |
| | (0.01366) | (0.05630) | (0.04772) |
| | [ 0.27696] | [ 1.22142] | [ 1.87073] |
| WHEAT_LAST_PRICE1(... | -0.003086 | -0.009148 | -0.023142 |
| | (0.01367) | (0.05635) | (0.04776) |
| | [-0.22571] | [-0.16236] | [-0.48458] |

| | | | |
|---|---|---|---|
| WHEAT_LAST_PRICE1(... | -0.058690 | -0.034623 | -0.018894 |
| | (0.01457) | (0.06006) | (0.05090) |
| | [-4.02691] | [-0.57648] | [-0.37117] |
| WHEAT_LAST_PRICE1(... | -0.057896 | -0.058477 | -0.012546 |
| | (0.01464) | (0.06033) | (0.05114) |
| | [-3.95433] | [-0.96923] | [-0.24534] |
| WHEAT_LAST_PRICE1(... | 0.025362 | -0.027165 | -0.022802 |
| | (0.01473) | (0.06069) | (0.05144) |
| | [ 1.72214] | [-0.44762] | [-0.44330] |
| WHEAT_LAST_PRICE1(... | 0.004326 | -0.061368 | -0.017327 |
| | (0.01479) | (0.06095) | (0.05166) |
| | [ 0.29247] | [-1.00680] | [-0.33539] |
| WHEAT_LAST_PRICE1(... | 0.014763 | 0.040275 | -0.001107 |
| | (0.01481) | (0.06104) | (0.05174) |
| | [ 0.99662] | [ 0.65980] | [-0.02140] |
| WHEAT_LAST_PRICE1(... | -0.027456 | -0.004320 | 0.007863 |
| | (0.01482) | (0.06105) | (0.05175) |
| | [-1.85323] | [-0.07076] | [ 0.15196] |
| WHEAT_LAST_PRICE1(... | 0.013362 | 0.026144 | -0.055018 |
| | (0.01483) | (0.06111) | (0.05180) |
| | [ 0.90095] | [ 0.42779] | [-1.06215] |
| WHEAT_LAST_PRICE1(... | -0.026007 | -0.068462 | 0.018811 |
| | (0.01483) | (0.06111) | (0.05179) |
| | [-1.75383] | [-1.12034] | [ 0.36319] |
| GPRD_ACT(-1) | -0.001880 | 0.487137 | 0.059201 |
| | (0.00343) | (0.01412) | (0.01197) |
| | [-0.54862] | [ 34.4929] | [ 4.94578] |
| GPRD_ACT(-2) | 0.003308 | 0.194405 | 0.010180 |
| | (0.00379) | (0.01563) | (0.01325) |
| | [ 0.87218] | [ 12.4401] | [ 0.76855] |
| GPRD_ACT(-3) | -0.003319 | 0.092684 | 0.010661 |
| | (0.00385) | (0.01587) | (0.01345) |
| | [-0.86212] | [ 5.84182] | [ 0.79283] |
| GPRD_ACT(-4) | -0.006162 | 0.050473 | 0.020126 |
| | (0.00387) | (0.01593) | (0.01350) |
| | [-1.59395] | [ 3.16856] | [ 1.49067] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-5) | -0.000591 | 0.076980 | 0.007833 |
| | (0.00387) | (0.01595) | (0.01352) |
| | [-0.15284] | [ 4.82749] | [ 0.57956] |
| GPRD_ACT(-6) | 0.003374 | 0.009014 | 0.007842 |
| | (0.00387) | (0.01597) | (0.01353) |
| | [ 0.87073] | [ 0.56459] | [ 0.57946] |
| GPRD_ACT(-7) | -0.002683 | -0.019706 | -0.018338 |
| | (0.00387) | (0.01596) | (0.01353) |
| | [-0.69254] | [-1.23455] | [-1.35548] |
| GPRD_ACT(-8) | 0.001027 | -0.007115 | -0.016424 |
| | (0.00387) | (0.01596) | (0.01353) |
| | [ 0.26506] | [-0.44579] | [-1.21417] |
| GPRD_ACT(-9) | -0.002716 | -0.012573 | -0.022050 |
