JÖNKÖPING UNIVERSITY
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A “new” Consumer Price Index (CPI) for monetary policy decisions in Sweden

How does a "new" technological CPI compare to the traditional CPI in measuring inflation and influencing monetary policy decisions?

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Terminology

SOU - The government’s official investigations (Statens offentliga utredningar)

CPI – Consumer Price Index

SCB – The Swedish Central Bureau of Statistics (Statistics Sweden)

COLI – Cost of Living Index

Ethical statement

This report provides a subjective viewpoint on the comparison of the traditional and a "new" CPI in Sweden. It is important to note that the paper tries to raise awareness and recognition of the subject, rather than to advocate a certain agenda or ideology. The “new” CPI should be seen as a different measurement for monetary policies to account for both consumer and economic changes.

Abstract

This study proposes a “new" consumer price index (CPI) and investigates the influence of Sweden's monetary policy on the new index level and its variations over time. Unlike the traditional CPI that the SCB uses, the "new" CPI tries to consider technology improvements by using macro data. The research demonstrates that the "new" CPI resulted in less inflation than the traditional CPI computed from 1981 to 2020. The research predicts that the difference between the two CPIs would keep growing through 2020–2024, indicating that using the "new" CPI will lead to a more conservative approach to monetary policy. The findings suggest that policymakers should update the CPI regularly to reflect changes in consumer behavior and technological advancement, acknowledge the uncertainty associated with forecasting inflation, and be transparent with the public about the limitations of forecasting models. This study emphasizes the potential benefits of incorporating technology improvements into the CPI and its influence on monetary policy.

Key terms: Consumer Price Index, Inflation, Technology, Monetary Policies, and Forecast

JEL: E31, E37, E52

CONTENTS

1. INTRODUCTION

The concept of inflation has become increasingly complex in today's globalized and technologically advanced world. Measures like the Consumer Price Index (CPI) are used by governments and central banks to track price movements and evaluate the health of the economy. The traditional CPI, however, might not accurately reflect how technological development has affected the costs of products and services. It has been argued that this could lead to biases in monetary policy decisions and overall economic instability because the standard CPI may not accurately reflect the underlying inflation rate.

The CPI can be impacted by things other than technology-driven price shifts, such as the energy crisis and government initiatives. An energy crisis, for example, may cause a spike in the costs of oil and gas, which are critical inputs in many households and businesses. This will cause the CPI to rise as it becomes more expensive for transportation and heating. Changes in tax laws or regulations, for example, can also have an impact on the CPI. For example, a rise in sales tax on particular goods or services might cause price increases, affecting the CPI. Additionally, subsidies or other types of government assistance for specific businesses or goods might result in price decreases, which may affect the CPI.

In recent years, new CPI measures have been created in response to the mismeasurement of the CPI. Considerations such as how technology has changed for both products and services. The Swedish Central Bureau of Statistics (SCB) is the one accountable for calculating and changing the CPI, along with other important measurements in society. In 2021, SCB investigated a new way of measuring mobile phone and computer prices due to a recommendation from Eurostat about bridged overlap when measuring HICP (Harmonized Index of Consumer Prices)[1]. This is by measuring new products with a defined quality measurement that compares the CPU, screen quality, internal storage, and

[1] According to Regulation (EU) 2016/792 and its related implementing regulation, the Harmonised Index of Consumer Prices (abbreviated as "HICP") is a consumer price index that is created by each Member State of the European Union using a harmonized method. These indexes can be combined and are directly comparable between nations. The objective is to offer a reliable and comparable indicator of consumer price inflation. Eurostat. (2023). *Harmonised Indecies of Consumer Prices (HICP)*. https://ec.europa.eu/eurostat/web/hicp/faq

processor speed for e.g. mobile phones (Eliasson et al., 2021). By taking into consideration the influence of technical advancements on pricing as well as changes in the quality of goods and services, this new measure of prices seeks to provide a more realistic description of inflation and cost of living. This new way of measuring mobile phones and computers was then officially presented in the CPI changes 2022 (Eliasson & Nordin, 2022).

