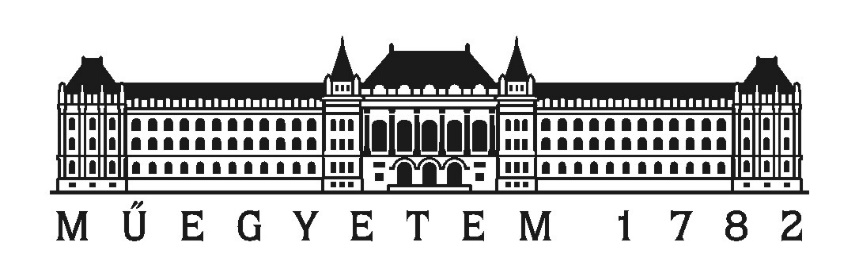
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Master Thesis

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Global inflation and the effect of commodity price shocks

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Abstract

In the wake of a decade characterized by extensive quantitative easing policies, the global economic landscape is witnessing a resurgence of inflationary pressure. This tension has placed the current state of the global financial and commodity markets in a precarious state, struggling to maintain former existing stability. Concurrently, the energy sector faces unprecedented challenges, exemplified by the daily surges in natural gas and oil prices, threatening energy companies and sending ripples through the interconnected globalized economies. These challenges underscore the critical need for an examination of the intricate dynamics at play. This thesis conducts a review of inflationary history, past monetary strategies, and their relevance to current challenges. Examining commodities markets, the role of energy products, and assessing the effectiveness of standard monetary interventions. Utilizing panel data analysis for G7 countries across the 1970s, 1990s, and 2010s decades respectively. The study aims to propose policy interventions based on the available literature and empirical analysis.

*Keywords: Inflation, Energy, Commodities, Price shock, Panel-data analysis, Python, LASSO regression*

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List of abbreviations

BIS – Bank of International Settlements

CME – Chicago Mercantile Exchange

CPI – Consumer Price Index

ECB – European Central Bank

FED – Federal Exchange

GDP – Gross Domestic Product

GNP – Gross National Product

G7 – Group of Seven countries

ICE – Intercontinental Exchange

IMF – International Monetary Fund

LME – London Metal Exchange

LNG – Liquified Natural Gas

NASDAQ - National Association of Securities Dealers Automated Quotations Stock Market

NATO – North Atlantic Treaty Organization

NYMEX – New York Mercantile Exchange

OPEC – Organization of the Petroleum Exporting Countries

PPI – Producer Price Index

PPP – Purchasing Power Parity

QE – Quantitative Easing

QT – Quantitative Tightening

WB – World Bank

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1. Introduction

The global economic landscape has witnessed a series of significant shocks in recent history, with fluctuations in commodity prices often at their epicentre. These shocks have sparked profound debates among economists, policymakers, and market participants regarding their impact on inflationary processes. The purpose of this paper is to examine the inflationary processes around periods, when the world economy was in the grip of a commodity shock. The globalized economy is highly susceptible to commodity price shocks, which can cause significant inflationary pressures. Commodity price shocks can occur due to various factors such as natural disasters, geopolitical tensions, (similarly to the recent conflict in Eastern Ukraine) or changes in global demand and supply (as we have seen with the collapse of global supply chains due to the SARS-CoV-19 pandemic). In recent decades, the world has witnessed several instances of commodity price shocks. These including events like the oil price shocks in the 1970s. That initiated a change for the western world, and later culminated in the end of the Bretton Woods financial System. Showing unemployment and inflation not seen since the Great Depression. The new neoliberal economic ideas of Milton Freedman were pushed to the light as well. The current post-pandemic surge in energy prices is just another symptom of the collapsed supply chains, shifting green markets and war profiteering. We can see these shocks have resulted in significant economic challenges, including rising inflation rates, unemployment, and declining economic growth. “Inflation persisting: Persistent labour market tightness could translate into stronger-than-expected wage growth. Higher-than-expected oil, gas, and food prices from the war in Ukraine or from a faster rebound in China’s growth could again raise headline inflation and pass through into underlying inflation. Such developments could cause inflation expectations to de-anchor and require an even tighter monetary policy.” (World Economic Outlook, 2023, p. 7)

The early 1970s saw the developed world grappling with the oil crisis, leading to soaring energy prices and unprecedented economic turbulence. Decades later, in the 1990s and 2010s, commodity markets experienced further upheavals, raising questions about the persistence of inflation, the adaptability of economies reliant on energy commodities, and the efficacy of traditional monetary interventions. The aim of this thesis is to explore the relationship between commodity price shocks and inflation, with a focus on examining the historical processes and proposing policy interventions. The study uses panel data analysis to investigate the inflationary processes of G7 (Group of Seven) countries during different decades, such as the 1970s, 1990s, and 2010s, and evaluates the effectiveness of standard monetary interventions in mitigating the impacts of commodity price shocks. Most of the data will be collected from the IMF database, at quarterly frequency if applicable. The most important variables are CPI, unemployment, productivity, (gap of certain GDP components from their trend value), current account balance or trade openness and international commodity prices. After the selection of the best regressors, the GMM method will be applied for the panel encompassing the Group of Seven nations.

The paper is structured as follows. First, an overview of the topic is being provided, including the research background, problem statement, and research questions. Next, we present a literature review of the existing literature on inflationary processes, commodity price shocks, and policy interventions. This discussion is based on preceding scientific studies such as OECD (1993), Chiaie (2017), van de Ven-Fouquet (2017). In the following chapter, we discuss the methodological challenges surrounding the measurement of commodity price indices and present the current commodity price index of the International Monetary Fund (IMF) as a tool to capture the inflationary effects of commodity price shocks. This chapter would discuss the data sources and variables used in the analysis, the econometric model and mathematical techniques employed, and any assumptions made. With focus on the methodology used in the study, including the panel analysis process. To understand the relationship between commodity price shocks and inflation and provide policy intervention recommendations, also to mitigate the impacts of such events. That point, our aim is to narrow the scope to the obtainable data and methods. Later, we use panel analysis to examine the historical inflationary processes in the G7 countries throughout the 1970s, 1990s, and 2010. The following chapter looks at the length inflation had persisted throughout various time periods and economies, especially in nations that rely significantly on energy resources. Here, the panel analysis would be carried out as well, while looking at how commodity price shocks affected inflation in the G7 nations during the chosen time periods. This section would present the empirical study' findings, including any noteworthy correlations between inflation and commodity price shocks discovered, and would also go into the implications of these conclusions for potential policy changes. During the analysis the effectiveness of standard monetary interventions, such as interest rate adjustments or quantitative tightening (QT) are being investigated for mitigating the impacts of commodity price shocks. Eventually we present policy intervention recommendations. Based on the mentioned literature review and empirical analysis. The last chapter proposes policy interventions to address the energy price-induced worldwide inflation and draws lessons from past experiences and current practices in energy trade.

The current period of new inflation after long benign decades has been disturbing economists and policymakers. In the recent past, central banks used several tools to mitigate the impact of inflation. Among them, solutions based on the classical Phillips-curve, linking unemployment to inflation. Different variations of quantitative tightening and interest rate manipulation to cool down economies. However, improper communication and forward guidance is to be avoided. That might rush markets into a halt. “That is to say, inflation is always and everywhere a macroeconomic and institutional phenomenon.” as (Totonchi, 2011) says. Nevertheless, there are several factors that can be found behind every historical period when prices rose high, and the value of currencies deteriorated. If staying for an elongated period, elevated price levels over the favoured 2-3% range, will hurt the interdependent economies. Meanwhile energy inflation remains among the dominant drivers of the increased price levels worldwide.