| | (0.00387) | (0.01596) | (0.01352) |
| | [-0.70139] | [-0.78802] | [-1.63054] |
| GPRD_ACT(-10) | 0.002901 | 0.029164 | -0.006962 |
| | (0.00387) | (0.01596) | (0.01353) |
| | [ 0.74903] | [ 1.82745] | [-0.51472] |
| GPRD_ACT(-11) | 0.001100 | 0.029590 | 0.008381 |
| | (0.00387) | (0.01597) | (0.01353) |
| | [ 0.28402] | [ 1.85337] | [ 0.61935] |
| GPRD_ACT(-12) | -0.003292 | -0.011901 | -0.014276 |
| | (0.00388) | (0.01597) | (0.01354) |
| | [-0.84934] | [-0.74516] | [-1.05465] |
| GPRD_ACT(-13) | 0.002088 | 0.006449 | -0.013151 |
| | (0.00387) | (0.01596) | (0.01353) |
| | [ 0.53883] | [ 0.40398] | [-0.97191] |
| GPRD_ACT(-14) | 0.005602 | -0.003948 | -0.001757 |
| | (0.00388) | (0.01597) | (0.01354) |
| | [ 1.44544] | [-0.24721] | [-0.12982] |
| GPRD_ACT(-15) | 0.000418 | 0.015101 | -0.012277 |
| | (0.00388) | (0.01597) | (0.01353) |
| | [ 0.10780] | [ 0.94569] | [-0.90711] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-16) | 0.003173 | -0.007964 | -0.013879 |
| | (0.00388) | (0.01598) | (0.01355) |
| | [ 0.81828] | [-0.49833] | [-1.02466] |
| GPRD_ACT(-17) | 0.001556 | -0.031055 | -0.015995 |
| | (0.00388) | (0.01599) | (0.01355) |
| | [ 0.40110] | [-1.94214] | [-1.18018] |
| GPRD_ACT(-18) | -0.000871 | 0.004463 | 0.009305 |
| | (0.00389) | (0.01601) | (0.01357) |
| | [-0.22421] | [ 0.27872] | [ 0.68553] |
| GPRD_ACT(-19) | -0.004510 | 0.008345 | 0.002358 |
| | (0.00389) | (0.01601) | (0.01357) |
| | [-1.16066] | [ 0.52116] | [ 0.17371] |
| GPRD_ACT(-20) | 0.001605 | 0.008934 | 0.015093 |
| | (0.00388) | (0.01601) | (0.01357) |
| | [ 0.41323] | [ 0.55812] | [ 1.11251] |
| GPRD_ACT(-21) | 0.000789 | 0.050002 | 0.017040 |
| | (0.00389) | (0.01601) | (0.01357) |
| | [ 0.20302] | [ 3.12316] | [ 1.25573] |
| GPRD_ACT(-22) | -0.006101 | -0.045165 | -0.035097 |
| | (0.00389) | (0.01603) | (0.01359) |
| | [-1.56805] | [-2.81692] | [-2.58263] |
| GPRD_ACT(-23) | 0.001226 | 0.024642 | -0.013950 |
| | (0.00390) | (0.01605) | (0.01361) |
| | [ 0.31472] | [ 1.53505] | [-1.02530] |
| GPRD_ACT(-24) | 0.005488 | -0.040275 | 0.011340 |
| | (0.00390) | (0.01606) | (0.01361) |
| | [ 1.40860] | [-2.50848] | [ 0.83331] |
| GPRD_ACT(-25) | -0.000534 | 0.028404 | 0.013548 |
| | (0.00389) | (0.01604) | (0.01360) |
| | [-0.13715] | [ 1.77053] | [ 0.99638] |
| GPRD_ACT(-26) | 0.000827 | -0.002577 | -0.016395 |
| | (0.00389) | (0.01603) | (0.01359) |
| | [ 0.21269] | [-0.16075] | [-1.20676] |
| GPRD_ACT(-27) | -0.007658 | -0.011505 | 0.001181 |
| | (0.00388) | (0.01599) | (0.01355) |
| | [-1.97394] | [-0.71970] | [ 0.08717] |