This paper aims to compare the traditional CPI to a proposed CPI in the short and long term. The two indices are compared with respect to their performance to accurately measure inflation and evaluate the "new" CPI's potential influence on Swedish monetary policy decisions. Although the HICP is an additional comprehensive indicator of inflation than the conventional CPI, it is not specially designed for Sweden and may not accurately reflect the peculiar economic circumstances of the nation (Eurostat, 2023). The questions that the paper will try to answer will be as followed:

- Does the use of the "new" CPI influence monetary policies in Sweden and how?
- Would the use of the "new" CPI affect the current inflation forecasts in Sweden?
- What is the impact of the "new" CPI on grants costs based on CPI calculations?

To do so, the first objective is to assess the accuracy of estimating inflation using the "new" and old CPIs. The second objective is to investigate how the "new" CPI impacts monetary policy, namely how successfully it manages inflation. Thirdly, to discuss if making monetary policy decisions based on the "new" CPI rather than the traditional CPI would be biased in any way. Finally, to evaluate any potential impacts of the "new" CPI on the price base amount cost in the economy. The research will also provide recommendations to policymakers on how to improve the precision of inflation forecasting and the effectiveness of monetary policy.

By assessing the "new" CPI and its influence on monetary policy decisions in Sweden, this paper fills a gap in the literature and offers insight into the possible advantages and disadvantages of this "new" measure of inflation. Policymakers can utilize the paper's findings to inform their decisions about inflation and monetary policy, which will eventually help to maintain and expand the Swedish economy.

2. THEORETICAL FRAMEWORK

The theoretical framework of this study seeks to provide a theoretical basis for the research questions and the overall objectives. The theoretical framework for this paper is based on several key economic theories, hypotheses, and terminology.

2.1. CPI AND COLI

The definition of CPI can have different approaches and depends on the questions provided. In 1989 ILO (International Labor Organization) made a CPI manual where they provide concepts and methods regarding the CPI (Turvey, 1989). Based on the 2020 updated version of the original manual ILO discuss three main uses for the CPI, which are indexation, national accounts deflation, and inflation measurement (Graf, 2020).

Edvinsson & Söderberg (2010) uses the definition of CPI and COLI provided by ILO in their paper regarding the evolution of Swedish consumer prices, 1290-2008. They explained that there exists a cost differential between the cost of a typical basket of consumer goods and the cost of ensuring a given level of utility or well-being for a customer. The first is known as CPI, whereas the second is known as COLI (Edvinsson & Söderberg, 2010).

Further explanation from ILO states that there is a basic conceptual difference between a basket index and a COLI. A basket index in a CPI context is an index that reflects the change in total spending required to purchase a certain set, or basket, of consumer goods and services between two time periods. This is known as a "Lowe index" in the Manual.

A COLI is an indicator that assesses the change in the lowest cost of living for a particular quality of living. Both indices thus have similar purposes in that they try to quantify the change in total spending required to acquire either the same basket or two baskets whose content may differ but between which the family is indifferent (Graf, 2020).

The distinction between CPI and COLI is necessary since they measure different things. The CPI is a measurement of how much a basket of products and services that are frequently bought by households has changed in price over time. It is commonly used to calculate inflation and to alter earnings, salaries, and social security benefits. Even though family spending habits vary over time, the CPI is still determined using a constant basket of goods and services.

COLI on the other hand, is a more comprehensive indicator that considers changes in the cost of sustaining a specific standard of living, which may include changes in consumption patterns as families adjust to changes in relative pricing. COLI measures changes in the cost of sustaining a specific level of living, whereas CPI measures changes in the prices of a set basket of goods and services.

As a result, while both metrics are useful in assessing the cost of living, they do so in diverse ways. CPI is important for assessing inflation and modifying payments. However, COLI is more valuable for understanding how the cost of sustaining a specific standard of living varies over time. Because technological progress may impact the composition and quality of products and services, it can cause direct price changes and affect the accuracy of CPI, as well as indirect changes in the cost of living.

2.2. INDEX NUMBER THEORY

The CPI and other economic indicators are constructed and understood in large part because of Konüs's index number theory. The Konüs theory offers a framework that optimizes consumer behavior and precisely measures changes in price levels and living standards.

Konüs index number theory is relevant because it may be used to build indices while capturing customer preferences and reducing expenses. It ensures the precision and dependability of price measures by considering the substitution impact and utilizing suitable weighting procedures, such as the Laspeyres-Konüs and Paasche-Konüs indices.