1. Overview of the topic and background

Let us explore the topic. Including the research background, problem statement, and research questions. This thesis aims at measuring the varying degree of the change in commodity prices, past inflation on the current inflation level also addressing methodological questions. The main questions addressed are:

• How persistent the inflation is the examined time periods?

• How does inflation change in economies of the particular countries, that have a higher weight in energy commodities-based industries?

• Do standard monetary interventions have a visible effect in their respective time frames?

The study of inflation and its drivers is a fundamental concern in economics and crucial to discussions of stability and growth. Inflation is a phenomenon with far-reaching consequences for economies, households, and businesses. It is by definition the sustained increase in the general price level of goods and services. From a different approach, it is the decrease of purchasing power of consumers. It influences investment decisions made by households and businesses. Monetary policy of central banks, and the overall economic health of nations.

Despite extensive research on the determinants of inflation, studies that investigate the relationship between commodity price shocks, inflation dynamics, and the effectiveness of policy interventions are few. The available literature though offers valuable insights into each component of the phenomenon but lacks a unified framework that integrates them. This gap presents an opportunity to examine the multifaceted aspects of our topic within this changing landscape.

1. Literature and history of inflation

Inflation, as a fundamental economic phenomenon, has earned significant attention from policymakers, economists, and scholars. In the realm of inflation, commodity price shocks have been shown as crucial drivers of inflationary processes. Amidst this literature review we aim to provide a comprehensive overview of existing research on inflationary processes, commodity price shocks, and policy interventions. Analysing the findings of previous studies on the impacts of commodity price shocks, explore the theoretical frameworks used to understand these dynamics, and evaluate the effectiveness of standard well researched monetary interventions in mitigating the impacts of said shocks.

The study of inflation and its causes has a long history, with theories dating back to ancient civilizations. In the time of classical Greece, philosophers such as Aristotle wrote about the concept of "monetary inflation," or the idea that an increase in the money supply can lead to higher prices.

In the 16th century, economist Thomas Gresham developed the "*law of Gresham*," which stated that bad money drives out good money when the two are used in circulation together. In the 18th and 19th centuries, classical economists such as Adam Smith and David Ricardo developed theories of value and price that focused on the role of supply and demand in determining the price of goods and services. Mainly about land, as the most important property of their time. These theories did not explicitly address the concept of inflation, as the monetary system at the time was based on the gold standard, which limited the money supply. Among these were the *Demand-pull inflation theory*. This suggests that inflation occurs when the demand for goods and services in an economy outstrips the available supply, leading to upward pressure on prices.

Recently in the 20th century, renowned economist John Maynard Keynes in his famous work *The General Theory of Employment, Interest and Money* developed a theory of inflation that focused on the role of aggregate demand in driving the price level. According to Keynes, inflation can be caused by persistent increases in aggregate demand that outstrip the growth in the supply of goods and services. Monetarist in the 1960s, spearheaded by economist Milton Friedman (“Only money matters”) and others developed a theory that focused on the role of the money supply in driving the price level. According to their theory, inflation is caused by the increase in the money supply that exceeds the growth in economic activity. Later other concepts emerged to grasp inflation from other directions. Respectively the *Cost-push inflation*. This theory suggests that inflation occurs when the cost of production increases, leading firms to pass on the higher costs to consumers in the form of higher prices. As (Richard Layard, 1994) said: “when buoyant demand reduces unemployment, inflationary pressure develops. Firms start bidding against each other for labour, and workers feel more confident in pressing wage claims. If the inflationary pressure is too great, inflation starts spiralling upwards: higher wages lead to higher price rises, leading to still higher wage rises, and so on. This is the wage-price spiral.” Next, we should mention *Structural inflation*. This suggests that inflation caused by structural problems in an economy, such as an overvalued currency or rigid wages that prevent adjustments in the price level. Most of the models overlook the fact that non-economic factors, such as political and social effects can determine the direction of future inflation as well.

**The definition of price shock**

A commodity price shock refers to sudden, substantial fluctuations in the prices of key commodities, such as oil, grain, and metals. These shocks can be triggered by various factors, such as geopolitical conflicts, changes in supply and demand dynamics, or natural disasters. These shocks can have far-reaching implications for inflation. For instance, a sudden disruption in oil supplies due to geopolitical tensions in a major oil-producing region can lead to a sharp increase in oil prices, which, in turn, can have cascading effects on the prices of various goods and services. However, this relationship can vary significantly across countries and time periods. Numerous studies have investigated the relationship between commodity price shocks and inflation. Research by Kilian (2009) and Barsky and Kilian (2002) suggests that commodity price shocks can indeed exert upward pressure on inflation, particularly in economies that are heavily reliant on commodity imports or that have a high degree of exposure to international commodity markets.

Now let us look at the theoretical frameworks about inflation and commodity price shocks. By now we can see that many factors contribute to this variability. One crucial factor is the exchange rate regime in place dictated by local central banks. If certain economies have flexible exchange rates, currency depreciation can partially reduce the impact of rising commodity prices, reducing the pass-through to domestic consumer prices with a certain delay. In contrast, in economies with fixed or semi-fixed exchange rate regimes, the pass-through can be more direct and pronounced. (**source**)

Central bank policies play a critical role as well. Research by Blanchard and Gali (2007) and Cunado and Gracia (2005) highlights that central banks' responses to commodity price shocks can influence the inflation outcome. If central banks respond to commodity price increases with accommodative monetary policies, such as lowering interest rates, it can exacerbate inflationary pressures. Conversely, if central banks adopt a more hawkish stance, inflation may be contained more effectively.

Similarly, to the above-mentioned inflation theories, we can take look at the corresponding literature for commodity price shocks.

**Cost-Push Inflation Theory**: This framework states that increases in commodity prices directly raise the production costs for firms, leading to upward pressure on consumer prices. Wage-price spirals may also emerge as workers demand higher wages to compensate for rising living costs (Dornbusch, 1975).

**Monetary Theory of Inflation**: This framework argues that central bank policies, particularly the expansion of the money supply, are the primary drivers of inflation. Commodity price shocks can exacerbate inflation if central banks accommodate them with loose monetary policies (Sargent & Wallace, 1981).

**Exchange Rate Pass-Through**: Exchange rate movements play a pivotal role in transmitting commodity price shocks to domestic inflation. The extent to which exchange rates adjust to changes in commodity prices and the speed of pass-through to consumer prices are essential considerations (Gopinath & Rigobon, 2008).

**Expectations and Forward-Looking Behaviour**: Rational expectations theory suggests that inflation expectations influence actual inflation outcomes. Commodity price shocks can lead to inflation if they alter expectations about future price levels and lead to adaptive wage and price-setting behaviour (Muth, 1961).

**Connection of energy and inflation**

Changes in energy prices can significantly affect the prices in an economy. Energy is an important input in the production of goods and services in every market, and changes in its cost can affect the cost of production of products and services. If the cost of energy increases, firms may pass the on the higher costs to consumers in the form of higher prices, this may contribute to inflation. On the other hand, if the cost of energy decreases, firms may be able to reduce their prices, which could help to offset inflationary pressures. It is notable that the relationship between energy prices and inflation is complex. Factors such as the level of economic activity, availability of alternative sources, and the strength of the local currency can also affect the relationship between energy prices and inflation.

* Analyses the findings of previous studies on the impacts of commodity price shocks on inflation.
* Evaluates the effectiveness of standard monetary interventions in mitigating the impacts of commodity price shocks.