| | | | |
|---|---|---|---|
| GPRD_ACT(-28) | 0.005348 | -0.003783 | -0.003943 |
| | (0.00383) | (0.01577) | (0.01336) |
| | [ 1.39780] | [-0.23994] | [-0.29507] |
| GPRD_ACT(-29) | -0.001906 | 0.019996 | 0.004083 |
| | (0.00347) | (0.01428) | (0.01210) |
| | [-0.55006] | [ 1.40013] | [ 0.33732] |
| GPRD_THREAT(-1) | 0.014921 | 0.008608 | 0.333758 |
| | (0.00404) | (0.01667) | (0.01413) |
| | [ 3.68879] | [ 0.51643] | [ 23.6249] |
| GPRD_THREAT(-2) | 0.002433 | 0.042616 | 0.172169 |
| | (0.00427) | (0.01759) | (0.01491) |
| | [ 0.57006] | [ 2.42261] | [ 11.5475] |
| GPRD_THREAT(-3) | 0.011742 | -0.019176 | 0.064654 |
| | (0.00432) | (0.01781) | (0.01509) |
| | [ 2.71713] | [-1.07683] | [ 4.28350] |
| GPRD_THREAT(-4) | 0.008100 | -0.016142 | 0.029011 |
| | (0.00434) | (0.01786) | (0.01514) |
| | [ 1.86843] | [-0.90360] | [ 1.91609] |
| GPRD_THREAT(-5) | -0.006953 | 0.044555 | 0.080313 |
| | (0.00434) | (0.01788) | (0.01516) |
| | [-1.60234] | [ 2.49174] | [ 5.29934] |
| GPRD_THREAT(-6) | 0.002403 | -0.016217 | 0.030080 |
| | (0.00435) | (0.01792) | (0.01519) |
| | [ 0.55259] | [-0.90482] | [ 1.98014] |
| GPRD_THREAT(-7) | -0.005387 | -0.001072 | 0.016075 |
| | (0.00435) | (0.01793) | (0.01520) |
| | [-1.23815] | [-0.05978] | [ 1.05784] |
| GPRD_THREAT(-8) | -0.001533 | -0.002687 | -0.004533 |
| | (0.00435) | (0.01792) | (0.01519) |
| | [-0.35250] | [-0.14993] | [-0.29842] |
| GPRD_THREAT(-9) | -0.006203 | 0.031608 | 0.022467 |
| | (0.00436) | (0.01797) | (0.01523) |
| | [-1.42257] | [ 1.75913] | [ 1.47527] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-10) | -0.006023 | 0.006726 | 0.041603 |
| | (0.00436) | (0.01797) | (0.01523) |
| | [-1.38133] | [ 0.37432] | [ 2.73189] |
| GPRD_THREAT(-11) | -0.002628 | -0.035530 | 0.012999 |
| | (0.00436) | (0.01798) | (0.01524) |
| | [-0.60227] | [-1.97595] | [ 0.85296] |
| GPRD_THREAT(-12) | 0.003025 | -0.011271 | -0.028459 |
| | (0.00437) | (0.01803) | (0.01528) |
| | [ 0.69149] | [-0.62526] | [-1.86264] |
| GPRD_THREAT(-13) | -0.004915 | -0.048325 | -0.024431 |
| | (0.00438) | (0.01803) | (0.01528) |
| | [-1.12326] | [-2.68003] | [-1.59860] |
| GPRD_THREAT(-14) | -0.002920 | 0.039861 | 0.015685 |
| | (0.00438) | (0.01805) | (0.01530) |
| | [-0.66684] | [ 2.20886] | [ 1.02547] |
| GPRD_THREAT(-15) | -0.003874 | 0.022188 | 0.051409 |
| | (0.00438) | (0.01805) | (0.01530) |
| | [-0.88462] | [ 1.22952] | [ 3.36111] |
| GPRD_THREAT(-16) | -0.003096 | -0.000557 | 0.016061 |
| | (0.00439) | (0.01809) | (0.01533) |
| | [-0.70517] | [-0.03081] | [ 1.04743] |
| GPRD_THREAT(-17) | 0.005683 | -0.012207 | -0.002335 |
| | (0.00439) | (0.01809) | (0.01533) |
| | [ 1.29475] | [-0.67486] | [-0.15230] |
| GPRD_THREAT(-18) | 0.000918 | -0.002611 | -0.000275 |
| | (0.00439) | (0.01808) | (0.01533) |
| | [ 0.20916] | [-0.14437] | [-0.01794] |
| GPRD_THREAT(-19) | -0.003832 | 0.001064 | 0.018544 |
| | (0.00439) | (0.01808) | (0.01533) |
| | [-0.87322] | [ 0.05882] | [ 1.21002] |
| GPRD_THREAT(-20) | 0.001410 | 0.017277 | 0.043152 |
| | (0.00439) | (0.01808) | (0.01532) |
| | [ 0.32137] | [ 0.95563] | [ 2.81618] |
| GPRD_THREAT(-21) | 0.003325 | -0.024860 | -0.017296 |
| | (0.00439) | (0.01808) | (0.01533) |
| | [ 0.75775] | [-1.37480] | [-1.12853] |