The use of Konüs theory in the construction of the CPI allows for a more in-depth understanding of the complex relationship between consumer behavior, substitution effects, and price fluctuations. This enables policymakers, economists, and researchers to make better-informed decisions, devise successful policies, and assess the impact of economic changes on individuals and society (Diewert, 2004).

2.3. THE PRODUCER PRICE INDEX

The Producer Price Index (PPI) is an economic indicator that tracks the average changes in prices domestic producers receive over time for their production. It serves as a leading indicator of economic inflationary pressure since it depicts the price level at the start of the supply chain.

The PPI is intended to represent changes in the prices of products and services as they leave the production process and enter the market, according to the Producer Price Index Manual by the International Monetary Fund. It serves as an indicator of inflationary pressures within the economy to track the development of prices for intermediate and completed products and services produced in a nation.

The PPI monitors prices at the wholesale level as opposed to the CPI, which measures prices for products and services individuals pay. The PPI is derived from pricing data that has been gathered from a representative sample of producers across different industries and weighted according to their relative significance to the economy. The PPI is a useful tool for analysts, firms, and policymakers since it predicts inflationary trends in advance and helps pinpoint the sectors of the economy where pricing pressure is intensifying (International Labour et al., 2004).

2.4. CPI CALCULATIONS [2]

When it comes to calculating the CPI there are several methods for calculating it, each with its own set of advantages and disadvantages. The key methods, The Laspeyres, Paasche, and Fisher index will be presented briefly to establish a foundation for how the CPI is calculated.

The Laspeyres index is calculated by establishing the consumption bundle of goods and services in a base period and computing the price changes in succeeding periods for the same bundle (Eurostat, 2018a). This index is frequently criticized for exaggerating the cost of living rises since it ignores the possibility that families may alter their spending habits in response to price fluctuations. See example: (Braithwait, 1980)

The Paasche index is computed by allowing the consumption bundle to vary from period to period, with weights dependent on the amounts consumed in each period (Eurostat, 2018b). Because it ignores the possibility that consumers may eventually replace more costly goods and services with less expensive ones over time, this index does not accurately reflect the volume growth rates when the periods being examined are distant from the base year (Viet, 2011).

[2] The mathematical formulas for the mentioned indices can be found in the appendix.

The Fisher index is a different metric for determining whether total amounts are increasing, decreasing, or remaining stable. This index is the geometric mean of the Laspeyres and Paasche quantity indexes in its original formulation. Because it accounts for both substitution effects and changes in relative prices over time, this indexation is seen to be a more accurate indicator of inflation (Graf, 2020).

Understanding how the CPI is currently computed is vital to understand the limits of the existing index and how embracing technological progress might enhance the index's accuracy. As of today, the SCB updates the CPI weights and quality adjustments on a yearly basis. This, however, may not reflect the fast dynamic shifts in consumer behavior caused by technological advancement.

The new method of a fixed basket of adjustment to phones and computers will be adjusted on a monthly basis which is good, but other products are not as of today (Eliasson & Nordin, 2022).

2.5. THE RIKSBANK

The assessment of the CPI by the Riksbank is critical as it lays the foundation for monetary policy decisions. Therefore, the Riksbank has regulations and guidelines to follow when it comes to monetary policies. In January 2023, a new Riksbank Act was introduced to further establish regulations on the Riksbank’s operations, organization, and capital. Past regulations have been updated and one of them is the Riksbank's overriding purpose to ensure low and steady inflation (the price stability objective). Without compromising the price stability goal, the Riksbank must also contribute to balanced output and employment growth (real economic considerations). See Chapter 2, Section 1, Sveriges Riksbank Act (2022:1568).

Compared to the earlier Act, the consideration of the real economy is new, although the Riksbank had previously considered the development of output and employment, a practice known as flexible inflation targeting. The measurement of inflation and the target of 2% plus minus 1% is still the same (Riksbanken, 2023).