A commodity price shock refers to a sudden, unexpected, and substantial change in the prices of key raw materials or primary commodities that are traded in global markets. These shocks can manifest as rapid increases (commodity price spikes) or steep declines (commodity price crashes) in the prices of commodities such as oil, metals, agricultural products, and minerals. Commodity price shocks can have significant economic, financial, and policy implications, as they affect production costs, inflation, trade balances, and the overall stability of economies.

1. **Causes and Types of Commodity Price Shocks:**
   * **Supply-side Shocks:** These shocks result from factors affecting the production or supply of commodities, such as natural disasters, geopolitical conflicts, or disruptions in production processes. Research often analyzes the impacts of supply shocks on commodity markets and their ripple effects on global economies (e.g., the impact of oil supply disruptions on global oil prices).
   * **Demand-side Shocks:** These shocks arise from changes in global demand for commodities, often driven by economic growth, shifts in consumption patterns, or policy changes. Studies explore how fluctuations in demand affect commodity prices, particularly for goods like metals and agricultural products.
   * **Financial Market Shocks:** Commodity prices can be influenced by financial market developments, including speculative activities, futures market dynamics, and changes in investor sentiment. The literature investigates the links between financial market shocks and commodity price movements.
2. **Macroeconomic Implications:**
   * **Inflation:** Commodity price shocks can lead to inflationary pressures, especially when they result in higher production costs. Researchers examine the transmission mechanisms of commodity price shocks to inflation and central banks' responses to manage inflation expectations.
   * **Economic Growth:** The literature explores how commodity price shocks affect economic growth, particularly in resource-rich countries. It considers factors like the resource curse, fiscal policies, and investment patterns.
   * **Trade Balances:** Changes in commodity prices can impact trade balances, as countries that are net exporters or importers of commodities are affected differently. Research investigates the trade implications of commodity price shocks.
3. **Policy Responses:**
   * **Monetary Policy:** Scholars examine how central banks respond to commodity price shocks, considering the trade-offs between stabilizing inflation and supporting economic growth. This includes discussions on the effectiveness of inflation targeting regimes.
   * **Fiscal Policy:** The literature assesses the role of fiscal policies, such as subsidies, taxes, and sovereign wealth funds, in mitigating the impact of commodity price shocks and managing revenue volatility in resource-rich countries.
   * **Exchange Rate Policies:** Research explores how exchange rate regimes influence the transmission of commodity price shocks to domestic economies, particularly in countries with flexible or fixed exchange rate systems.
4. **Global Implications and Interactions:**
   * **Global Value Chains:** The literature analyzes the role of commodity price shocks in global value chains and production networks, emphasizing how disruptions can affect various industries and regions.
   * **Global Governance and International Relations:** Scholars examine the geopolitical implications of commodity price shocks, including conflicts over resources, energy security concerns, and international cooperation on commodity markets.
5. **Environmental and Sustainability Considerations:**
   * Researchers increasingly consider the environmental aspects of commodity price shocks, including the effects of climate-related disruptions on agricultural commodities and the implications for food security.

Core inflation without food and energy also rising. Sources and two sentences for both.

**Policy interventions**

Policy interventions aimed at mitigating the impacts of commodity price shocks on inflation vary in their effectiveness. Conventional monetary policy tools, such as interest rate adjustments, are commonly employed to stabilize inflation. However, their effectiveness depends on the context and the central bank's credibility.

Research indicates that forward-looking central banks with a strong commitment to price stability can better anchor inflation expectations and mitigate the pass-through of commodity price shocks to consumer prices (Gali & Monacelli, 2005). Nonetheless, the scope of monetary policy to counteract commodity price shocks may be limited in economies with high inflation inertia or deeply entrenched inflation expectations.

In addition to monetary policy, fiscal measures, such as targeted subsidies or tax adjustments, can be used to alleviate the burden of rising commodity prices on consumers. However, the fiscal response must be well-designed to avoid unintended consequences, such as fiscal imbalances or distortions in resource allocation (Corden & Neary, 1982).

* **Monetary Policy**: Central banks often use monetary policy tools, such as adjusting interest rates, to stabilize inflation in response to commodity price shocks. The effectiveness of these measures depends on the credibility of the central bank, its commitment to price stability, and the economic context. Research, as highlighted by Gali and Monacelli (2005), suggests that forward-looking central banks with a strong reputation for maintaining low and stable inflation are better equipped to anchor inflation expectations and mitigate the pass-through of commodity price shocks to consumer prices.
* **Fiscal Measures**: Fiscal interventions, such as targeted subsidies or tax adjustments, can also be employed to alleviate the impact of rising commodity prices on consumers. For instance, governments may implement fuel subsidies to cushion the blow of soaring oil prices. However, it's essential for these measures to be well-designed to avoid unintended consequences, such as fiscal imbalances or distortions in resource allocation, as discussed by Corden and Neary (1982).

**IV. Policy Responses to Commodity Price Shocks**

The effectiveness of policy interventions in response to commodity price shocks is contingent not only on the choice of policy instruments but also on the broader economic context. Here, we delve deeper into the policy responses and their nuances:

* **Monetary Policy in Detail**: Central banks have several tools at their disposal to respond to commodity price shocks. These tools include interest rate adjustments, open market operations, and forward guidance. The effectiveness of these measures depends on whether the central bank is targeting inflation, a specific inflation target, or a broader set of objectives like full employment and financial stability. Inflation targeting central banks, as explored by Svensson (2003), may adjust interest rates more aggressively to bring inflation back to its target in the face of commodity price shocks.
* **Exchange Rate Dynamics**: The role of exchange rates in transmitting commodity price shocks to inflation deserves further attention. When a country's currency depreciates in response to rising commodity prices, it can make imports more expensive, adding inflationary pressure. However, exchange rate movements can also have a dampening effect by making exports more competitive, potentially boosting economic activity. The balance between these effects can be influenced by the elasticity of demand for imports and exports, as well as the composition of a country's trade.
* **Fiscal Measures and Challenges**: While fiscal measures like subsidies and tax adjustments can alleviate the immediate impact of commodity price shocks on consumers, they present their own set of challenges. Subsidies can strain government budgets and may not always reach the most vulnerable populations effectively. Moreover, they can distort market incentives, potentially leading to overconsumption of subsidized goods. Tax adjustments must be carefully targeted to avoid regressive effects on low-income households. Effective communication and public support are critical for the success of these fiscal measures.

**V. Future Directions for Research**

The literature reviewed here highlights the evolving and multifaceted nature of the relationship between commodity price shocks and inflation. Given the increasing interconnectedness of the global economy and the persistent importance of commodities in international trade, several avenues for future research emerge:

* **Dynamic Models**: Expanding dynamic models that account for various dimensions of the relationship between commodity prices and inflation can provide valuable insights. These models can consider the time lags involved in transmission mechanisms, the role of expectations, and the interactions between different economic agents.
* **Global Supply Chains**: Understanding how commodity price shocks propagate through global supply chains and affect inflation in different regions is crucial. The COVID-19 pandemic, for example, exposed vulnerabilities in global supply chains, with disruptions in one region impacting production and prices worldwide. Research in this area can shed light on the dynamics of cross-border transmission.
* **Policy Coordination**: Exploring the potential benefits of policy coordination at the international level to address the impacts of commodity price shocks could be beneficial. Coordination can help stabilize global commodity markets and reduce the spillover effects of policy responses across borders.
* **Sustainable Development**: Given the importance of sustainable development and environmental concerns, future research should also consider the implications of commodity price shocks for sustainable resource management and the transition to greener economies.