| | | | |
|---|---|---|---|
| GPRD_THREAT(-22) | 0.003631 | 0.030871 | 0.040039 |
| | (0.00439) | (0.01811) | (0.01535) |
| | [ 0.82640] | [ 1.70485] | [ 2.60887] |
| GPRD_THREAT(-23) | -0.005428 | 0.005818 | 0.005712 |
| | (0.00440) | (0.01814) | (0.01538) |
| | [-1.23307] | [ 0.32072] | [ 0.37153] |
| GPRD_THREAT(-24) | -0.000408 | -0.007114 | -0.031563 |
| | (0.00440) | (0.01813) | (0.01536) |
| | [-0.09278] | [-0.39241] | [-2.05426] |
| GPRD_THREAT(-25) | 0.004855 | 0.001857 | 0.004410 |
| | (0.00440) | (0.01815) | (0.01538) |
| | [ 1.10225] | [ 0.10232] | [ 0.28669] |
| GPRD_THREAT(-26) | 0.001068 | -0.035105 | 0.011071 |
| | (0.00440) | (0.01814) | (0.01538) |
| | [ 0.24256] | [-1.93517] | [ 0.72006] |
| GPRD_THREAT(-27) | 0.006319 | -0.006739 | -0.002932 |
| | (0.00441) | (0.01816) | (0.01539) |
| | [ 1.43428] | [-0.37117] | [-0.19056] |
| GPRD_THREAT(-28) | 0.002957 | 0.028668 | 0.017409 |
| | (0.00437) | (0.01800) | (0.01526) |
| | [ 0.67689] | [ 1.59257] | [ 1.14106] |
| GPRD_THREAT(-29) | -0.010735 | -0.031389 | 0.018332 |
| | (0.00418) | (0.01721) | (0.01459) |
| | [-2.57043] | [-1.82394] | [ 1.25684] |
| C | -0.563900 | 5.865145 | 8.519906 |
| | (0.47261) | (1.94755) | (1.65069) |
| | [-1.19316] | [ 3.01154] | [ 5.16143] |

| | | | |
|---|---|---|---|
| R-squared | 0.043815 | 0.769241 | 0.570636 |
| Adj. R-squared | 0.028387 | 0.765517 | 0.563709 |
| Sum sq. resids | 874436.4 | 14849016 | 10667118 |
| S.E. equation | 12.73471 | 52.47759 | 44.47834 |
| F-statistic | 2.839988 | 206.6015 | 82.36919 |
| Log likelihood | -21674.36 | -29434.34 | -28528.04 |
| Akaike AIC | 7.942468 | 10.77458 | 10.44381 |
| Schwarz SC | 8.048596 | 10.88071 | 10.54994 |
| Mean dependent | 0.134124 | 114.2487 | 112.8077 |
| S.D. dependent | 12.91941 | 108.3724 | 67.33801 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 8.21E+08 |
| Determinant resid covariance | 7.82E+08 |
| Log likelihood | -79434.21 |
| Akaike information criterion | 29.08694 |
| Schwarz criterion | 29.40532 |
| Number of coefficients | 264 |