The Riksbank's objective is to maintain price stability, defined as a low and consistent rate of inflation. The Riksbank sets an inflation target and changes its policy interest rate to achieve this objective. The intent of the Riksbank to meet its inflation target and uphold price stability would be impacted by any modifications to the CPI methodology. For

example, if the “new” CPI with technological change results in a higher measure of inflation, the Riksbank may need to increase its policy interest rate to counter inflationary pressures.

2.6. NEW KEYNESIAN PHILLIPS CURVE

A central concept for monetary policy decisions and macroeconomics that helps explain the connection between inflation and unemployment is the New Keynesian Phillips Curve (NKPC). According to the NKPC, inflation is influenced by the interaction of three important factors: predicted inflation, present unemployment, and supply shocks. The NKPC argues specifically that when unemployment is low, inflation tends to increase because businesses face more competition for labor and are pressured to raise wages and prices. In contrast, when unemployment is high, inflation tends to decrease since businesses have less negotiating leverage and can't easily raise prices.

The NKPC is essential for monetary policy because it implies that changes in economic activity, such as changes in the unemployment rate or changes in the output gap, might impact inflation. This implies that Riksbanken can use monetary policy to influence inflation by changing interest rates, which can have an impact on economic activity and the output gap. If the central bank wishes to control inflation, it can raise interest rates, slowing economic growth and increasing unemployment. On the other hand, if the central bank wants to raise inflation and the economy, it can do so by lowering interest rates to promote borrowing and investment. That will in turn lower unemployment and stimulate the labor market (Clarida et al., 1999).

The development of a new CPI that accounts for technological progress in Sweden might be significant in the context of the NKPC since it would increase the accuracy of inflation measures. If the current CPI does not accurately capture the effects of technological progress on pricing, the central bank may make less effective policy decisions as a result. A new CPI could provide a stronger foundation for monetary policy decisions, perhaps leading to improved economic results.

2.7. THE MISMEASUREMENT HYPOTHESIS

The mismeasurement hypothesis is a hypothesis based on the mismeasurement of quality change in data. Its origins come from that quality changes in products have played a role in explaining the recent weakness in productivity growth, for example by not fully capturing productivity gains from new technologies (Triplett, 2002). This

mismeasurement hypothesis is also relevant when it comes to accurately measuring inflation based on the calculation of the CPI. Therefore, for the Riksbank when conducting monetary policy, it is crucial to have accurate estimates of the CPI to best respond to inflation (Shapiro & Wilcox, 1996).

2.8. THE PRICE BASE AMOUNT

The price base amount is an index that is "used in social insurance and the tax system. An increase in the price base amount means that the guarantee pension, the nursing allowance, and the ceilings in the allowances from sickness and parental insurance are raised, as they are calculated based on the price base amount. Study grants from CSN are also affected." (Regeringskansliet, 2022) The price base amount is calculated by SCB and is calculated based on CPI. This will be used to quantify the difference between the "new CPI and the real CPI in terms of SEK amount. (Appendix Figure 1)

3. HISTORICAL BACKGROUND

The foundation of the CPI started as a Cost-of-Living Index (COLI) and has been measured since July 1914 to showcase the changes in the cost of living for a “normal family” (consisting of husband, wife, and two children of the working class or lower middle class living in a town or a built-up area) (The Swedish Social Welfare Board, 1961). Up until 1943, the cost-of-living index was based on budget inquiries in 1913, 1923, and 1933. The period 1914-1931 calculations were considered to be of a Laspeyre type, while the 1932-1943 period was rather a Lowe price index. Then in 1943, a major revision of the COLI was made that sparked the beginning of a chain index of Edgeworth’s type. It was based upon two major committees in the area SOU 1943:8 and SOU 1953:23 where in the first paper three primary areas of use for the CPI are addressed. These are as follows:

- for compensation purposes and as a general measure of changes in the cost of living,
- for computation and analysis of real income changes,
- as a general measure of the internal purchasing power of the Swedish currency, and as a target variable for monetary policy. (Dalén & Haglund, 1999)

The purpose of the first investigation (SOU 1943:8) was to “on the one hand, statistically illustrate the development of prices in the final stage of the commodity circulation, and on the other hand, provide a basis for the regulation of wages and pensions in the civil service, as well as for wages in a wide range of business sectors." (SOU, 1943)

When Sweden gave up the gold standard in 1931 there were worries about price increases. During the period 1931-1948, the Riksbank established a monthly price index to represent price increases for private consumption as a whole rather than for particular families. The advantage of this index was that it was updated more regularly and that it averaged data from two different periods. Particularly during the Second World War, when various products vanished from the market. The average price for potatoes, eggs, fruit, and vegetables during the preceding 12 months was utilized by the Riksbank to account for seasonal variations. The index was first calculated using an arithmetic method, but it was replaced in 1937 by a Törnqvist price index, which is a weighted geometric average of

price relatives calculated using the arithmetic average of spending shares in two periods (Edvinsson & Söderberg, 2010).