Certainly, let's continue to expand on the literature review:

**XI. Commodity Price Shock Transmission Mechanisms**

To gain a deeper understanding of how commodity price shocks affect inflation, it is essential to investigate the transmission mechanisms in greater detail. Research should explore how these shocks propagate through different sectors of the economy. For example, understanding how oil price fluctuations impact transportation costs, manufacturing, and ultimately consumer prices can provide valuable insights into the inflationary process.

Furthermore, examining how financial markets react to commodity price shocks and how these reactions influence inflation is an area ripe for investigation. This includes analyzing the role of commodity futures markets, exchange-traded funds (ETFs), and speculative trading in amplifying or dampening the effects of price shocks.

**XII. Behavioral Economics and Consumer Response**

Behavioral economics offers a lens through which to examine how consumers and businesses respond to commodity price shocks. Traditional economic models assume rational behavior, but behavioral economics recognizes that individuals often make decisions based on heuristics, emotions, and cognitive biases.

Research in this realm can delve into how consumer sentiment and expectations influence spending and saving patterns in the face of rising commodity prices. Additionally, it can explore how firms adjust their pricing strategies and production decisions in response to perceived changes in consumer behavior.

**XIII. Monetary Policy Beyond Interest Rates**

While interest rate adjustments are a common tool used by central banks to manage inflation, exploring alternative monetary policy tools is crucial. Research should investigate the effectiveness of unconventional monetary policies, such as quantitative easing and forward guidance, in mitigating the impact of commodity price shocks on inflation.

Additionally, examining the potential role of digital currencies and central bank digital currencies (CBDCs) in managing inflation in a world of fluctuating commodity prices is a timely and emerging area of interest.

**XIV. Socioeconomic Impacts of Inflation**

Inflation does not affect all segments of society equally. It disproportionately impacts vulnerable populations, including low-income households and those with limited access to financial resources. Research should assess the social and economic implications of inflation, including its effects on income inequality, poverty rates, and social stability.

Understanding the distributional consequences of inflation can inform the design of more equitable policy responses, such as targeted assistance programs or social safety nets.

**XV. International Collaboration and Policy Coordination**

Given the global nature of commodity markets and their impact on inflation, research should explore opportunities for international collaboration and policy coordination. Examining the effectiveness of international institutions and agreements in managing commodity price shocks can offer insights into how countries can work together to stabilize global commodity markets and reduce spillover effects.

Furthermore, assessing the feasibility and benefits of coordinated monetary and fiscal policies across countries in response to global commodity price shocks is an area that warrants further investigation.

**XVI. Long-Term Sustainability**

In an era characterized by concerns about sustainability and environmental degradation, research should also consider the long-term implications of commodity price shocks on resource management and ecological sustainability. How can policy responses address both short-term inflationary pressures and long-term sustainability goals?

Understanding the interplay between resource scarcity, commodity prices, and environmental policies can inform strategies that balance economic stability with environmental responsibility.

**The commodities market and energy**

Commodities are basic goods and raw materials that are produced and traded in large quantities. They include agricultural products, such as grains and livestock, as well as energy products, like oil and natural gas, also metals, such as gold and silver. Commodities are traded on commodity exchanges, such as the Chicago Mercantile Exchange (CME) and the London Metal Exchange (LME), where traders come together to negotiate prices. Commodities are generally priced based on supply and demand dynamics. When demand for a commodity is high, prices tend to rise. Conversely, when demand for a commodity is low, prices tend to fall. Supply also plays a key role in their prices, as an increase in supply can lead to lower prices, while a decrease in supply can lead to higher prices. Factors that can affect the demand for a commodity include changes in population, economic growth, and technological advances. An increase in population can lead to higher demand for food and energy products, while technological advances in renewable energy can lead to lower demand for fossil fuels. Other factors connect to the supply of a commodity including changes in production costs, weather, and geopolitical events. For example, a drought can lead to lower crop yields and higher food prices, while a war in a major oil-producing country can lead to supply disruptions and higher oil prices. Inventory effects and speculation are also significant factors. When inventories are high, prices tend to be lower, and when inventories are low, prices tend to be higher. The large presence of speculators in energy markets can increase volatility and make prices more sensitive to changes in supply and demand. As we could have experienced at the beginning of the Russia invasion of the Ukraine in early 2022. Since the occurrence of that event the effect of inflation became significant around the world. Inflation in the euro area has been high recently, mainly because of a surge in energy prices. (Arce, 2023) “The surge in euro area inflation since mid-2021 was mainly the consequence of the rapid rise of energy and commodity prices, but the role of domestic factors has been growing. The deterioration in the terms of trade following the pandemic and the energy and food commodity price shocks triggered by Russia’s war aggression against Ukraine implied that the initial surge in consumer inflation was largely imported. However, core inflation has been rising steeply since mid- 2021, reaching an annual rate of 7.4% in the first quarter of 2023, a historic high.”[[1]](#footnote-1)

Many commodities are also priced based on their future expected values. These are so-called futures contracts are legal documents to buy or sell a commodity at a certain price at a certain future date. Especially used in energy-related commodities, such as oil and natural gas. The pricing of these products reflects the market's expectations and the price of the commodity at the time of the expiration. This could allow traders to hedge against price fluctuations as they tend to be volatile.

**Energy related commodities and markets**

Crude oil is a fossil fuel that is extracted from the ground and refined into various products, including gasoline, diesel, and jet fuel. It is one of the most important energy commodities in the world and is traded on various commodity exchanges, including the New York Mercantile Exchange (NYMEX) and the Intercontinental Exchange (ICE).

Similarly, natural gas is a fossil fuel that is extracted from the ground and is primarily used for heating and electric power generation. It is traded on the NYMEX and the ICE, as well as other commodity exchanges. The availability of natural gas was the most important topic for the European energy independence when decoupled from Russian sources in 2022.

Coal is a fossil fuel that is mined from the ground and is primarily used for power generation. It is traded on the NYMEX, the ICE, and other commodity exchanges.

Electricity is a commodity that is generated from various sources, including coal, natural gas, renewable energy and nuclear fission energy (the process of splitting the nuclei of Uranium-235 isotope to free its energy to propel steam turbines). There are developments in nuclear fusion technologies (the process of forming helium from hydrogen nuclei similarly to the inner workings of stars) as well, however it will not be available in the foreseeable future as a possible zero emission alternative source of energy. Variations of hydrogen-based sources are spreading in the developed world, but the difficult technological and infrastructural requirements make it slow. It is traded on various wholesale electricity markets, such as the PJM Interconnection in the US, the Nord Pool in Europe, and the Australian Energy Market Operator (AEMO) in Australia.

Renewable energy certificates (RECs) represent the environmental attributes of renewable energy. They are traded on various commodity exchanges, such as the Chicago Climate Exchange (CCX) and the New England Power Pool (NEPOOL)

Biofuels are liquid fuels that are produced from renewable sources such as corn, sugarcane, and vegetable oils. They are traded on various commodity exchanges, such as the NYMEX.