## Section IV: VAR Granger Causality/ Block Exogeneity Wald Tests

**EViews Output 66: VAR Granger Causality/ Block Exogeneity Wald Tests – Cocoa**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:13
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Dependent variable: COCOA_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 20.07076 | 22 | 0.5786 |
| GPRD_THREAT | 19.24960 | 22 | 0.6299 |
| All | 39.61217 | 44 | 0.6600 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COCOA_LAST_PRICE1 | 10.59303 | 22 | 0.9801 |
| GPRD_THREAT | 39.54939 | 22 | 0.0122 |
| All | 51.10773 | 44 | 0.2146 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COCOA_LAST_PRICE1 | 34.53911 | 22 | 0.0433 |
| GPRD_ACT | 119.9085 | 22 | 0.0000 |
| All | 153.5507 | 44 | 0.0000 |

**EViews Output 67: VAR Granger Causality/ Block Exogeneity Wald Tests – Coffee**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:17
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Dependent variable: COFFEE_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 16.83384 | 22 | 0.7725 |
| GPRD_THREAT | 43.46527 | 22 | 0.0041 |
| All | 58.13955 | 44 | 0.0749 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COFFEE_LAST_PRICE1 | 20.61397 | 22 | 0.5447 |
| GPRD_THREAT | 41.88020 | 22 | 0.0065 |
| All | 61.20343 | 44 | 0.0439 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COFFEE_LAST_PRICE1 | 24.08939 | 22 | 0.3426 |
| GPRD_ACT | 120.7201 | 22 | 0.0000 |
| All | 142.8730 | 44 | 0.0000 |

**EViews Output 68: VAR Granger Causality/ Block Exogeneity Wald Tests – Corn**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:22
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Dependent variable: CORN_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 15.72131 | 22 | 0.8295 |
| GPRD_THREAT | 29.45956 | 22 | 0.1322 |
| All | 43.99508 | 44 | 0.4719 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| CORN_LAST_PRICE1 | 11.31862 | 22 | 0.9699 |
| GPRD_THREAT | 41.28192 | 22 | 0.0076 |
| All | 51.83874 | 44 | 0.1947 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| CORN_LAST_PRICE1 | 17.06297 | 22 | 0.7599 |
| GPRD_ACT | 119.0431 | 22 | 0.0000 |
| All | 135.6932 | 44 | 0.0000 |

**EViews Output 69: VAR Granger Causality/ Block Exogeneity Wald Tests – Cotton**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:25
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Dependent variable: COTTON_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 29.91529 | 29 | 0.4182 |
| GPRD_THREAT | 19.89438 | 29 | 0.8962 |
| All | 49.34170 | 58 | 0.7838 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COTTON_LAST_PRICE1 | 16.62066 | 29 | 0.9677 |
| GPRD_THREAT | 50.76171 | 29 | 0.0075 |
| All | 66.65310 | 58 | 0.2039 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| COTTON_LAST_PRICE1 | 22.56794 | 29 | 0.7959 |
| GPRD_ACT | 123.5320 | 29 | 0.0000 |
| All | 146.1232 | 58 | 0.0000 |

**EViews Output 70: VAR Granger Causality/ Block Exogeneity Wald Tests – No.11 Sugar**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:46
Sample: 3/31/2000 3/03/2022
Included observations: 5481

Dependent variable: SUGAR_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 21.77311 | 28 | 0.7917 |
| GPRD_THREAT | 26.18746 | 28 | 0.5627 |
| All | 47.04766 | 56 | 0.7972 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SUGAR_LAST_PRICE1 | 23.12817 | 28 | 0.7266 |
| GPRD_THREAT | 46.89714 | 28 | 0.0140 |
| All | 70.14642 | 56 | 0.0968 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SUGAR_LAST_PRICE1 | 17.58601 | 28 | 0.9361 |
| GPRD_ACT | 122.7153 | 28 | 0.0000 |
| All | 140.2735 | 56 | 0.0000 |

**EViews Output 71: VAR Granger Causality/ Block Exogeneity Wald Tests – Oats**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:34
Sample: 3/31/2000 3/03/2022
Included observations: 5485