Up until 1954, the COLI was handled by a special committee under the Social Welfare Board in a few designated locations. Since then, local officers of the (SCB) have been collecting pricing data and being the main source for the CPI calculations (The Swedish Social Welfare Board, 1961).

The overtake of the SCB meant that the fictive lower-income household was dropped, and the index evolved more into a measure of price changes for all private consumption. Even though the Riksbank index was more comparable to the design of the CPI. The CPI that was used was tied to the cost-of-living index rather than the monthly Riksbank index.

Throughout the years, the CPI methodology has undergone several changes to better represent changing consumer purchasing trends and technological improvements. The most significant changes date from the 1952 Index Committee, the 1955 Housing Index Inquiry, and the 1999 Index Inquiry, SOU 1999:124. The CPI base year is 1980 and based upon calculations from 1980 – 2004 the index contraction was different. This was changed in 2005 when different links is used to the index compared to the period 1980-2004 (SCB, 2023a).

To best capture the aggregated inflation chaining is ideal, when the examined period is very prolonged, as with a historical CPI. Due to the comparison over time getting increasingly challenging it requires chaining. Meaning that the price reference period is updated regularly, and several consecutive time series are linked to each other using a common period as the base period. In this case 1980. The SCB has several indices of the CPI where the base year is different, depending on what information and calculations are used (Edvinsson & Söderberg, 2010).

One that is used today by the Riksbank as the measurement of inflation is the Consumer Price Index with Fixed Interest (CPIF) and not the CPI. This change was made in September 2017 to better analyze the underlying inflation. CPIF with fixed interest is calculated as the CPI but without the direct effects of monetary policy changes, more explicitly the effect of interest rate payments by the households (SCB, 2023a).

Statistics Sweden (SCB) uses hedonic pricing, a technique for calculating the CPI, to take quality improvements and technical developments into account when determining the price of products and services. SCB has put a lot of work into implementing hedonic price adjustments throughout the years to improve the CPI's accuracy.

The CPI uses hedonic quality adjustment to consider variations in product quality over time. The pricing of the CPI-included goods must be changed to reflect innovation or the introduction of new products. The word "hedonic" is derived from its Greek roots, which have to do with enjoyment or usefulness.

Hedonic quality adjustment, in the context of the price index technique, requires breaking down a good into its components, assessing the value of utility obtained from each component, and utilizing these estimates to modify prices when a good's quality changes. To make sure that the CPI appropriately reflects the relative happiness or utility obtained from purchasing products, this adjustment is required (U.S. BUREAU OF LABOR STATISTICS, 2020).

Hedonic pricing has been included in the CPI in Sweden since the early 1990s, according to historical records. During this period, SCB realized that to offer a more accurate measure of inflation, it was necessary to account for the effect of shifting product quality on pricing.

In the mid-1990s, SCB created a thorough technique that explicitly accounted for quality variations in clothing. In future years, SCB refined its approach to hedonic pricing to assure its usefulness in capturing quality improvements. As technology advanced, SCB broadened the scope of hedonic modifications to cover a larger range of products and services. This required evaluating and considering quality improvements in industries like telecommunications, audiovisual technology, and other consumer goods (SCB, 2023b).

At the same time when hedonic pricing was introduced in Sweden, the Riksbank was one of the first in the world to adopt an explicit inflation goal in 1993. With this ambition, the Riksbank aimed to increase the predictability and transparency of its monetary policy while also establishing a framework for medium-term price stability. The Riksbank's inflation target is now set at 2%, with a tolerance zone of plus or minus one percentage point. This suggests that the Riksbank prefers to keep inflation close to 2%, but accepts inflation rates ranging from 1% to 3% (Riksbanken, 1990).