Chart, line chart

Description automatically generated

1. **Price indexes of selected commodity groups, source IMF via Statista[[2]](#footnote-2)**

**How is inflation being measured?**

The measures and metrics of inflation that are commonly used to track and analyse changes in the general level of prices in an economy are:

*Consumer Price Index (CPI)*. This is a measure of the average change in the prices of a basket of goods and services consumed by households. The CPI is typically based on a fixed basket of goods and services that is representative of the consumption patterns of a typical household. It is commonly used by central banks, governments, and economists to measure the rate of inflation and to make policy decisions. The CPI is calculated by taking a sample of prices for a basket of goods and services that are typically consumed by households. This is chosen to represent the consumption patterns of the average household and collected at regular intervals and are used to calculate the average change in prices over time. This might include food, clothing, housing, transportation, healthcare, and other miscellaneous items. The weight of each item in the basket is determined by its relative importance in the overall consumption patterns of households. For example, housing is typically given a larger weight in the basket than clothing because housing is a larger component of household expenditure. The calculation methods like Laspeyres[[3]](#footnote-3), Paasche and Fisher indices. There is also a difference between the headline and core inflation, the headline includes all items in the basket, while core inflation excludes certain items that are considered to be volatile, like energy and food prices, as they might change rapidly and cause short-term fluctuations in the inflation rate.

*Producer Price Index (PPI)*. This is a measure of the average change in the prices of goods and services received by producers. The PPI is typically based on a fixed basket of goods and services that is representative of the production patterns of a typical firm. The Producer Price Index (PPI) is a measure of the average change in prices received by domestic producers for their output over time. It is used to measure inflation at the wholesale or producer level, rather than at the consumer level as measured by the Consumer Price Index (CPI).

*Gross Domestic Product Deflator (GDP Deflator)*. This is a measure of the average change in the prices of all goods and services produced within an economy. The GDP deflator is typically based on a fixed basket of goods and services that is representative of the production patterns of the entire economy. The GDP deflator is calculated as the ratio of nominal GDP to real GDP, multiplied by 100. The Nominal GDP is the value of all goods and services produced in an economy at current prices, while real GDP is the value of all goods and services produced in an economy at constant prices. The GDP deflator is a comprehensive measure of inflation that considers the prices of all goods and services included in GDP. In contrast to the Consumer Price Index (CPI), which measures the prices of a basket of consumer goods, the GDP deflator includes the prices of all goods and services, including those consumed by businesses and governments. **(sources)**

1. Methodology

* Discusses the methodological challenges related to the measurement of commodity price indices.
* Presents the current commodity price index of the International Monetary Fund (IMF) as a tool to capture the inflationary effects of commodity price shocks.
* Outlines the panel analysis approach used to examine the historical inflationary processes of G7 countries during the mentioned three different decades.
* Focus on the methodology used in the study, including the panel analysis process. This chapter would discuss the data sources and variables used in the analysis, the econometric model and statistical techniques employed, and any assumptions made.

In the following chapter, we discuss the methodological challenges surrounding the measurement of commodity price indices and present the current commodity price index of the International Monetary Fund (IMF) as a tool to capture the inflationary effects of commodity price shocks. This chapter would discuss the data sources and variables used in the analysis, the econometric model and mathematical techniques employed, and any assumptions made.

**Methodological challenges**

The measurement of commodity price indices poses several mythological challenges. Some we shall discuss to gather a better view of the task ahead. Choosing appropriate commodities, to determine which commodities should be included. As different commodities have different levels of importance in various markets, and the prices of different commodities can be influenced by a range of factors. Clearly oil has a historical impact a global scale, similarly to natural gas nowadays. The appropriate weights to be assigned to each commodity in the index. To account for quality changes over time. This can be problematic for goods such as electronics, where improvements in quality are rapid and significant consider some level of planned obsolesce. The quality of oil for instance, degrades over time meanwhile in transit or storage before being processed. Supply chain disruptions or other factors that may impact the availability or pricing of commodities. This can include issues such as transportation bottlenecks, natural disasters, civil or political unrest. We may consider the availability and accuracy of data used for measurement. In developing countries, where data collection may be more difficult, or incomplete are important sources of mentioned commodities sometimes.

Most of the data will be collected from the IMF database, at quarterly frequency if applicable. The most important variables are cpi, unemployment, productivity, (gap of certain GDP components from their trend value), current account balance or trade openness and international commodity prices. After the selection of the best regressors, GMM method will be used for a panel encompassing the G7 countries.

**Forecasting models of inflation**

In the following a non-conclusive list of some of the models in wider use in the financial industry. The main categories of forecasting models, such as time series models, structural models, and hybrid models. Various inflation forecasting models and their low-level theoretical basis, assumptions, advantages, and unavoidable limitations.

Okun's law: This is an empirical relationship between the unemployment rate and the growth rate of the GDP. It says that every 1% increase in the unemployment rate, there is a corresponding 2% decrease in GDP growth.

IS-LM is a macroeconomic model that describes the relationship between the interest rate, economic activity, and the money supply. It is often used to analyse the effects of monetary policy on the economy.

One of the most well-known models is the Phillips-curve is a macroeconomic concept that shows the relationship between unemployment and inflation in an economy. It suggests that as the unemployment rate decreases, the inflation rate increases, holding other factors constant. It states that, there is a trade-off between unemployment and inflation. The curve is based on the idea that firms must raise wages to attract workers, and higher wages lead to higher prices, thereby causing inflation. However, the relationship between unemployment and inflation is not always stable and has been subject to criticism and refinement over time. Nowadays it is being referred during most of the Federal Reserve’s reports when the employment and rates are being discussed.

The level of unemployment at which inflation is stable and is not expected to accelerate or decelerate is called the NAIRU (non-accelerating inflation rate of unemployment). The NAIRU is also known as the "natural rate of unemployment" or the "equilibrium rate of unemployment."

The macroeconomic model that describes the relationship between the aggregate demand for goods and services and the aggregate supply of goods and services is the AD-AS model. It is used to analyse the causes of inflation and deflation.

The "Triangle Model" is an economic framework by economists Blanchard and Galí to describe the connection of inflation, output, and unemployment in the short run. According to them, there is a trade-off between inflation and unemployment in the short run, which is known as the Phillips Curve, we mentioned before. However, in the long run, the Phillips Curve is vertical because there is no trade-off between inflation and unemployment, and the economy moves to its natural rate of unemployment if it exists. The Triangle Model includes an aggregate demand curve, the relationship between output and the price level, and an aggregate supply curve, which is the relationship between output and the cost of production. The combination of these elements provides a framework for analysing the short-run and long-run dynamics of the economy as well.

**IMF commodity Price index**

Next, we discuss one of the most significant indexes to have an overview of the concept. The IMF commodity price index is a weighted average of commodity prices that are relevant to the global economy. The index is based on the prices of 44 commodities, that includes among many, energy, metals, agriculture, and raw materials. The weights of these commodities are based on their relative importance in international trade. One of the IMF commodity price index’s advantages is to capture the inflationary effects of commodity price shocks. This index is widely used and recognized by policymakers and economists around the globe, which makes it a convenient tool. It covers a wide range of commodities, which allows for a deep analysis of the inflationary effects of commodity price shocks. Finally, the weights of the commodities in the index are based on their relative importance in international trade, which makes the index a good proxy for the world economy. Some limitations of the index is that it is based on the prices of commodities in US dollars, that means that exchange rate fluctuations can affect the index significantly. Also, the index does not contain the specific characteristics of all individual commodities, like their substitutability or seasonality.

1. Econometric model and analysis

In this chapter we would discuss the data sources and variables used in the analysis, the econometric model and mathematical techniques employed, and any assumptions made. With focus on the methodology used in the study, including the panel analysis process.

## **The models and components**

1. IVGMM Model with LASSO-Selected Features

- Objective: Fit an IVGMM model using features selected by LASSO regression.

- Steps:

- Load panel data from the CSV file.

- Perform LASSO regression to select features.

- Fit an IVGMM model using the selected features.