Dependent variable: OATS_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 36.90133 | 24 | 0.0448 |
| GPRD_THREAT | 38.38025 | 24 | 0.0317 |
| All | 76.51345 | 48 | 0.0055 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| OATS_LAST_PRICE1 | 12.57169 | 24 | 0.9727 |
| GPRD_THREAT | 41.12736 | 24 | 0.0161 |
| All | 54.03658 | 48 | 0.2548 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| OATS_LAST_PRICE1 | 35.17141 | 24 | 0.0659 |
| GPRD_ACT | 119.4318 | 24 | 0.0000 |
| All | 154.4422 | 48 | 0.0000 |

**EViews Output 72: VAR Granger Causality/ Block Exogeneity Wald Tests – Rough Rice**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:37
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Dependent variable: ROUGH_RICE_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 17.43909 | 29 | 0.9549 |
| GPRD_THREAT | 31.71250 | 29 | 0.3326 |
| All | 50.10420 | 58 | 0.7601 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| ROUGH_RICE_LAST_... | 17.16749 | 29 | 0.9595 |
| GPRD_THREAT | 49.90528 | 29 | 0.0092 |
| All | 67.20498 | 58 | 0.1910 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| ROUGH_RICE_LAST_... | 20.98404 | 29 | 0.8597 |
| GPRD_ACT | 123.8057 | 29 | 0.0000 |
| All | 144.5031 | 58 | 0.0000 |

**EViews Output 73: VAR Granger Causality/ Block Exogeneity Wald Tests – Soybean**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:40
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Dependent variable: SOYBEAN_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 18.45569 | 22 | 0.6787 |
| GPRD_THREAT | 28.10236 | 22 | 0.1723 |
| All | 46.82797 | 44 | 0.3572 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SOYBEAN_LAST_PRI... | 14.29681 | 22 | 0.8906 |
| GPRD_THREAT | 39.93292 | 22 | 0.0110 |
| All | 54.83914 | 44 | 0.1267 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SOYBEAN_LAST_PRI... | 30.16467 | 22 | 0.1145 |
| GPRD_ACT | 121.0399 | 22 | 0.0000 |
| All | 149.0808 | 44 | 0.0000 |

**EViews Output 74: VAR Granger Causality/ Block Exogeneity Wald Tests – Soybean Oil**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:43
Sample: 3/31/2000 3/03/2022
Included observations: 5487

Dependent variable: SOYBEAN_OIL_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 12.85083 | 22 | 0.9372 |
| GPRD_THREAT | 36.49668 | 22 | 0.0268 |
| All | 46.49765 | 44 | 0.3699 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SOYBEAN_OIL_LAST_... | 12.11792 | 22 | 0.9549 |
| GPRD_THREAT | 40.52309 | 22 | 0.0094 |
| All | 52.64400 | 44 | 0.1743 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| SOYBEAN_OIL_LAST_... | 32.57016 | 22 | 0.0682 |
| GPRD_ACT | 119.9060 | 22 | 0.0000 |
| All | 151.5388 | 44 | 0.0000 |

**EViews Output 75: VAR Granger Causality/ Block Exogeneity Wald Tests – Wheat**

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/27/22 Time: 20:51
Sample: 3/31/2000 3/03/2022
Included observations: 5480

Dependent variable: WHEAT_LAST_PRICE1

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| GPRD_ACT | 26.25644 | 29 | 0.6118 |
| GPRD_THREAT | 78.53201 | 29 | 0.0000 |
| All | 100.0333 | 58 | 0.0005 |

Dependent variable: GPRD_ACT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| WHEAT_LAST_PRICE1 | 20.91056 | 29 | 0.8624 |
| GPRD_THREAT | 51.33681 | 29 | 0.0065 |
| All | 70.98268 | 58 | 0.1177 |

Dependent variable: GPRD_THREAT

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| WHEAT_LAST_PRICE1 | 22.81075 | 29 | 0.7851 |
| GPRD_ACT | 125.5436 | 29 | 0.0000 |
| All | 146.3715 | 58 | 0.0000 |