In the recent decade, there has been increasing recognition of the CPI's limitations in capturing changes in the costs of goods and services caused by technological advances. As a result, new techniques have been put forward that consider how technological advancements have improved the quality of goods and services. Sweden has been at the front of these efforts, introducing such changes as mentioned in the introduction to account for the constant changes in consumer habits and technological improvements.

4. LITERATURE REVIEW

The fact that the CPI does not consider changes in the quality of goods and services, as well as the emergence of new products and technology, has led to several studies on the subject. Policymakers and researchers in Sweden have recognized the necessity to update the CPI to account for quality improvements and technological advances.

In 2015 Riksbanken published a short research paper about digitization and inflation where they recognized that a structural change, such as technological improvement in society, has a downward pressure on inflation and "if a structural change can be expected to have a dampening effect on inflation, this can be compensated for by a more expansionary monetary policy."

According to the Riksbank research, advancements in technology may have both inflationary and deflationary consequences. It could cause prices to rise because of increased demand for products and services, which might be inflationary. On the other side, if it results in greater productivity and reduced manufacturing costs, which can lower prices, it could be deflationary.

The report highlights three major channels on how digitization influences inflation: digital technology advancement, automation, and e-commerce and better-informed customers. The digital technology development channel has the potential to increase productivity and cut costs, putting downward pressure on inflation. Additionally, it may also result in increased demand and more fierce competition, which may lead to inflation.

The automation channel can potentially contribute to increased productivity and reduced costs, but it can also lead to technical unemployment and a decline in labor demand, putting downward pressure on wages and inflation. Finally, the E-commerce channel and more knowledgeable customers can improve competition and provide consumers with access to a broader selection of products and services, putting downward pressure on prices (Riksbanken, 2015).

Groshen, et. al. (2017) study how statistics agencies correct for biases in the measurement of inflation brought on by quality change and the introduction of new goods in the era of digital technologies in their paper "How Government Statistics Adjust for Potential Biases from Quality Change and New Goods in an Age of Digital Technologies: A View from the Trenches."

The writers examine a variety of quality change challenges, including product innovation, changes in product mix, and quality adjustments. They draw attention to the difficulties these changes cause in measuring inflation and outline the strategies statistical organizations have adopted to overcome these difficulties. They also examine the importance of hedonic pricing indices in compensating for quality variations.

The article also discusses the difficulty of identifying and measuring the price of new items, as well as the significance of scanner data and online pricing in improving price measurement. The writers also explore the issues faced by free commodities, such as digital material, and the methods used to account for their worth.

Overall, the paper offers a thorough review of the difficulties statistics organizations have while calculating inflation in the age of digital technology, as well as the solutions used to overcome these difficulties. The authors underline the necessity of continual research and development in improving inflation assessment in the face of rapidly changing economic conditions (Groshen et al., 2017).

The Menz et al. (2023) study uses micro and macro pricing data from Germany and the eurozone to assess the influence of quality adjustment on consumer price inflation. According to the study, quality adjustment applies to a wide spectrum of products and services, although quality adjustments only cut headline inflation by 0.06 percentage points on average. Furthermore, the paper examines the impact of various quality adjustment techniques in the eurozone and estimates the influence of quality adjustment on inflation rates for typical quality-adjusted items in member countries.

The study emphasizes how crucial it is to understand how quality adjustment affects consumer price inflation, particularly when evaluating how well monetary policies manage inflation. The study also highlights the drawbacks of using conventional CPI measurements that do not consider changes in product quality, which may result in an overestimation of inflation (Menz et al., 2023).

Although the Menz et al. (2023) study offers insightful information on the relationship between quality adjustment and consumer price inflation, it does not answer the more general question of how consumer welfare is impacted by technical improvements.

In this regard, the "new" CPI closes a significant gap in the literature by offering an additional assessment of inflation that considers adjustments in technological improvements with macro data. It may also help guide policy choices on matters like intellectual property rights and how technology improvements affect economic growth. The "new" CPI is a step in this direction, giving some improvements over the traditional CPI. But to put it into practice, measurement issues and the requirement for a constant framework for comparison throughout time must be carefully considered.