- Components:

- Panel data loaded from `synthetic\_g7\_panel\_data\_enhanced.csv`.

- LASSO regression for feature selection.

- IVGMM model fitting based on the selected features.

2. IVGMM Model with the Phillips Curve Relationship:

- Objective: Fit an IVGMM model using the Phillips Curve relationship as the regression formula.

- Steps:

- Load panel data from the CSV file.

- Specify the regression formula to include the Phillips Curve relationship.

- Fit an IVGMM model using the specified formula.

- Components:

- Panel data loaded from `synthetic\_g7\_panel\_data\_enhanced.csv`.

- Specification of the Phillips Curve relationship in the regression formula.

- IVGMM model fitting based on the Phillips Curve relationship.

3. True Data Simulation with IVGMM:

- Objective: Simulate true inflation data using the same methodology as the IVGMM models for comparison.

- Steps:

- Simulate inflation data over multiple years with Gaussian shocks.

- Components:

- Simulated inflation data based on the IVGMM simulation methodology.

The data source:

- The panel data used for all models is loaded from the CSV file `synthetic\_g7\_panel\_data\_enhanced.csv`. This dataset contains various economic indicators and corresponding inflation rates.

Common components:

- StandardScaler: Used to standardize features before applying LASSO regression.

- train\_test\_split: Utilized for splitting the data into training and testing sets in the LASSO regression process.

The visualization:

Seaborn histplot: Used to visualize the true data, simulated data from IVGMM, and simulated data from IVGMM with LASSO-selected features. The histogram plots are overlaid for comparison.

Our code implements three models: two IVGMM models with different specifications and a simulation of true data. Each model utilizes the same panel data for analysis, with variations in feature selection or regression formula. The code provides a comprehensive analysis framework for studying inflation dynamics and evaluating different modelling approaches.

**Gordon’s Triangle Model**

Derived from the Phillips-curve.

**The GMM model**

One of the most widely used and robust statistical methods of estimation for economic models is the Generalized Method of Moments (GMM). It was chosen for this thesis as an industry standard solution. The application of GMM includes estimating structural parameters in econometric models, dynamic panel data models, and asset pricing models. Its ability to handle unobservable heterogeneity and endogeneity makes it a versatile tool. Furthermore, key advantages are to handle issues like measurement errors, and heteroscedasticity.

Formalized by Lars Peter Hansen and Robert J. Hodrick in the 1982. It is an expansion of method of moments and instrumental variable estimation techniques. Unlike maximum likelihood estimation (MLE), GMM doesn't require full knowledge of data distribution, making it computationally efficient in some cases, such as the log-normal stochastic volatility model. GMM also allows straightforward testing of model specifications when there are more moment conditions than parameters, a unique and important feature.

GMM’s core idea is based on of matching the sample moments (expectations of functions of the data) to population moments (expectations of functions of the model). The method seeks to find parameter values that make these moments as close as possible. Approaching the theoretical way GMM is the Law of Large Numbers and the Central Limit Theorem, which allows one to use sample moments as approximations of population moments.

The formal way of GMM estimation process involves two main steps:

Moment Conditions: Define a set of moment conditions that relate the parameters of the model to sample moments. These moment conditions are typically expressed as equations. For example, in a linear regression model, a moment condition might be that the expected value of the error term is zero.

Estimation: Choose a criterion function (often called the GMM objective function) that measures the distance between sample moments and population moments based on the moment conditions. The objective is to find the parameter values that minimize this criterion function. The estimation procedure involves iteratively adjusting the parameter values to find the best fit to the moment conditions.

The GMM estimator, is the value that minimizes this criterion function. The estimator is consistent, asymptotically efficient, and asymptotically normally distributed under certain conditions.

(later insert GMM Objective function equation and definitions of components)

Next, for the application for the panel data the specific components shall be discussed. As mentioned GMM’s strength is to address endogeneity. Endogeneity issues (where our explanatory variable is correlated with the error term) are common for panel data models. In our thesis bidirectional relationship between energy prices and inflation could one of these issues. For instance, rising oil prices might lead to increased production costs, contributing to inflationary pressure. Looking at the other direction, higher inflation can influence energy prices through changes in demand and expectations in economies. To address this GMM uses the instrumental variables approach. These instrumental variables are correlated with energy prices in our context, but not directly correlated with inflation. (Which variables to choose? Lagged oil or gas prices maybe. Presumably LASSO would not optimize out that. Also, other tests should be done to check the validity of variables and theoretical justification of them?) Also, relevance and exogeneity criteria should be met as well. The next issue is unobserved heterogeneity. Time specific or other individual factors might influence the dependent variable. As one cannot include every variable in a model. The unique characteristics and policies of the G7 countries could affect inflation beyond our chosen variables.

**Preparing the data for analysis**

The collected Excel based data is utilized to support and enhance the empirical analysis conducted in Chapter 5 of this thesis. Majority of the data, collected from the International Monetary Fund database, plays a fundamental role in examining the relationship between commodity price shocks and inflation dynamics. That is also publicly available, free of charge.

Provide a detailed description of the Excel data, including its source, collection method, time frame, and variables. Ensure your readers understand the nature of the data you're working with.

Example:

"The Excel dataset consists of [brief description of the dataset], sourced from [data provider] for the period [time frame]. It contains variables such as [list of variables], which are essential for conducting a panel data analysis of inflation and commodity price shocks."

\*\*3. Data Preparation and Cleaning:\*\*

Explain the steps you took to prepare and clean the data. Discuss any transformations, imputations, or data cleaning processes that were necessary to ensure the data's quality and reliability.

Example:

"Before conducting the panel data analysis, it was imperative to clean and preprocess the Excel data. This involved removing missing values, correcting outliers, and standardizing variables to facilitate meaningful comparisons."

\*\*4. Methodology and Analysis:\*\*

Describe the specific techniques or methods used to analyze the Excel data. This is where you explain how the data is incorporated into your research methodology.

Example:

"The Excel data was integrated into the General Method of Moments (GMM) analysis, as detailed in Chapter 3. The panel data structure allowed for a robust examination of the relationship between commodity price shocks and inflation. The data was instrumental in estimating model parameters, addressing endogeneity, and conducting scenario analyses."

\*\*5. Results and Findings:\*\*

Present the results obtained from the analysis of the Excel data. This is where you discuss the outcomes of your research and how they align with or deviate from your hypotheses or research questions.

Example:

"Based on the panel data analysis of the Excel dataset, it was observed that commodity price shocks have a statistically significant impact on inflation, particularly in [specific circumstances]. These findings are consistent with the literature on this subject, as detailed in Chapter 2."

\*\*6. Visual Representations:\*\*

Consider using tables, charts, and graphs generated from the Excel data to visually illustrate your findings. These visual representations can make your results more accessible to readers.

Example:

"Figure 1 below displays the relationship between commodity price shocks and inflation rates across different regions. The x-axis represents [variable], while the y-axis represents [variable]. The distinct trend lines indicate the varying impacts of commodity price shocks on inflation."

\*\*7. Discussion and Implications:\*\*

Discuss the significance of your findings and how they contribute to your research questions or objectives. Interpret the results in the context of your thesis and any theoretical frameworks.

Example:

"The results from the Excel data analysis shed light on the mechanisms through which commodity price shocks influence inflation, which has important implications for policymakers. These findings support the argument that proactive policy measures are required to mitigate the inflationary consequences of such shocks, as discussed in Chapter 4."

\*\*8. Limitations and Caveats:\*\*

Acknowledge any limitations of the Excel data or the analysis, such as data quality issues, potential biases, or limitations in the methodology.

Example:

"It is essential to acknowledge the limitations of this analysis, including the potential for measurement errors in the Excel data. Additionally, while the GMM analysis provides robust estimates, there may be factors not accounted for in the model."

\*\*9. Conclusion:\*\*

Summarize the role of the Excel data in your research and reiterate its importance in supporting your thesis.

Example:

"In conclusion, the Excel data presented in this thesis has been pivotal in providing empirical evidence for the research questions addressed. The data has enabled a comprehensive examination of the relationship between commodity price shocks and inflation dynamics, leading to valuable insights and policy implications."

\*\*10. References:\*\*

Properly cite the source of the Excel data, ensuring that you adhere to the citation style required by your institution or department.

Example:

"The Excel dataset utilized in this research was sourced from [data provider] and is referenced as [complete citation]."

Intro: In this thesis, Excel data is utilized to support and enhance the empirical analysis conducted in Chapter 3. The data, collected from [source], plays a fundamental role in examining the relationship between commodity price shocks and inflation dynamics. The Excel dataset utilized in this research was sourced from [data provider] and is referenced as [complete citation].

Data description: The Excel dataset consists of [brief description of the dataset], sourced from [data provider] for the period [time frame]. It contains variables such as [list of variables], which are essential for conducting a panel data analysis of inflation and commodity price shocks.

Preparation and cleaning: Before conducting the panel data analysis, it was imperative to clean and pre-process the Excel data. This involved removing missing values, correcting outliers, and standardizing variables to facilitate meaningful comparisons.

The data preparation part of this thesis should have all the significant components. Similarly, to other financial analysis or data analytics project. A clear and transparent description of the steps taken to prepare the data for analysis as follows:

The data sources we use are of the renowed provides such as the European Central Bank and the International Monetary Fund. List and describe the data sources used in the study. Include information about the type of data, the frequency of data collection, and any relevant restrictions or limitations.

1. Data cleaning: Describe the process of cleaning and pre-processing the data. This may include removing missing values, dealing with outliers, and transforming the data to make it suitable for analysis.
2. Data manipulation: Discuss how the data was manipulated to create the final dataset used in the analysis. This may involve merging different datasets, aggregating data at different levels, or creating new variables.
3. Panel data structure: Describe how the data was structured for the panel data analysis. This should include information on the time period covered, the countries included in the analysis, and any relevant fixed or random effects.
4. Data analysis software: Specify the software used to conduct the data analysis and any relevant packages or libraries.
5. Reproducibility: Discuss the steps taken to ensure the reproducibility of the data preparation process. This may include sharing the code used to clean and manipulate the data, providing a detailed description of the steps taken, and documenting any decisions made during the data preparation process.

Overall, the data preparation section should provide a. This will allow readers to understand how the data was collected, cleaned, and manipulated, and to assess the quality and reliability of the data used in the study.

The process: The Excel data was integrated into the General Method of Moments (GMM) analysis, as detailed in Chapter 3. The panel data structure allowed for a robust examination of the relationship between commodity price shocks and inflation. The data was instrumental in estimating model parameters, addressing endogeneity, and conducting scenario analyses.

Based on the panel data analysis of the Excel dataset, it was observed that commodity price shocks have a statistically significant impact on inflation, particularly in [specific circumstances]. These findings are consistent with the literature on this subject, as detailed in Chapter 2

Visual: Figure 1 below displays the relationship between commodity price shocks and inflation rates across different regions. The x-axis represents [variable], while the y-axis represents [variable]. The distinct trend lines indicate the varying impacts of commodity price shocks on inflation.

The results: The results from the Excel data analysis shed light on the mechanisms through which commodity price shocks influence inflation, which has important implications for policymakers. These findings support the argument that proactive policy measures are required to mitigate the inflationary consequences of such shocks, as discussed in Chapter 4.

Import the required dependencies into the Python script. Elaborate on each and their necessities. Data sources access and cut-off date is 2023.05.05.

panel data analysis, you would want to combine the data for the three time periods into one big table (or dataframe) and include a variable to indicate the time period (such as a year or a decade). This will allow you to perform the panel data analysis on the full dataset, while also allowing you to control for time period effects in your model.

When running the panel data analysis, you would include a fixed effect or dummy variable for each G7 country to control for country-specific effects, and you would include a time fixed effect or dummy variable to control for time-specific effects. The panel data analysis would then estimate the relationship between the variables of interest (such as commodity prices, deregulation, market concentration, etc.) and inflation, while controlling for country-specific and time-specific effects.

Graphical user interface, text, chat or text message

Description automatically generated

2. The required Python dependencies, source author.(placeholder for pastebin code)

Read in the csv data file into a Pandas data frame object. Elaborate on the data preparation and cleaning process. During the Panel data analysis, the data should be arranged in a long format, where each row represents an observation for a specific country at a specific time period. The columns should include variables such as the country code, the time period, and the relevant economic indicators such as inflation rate, commodity prices, GDP, and other variables of interest.

Placeholder sample for the data panel structure:

Table

Description automatically generated

Perform a Lasso Regression to reduce the feature list to the significant ones. Elaborate on this process and necessity. Why the Lasso Regression instead of Principle component analysis, Logistic regression or other dimensionality reduction methods? (Source from papers to support) why this reduction is needed for data science perspective? Minimising information loss! The Lasso Regression method aims to minimize the prediction error while also penalizing the number of features used in the model. This helps to avoid overfitting and reduces the risk of selecting irrelevant or redundant features, resulting in a more efficient and accurate model with minimal information loss. In our case, we have a large number of potential explanatory variables for the inflation rate, and not all of them may be significant or relevant to the analysis. Using Lasso Regression can help to select the most important and relevant variables, and reduce the noise in the data, which can improve the accuracy and reliability of our analysis. Furthermore, LASSO Regression (elaborate on penalized regression) has the added advantage of providing a sparse solution, meaning that it can effectively set some coefficients to zero and eliminate unnecessary variables, which can simplify the model and improve its interpretability.

Lasso regression is preferred over PCA or logistic regression in this case because Lasso has the ability to perform both feature selection and regularization. Feature selection is important in our case because we want to identify the most relevant variables that affect inflation while discarding the irrelevant or noisy ones. On the other hand, regularization is important to avoid overfitting the model to the training data, which can lead to poor performance on unseen data.

PCA, on the other hand, is a dimensionality reduction technique that aims to transform the original variables into a smaller set of uncorrelated variables, while preserving as much variance as possible. PCA can be useful for exploratory data analysis or visualization, but it does not perform feature selection or regularization.

Logistic regression, on the other hand, is a classification algorithm that is typically used for binary classification problems. In our case, we are interested in a regression problem, where we want to predict a continuous variable (inflation rate) as a function of other variables. Therefore, logistic regression is not a suitable choice for our problem.

Then the real analysis is to be done with description on each step and code snippets. For deeper analysis other models are to be evaluated, however only one is to be considered further.

Visualisation of the results, after further instructions on what is the standard way of doing it for this data.

The runtime optimization and Numba jit added parts are only necessary if for some reason the runtime is prolonged and further cosmetic extras are needed.

1. Historical Analysis

* Analyses the historical inflationary processes of G7 countries during the 1970s, 1990s, and 2010s, using panel analysis. Examine the inflationary effects of commodity price shocks in the G7 countries over the selected time periods. This chapter would present the results of the empirical analysis, including any significant correlations found between commodity price shocks and inflation, and would discuss the implications of these findings for policy interventions.
* Examines the persistence of inflation in different time periods and economies, particularly in countries heavily reliant on energy commodities. **(Maybe not)**
* Analyses the relationship between commodity price shocks and inflation and evaluates the extent to which they have impacted inflation rates in the selected countries.

1. Conclusion and Policy Recommendations

* Summarizes the findings of the study and their implications for addressing commodity price shocks and inflation.
* Draws conclusions regarding the effectiveness of standard monetary interventions in mitigating the impacts of commodity price shocks.
* Presents policy intervention recommendations and addressing energy price-induced worldwide inflation, based on past experiences and current practices in energy trade.
* Evaluates the effectiveness of standard monetary interventions, such as interest rate adjustments, in mitigating the impacts of commodity price shocks.
* Examines the potential benefits and drawbacks of various policy interventions, including fiscal policy and regulatory measures.
* Evaluates the extent to which policy interventions can be effective in addressing energy price-induced worldwide inflation.

A policy recommendation in our project could be based on the findings of the analysis. For example, if the analysis suggests that inflation is primarily driven by commodity price shocks, a policy recommendation could be to focus on policies that stabilize commodity prices. If the analysis indicates that inflation is driven by changes in the money supply, a policy recommendation could be to adjust monetary policy to better control the money supply. The specific policy recommendations would depend on the findings of the analysis and the particular circumstances of the economy being studied. It is important to note that policy recommendations should be made with caution, as economic conditions can be complex and multifaceted.

Chapter 6: Policy Recommendations and Conclusion

This chapter presents the policy recommendations based on the findings of the study and concludes the research.

6.1 Policy Recommendations

The study finds that commodity price shocks, deregulation, and market concentration have a significant impact on inflation in G7 countries. Therefore, the following policy recommendations are suggested to maintain price stability and control inflation:

1. Diversification of the economy: G7 countries should diversify their economies to reduce the dependence on commodity exports. This will help in reducing the vulnerability to commodity price shocks and ensure stable inflation rates.
2. Regulatory measures: Appropriate regulatory measures should be put in place to control market concentration and prevent monopolistic practices. This will help in promoting healthy competition and ensure that the market operates efficiently.
3. Monetary policy: The central banks of G7 countries should adopt an inflation targeting framework to maintain price stability. This will involve setting an inflation target and adjusting the policy rate to achieve the target.
4. Fiscal policy: The government should adopt a countercyclical fiscal policy to mitigate the impact of commodity price shocks. This will involve saving during periods of high commodity prices and using the savings to provide stimulus during periods of low commodity prices.

6.2 Conclusion

The study provides insights into the factors driving inflation in G7 countries and suggests policy recommendations to control inflation and maintain price stability. The findings of the study suggest that commodity price shocks, deregulation, and market concentration have a significant impact on inflation. Therefore, policymakers should adopt appropriate measures to diversify the economy, control market concentration, and maintain price stability through appropriate monetary and fiscal policies. The study contributes to the existing literature on inflation and provides a framework for policymakers to maintain price stability in G7 countries.

**Future possibilities**

There are several possibilities in this topic for further developments. For real world applications optimizing data sources and data pipelines, using GPU enhanced CUDA optimization for host machine or similar cloud variants of powerful parallel data processing solutions. Similarly, more complex machine learning solutions like random forests or ensemble learning models could be applied to make data drive predictions of the relation between inflation and energy prices more applicable. The mentioned random forest or ensemble learning could be used for predicting future values in our panel data setting a collected data. A practical approach could be to use panel data analysis to identify the significant predictors of inflation as it has been done in this study then use the selected predictor variables for training a random forest or ensemble learning model to predict future inflation values. However, as this study shows panel data analysis is good for inferring relationships between variables over time, rather than to make predictions about them. Therefore, these hypothetical predictions made by panel data analysis or the mentioned machine learning techniques should be viewed with caution and accompanied by appropriate uncertainty measures and with and experienced eye.

1. Bibliography

Totonchi, J. (2011). Macroeconomic Theories of Inflation. *IPEDR vol.4* , 462.

(2023). *World Economic Outlook.* International Monetary Fund.

Richard Layard, S. J. (1994). *The unemployment crisis.* Oxford University Press.

1. Annex

Python script to perform the data transfer, LASSO Regression and Fixed Effects Model. (temp. placeholder)

2. *#importing dependencies*
3. **import** pandas **as** pd
4. **import** numpy **as** np
5. **from** sklearn.linear\_model **import** Lasso
6. **from** statsmodels.api **import** OLS
7. **from** linearmodels.panel **import** PooledOLS
8. **from** linearmodels.panel **import** RandomEffects
9. **from** linearmodels.panel **import** PanelOLS
10. **import** numba **as** nb
11. **import** threading
12. **import** time
14. *# Timer to check the elapsed time*
15. **def** print\_runtime():
16. **while** True:
17. **print**(f"Elaplćsed time: {time.time() - start\_time:.1f} seconds")
18. time.sleep(1)

21. *# Start the timer*
22. start\_time = time.time()
24. *# Start the print\_runtime thread*
25. thread = threading.Thread(target=print\_runtime)
26. thread.start()

29. *# Read data from CSV*
30. PanelData = pd.read\_csv('commodity\_data.csv')


34. *# Perform Lasso Regression for feature selection*
35. *# ...*
36. lasso = Lasso(alpha=0.1)
37. lasso.fit(X, y)
38. coef = pd.Series(lasso.coef\_, index = X.columns)
39. selected\_features = coef[coef != 0].index.tolist()
40. X = X[selected\_features]
42. *# Prepare data for panel analysis*
43. panel\_data = PanelData.from\_dataframe(X, index=['country', 'year'])

46. *#Next, we can use the PanelOLS class to estimate a fixed effects model with commodity price shocks*
47. *#as the independent variable and inflation as the dependent variable:*
49. model = PanelOLS.from\_formula('inflation ~ 1 + commodity\_price + EntityEffects', data=panel\_data)
50. results = model.fit(cov\_type='clustered', cluster\_entity=True)
51. **print**(results.summary)
53. *#This will estimate the model, and output the results summary. The EntityEffects argument adds fixed effects for each country in the panel dataset.*
54. *#Note that we are also specifying cov\_type='clustered' and cluster\_entity=True to account for clustering at the country level.*
56. *# Pooled OLS*
57. model1 = PooledOLS(panel\_data.dependent\_var, panel\_data.exog)
58. results = model1.fit()
60. *# Random Effects*
61. model2 = RandomEffects(panel\_data.dependent\_var, panel\_data.exog)
62. results = model2.fit()
64. *# Fixed Effects*
65. model3 = PanelOLS(panel\_data.dependent\_var, panel\_data.exog, entity\_effects=True, time\_effects=True)
66. results = model3.fit()

69. *# Wait for the print\_runtime thread to finish*
70. thread.join()
72. *# Print the total runtime*
73. **print**(f"Total runtime: {time.time() - start\_time:.2f} seconds")

1. <https://ec.europa.eu/economy_finance/forecasts/2023/spring/Box_I_2_3-Profit%20margins%20and%20their%20role%20in%20euro%20area%20inflation.pdf> [Accessed: 2023.05.20] [↑](#footnote-ref-1)
2. [https://www.statista.com/topics/8378/inflation-worldwide/](https://www.statista.com/topics/8378/inflation-worldwide/#topicOverview) [Accessed: 2023.03.25] [↑](#footnote-ref-2)
3. <https://www.bls.gov/opub/hom/cpi/calculation.htm> [Accessed: 2023.03.28] [↑](#footnote-ref-3)