5. METHODOLOGY

Time series analysis is a statistical tool for identifying trends, patterns, and forecasting future values by analyzing data points gathered over time. A variety of techniques exist for evaluating time series data and an ARIMA (Autoregressive Integrated Moving Average) model is one of them. In their book, Time Series Analysis: Forecasting and Control, George Box and Gwilym Jenkins developed the ARIMA approach. A linear model that takes into consideration the relationship between observations and the time series' trend (Tsay, 2000). The ARIMA model was chosen as the best approach to answer the research questions and analyze the data. The ARIMA model is widely used in time series analysis and can capture the underlying patterns and trends in the data. The ARIMA model will be used to analyze and forecast the CPI data for both the real CPI by SCB and the “new” CPI.

5.1. THE REAL CPI

The quarterly data for the CPI was collected from the SCB database with the base year 1949. The index was then transformed to a base, index number 100 in the resulting figures, of 1980 Q4 (1981-01-01) to account for missing data in the “new” CPI. The interpretation of the CPI is if the value is 300, the CPI has increased 200% since 1980 Q4. The SCBs CPI is used as the real inflation and is the reference point to the analysis of the “new” CPI.

5.2. THE “NEW” CPI

The “new” CPI will be based on SCBs CPI but have an additional weighted technical constant that is based upon 3 variables. This constant will represent the change in the value of goods and services due to technical progress.

The "new" CPI is expressed as:

$$CPI_t\,\% = \theta_t + \pi_t\% \qquad (1)$$

Where CPI_t % is the "new" CPI in percent at time t, θ_t is the weighted constant based on patents, TFP, and wages at time t and π_t% is the traditional CPI change (inflation) from t-1 to t.

The first variable included in the "new" CPI is patents. Patents can be indicated as a technological development and innovation measurement as a result of R&D investments. The launch of new items and a higher degree of innovation are frequently associated with a rise in patents. Due to their novelty, distinctive characteristics, or greater quality, new items may initially cost more when they first hit the market. Given that the pricing of these new items is considered by the CPI, this may increase inflationary pressures. (The cost from R&D investments to get the patent needs to be calculated for the new product). The patent data is collected from WIPO (World Intellectual Property Organization) where the total amount of patents from Sweden was collected.

The Total Factor Product (TFP), a measure of economic productivity, is the second variable in the "new" CPI. It considers changes in the effectiveness of industrial processes brought on by technological advancement. (A decrease in input and an increase in output). The TFP was collected from the Penn World Table version 10.01 where the TFP level is calculated at current PPPs (USA=1). Indicating that an increase in TFP can be explained as a greater increase in Sweden compared to the USA.

Wages, as the third and final variable, serve as a measure of the compensation that employees receive for their contributions to production. Adding this, the "new" CPI considers improvements in labor productivity brought on by advancements in technology. The wages were collected from SCB and are the yearly average in Sweden from 1993 to 2020.

It may be debatable whether to include patents, TFP, or wages in the CPI because of their indirect connection to consumer spending. However, they can still offer important insights into the larger economic variables that affect consumer pricing and purchasing power. These factors are added to the "new" CPI to give a more thorough analysis of inflationary trends and economic dynamics.

The θt will therefore be calculated as followed:

$$\theta t = \%\Delta A \omega_t \rho_k + \%\Delta B \omega_t \rho_k + \%\Delta C \rho_k \qquad (2)$$

Where $\%\Delta A, \%\Delta B$ and $\%\Delta C$ are the change in patents, TFP, and wages respectively in percent. The change was calculated by a straight-line growth approach. This can be expressed in the following formula:

$$Y(t) = Y(0) + \frac{t}{n} \times [Y(1) - Y(0)]\rho_k \quad (3)$$

Where Y(t) is the estimated value at time t, Y(0) is the initial value at time 0, Y(1) is the final value at time n, n is the total number of periods and t is the number of periods from time 0 to time t. By doing this, the yearly data of the variables can be transformed into quarterly data based upon the assumption of a straight growth rate.

The ω_t is the weight from the period 1981 – 1993 Q1 where $\omega_t = 0{,}5$ otherwise 1 and ρ_k is the weight from 1993 Q1 – 2020 where $\rho_k = \frac{1}{3}$ otherwise 1.

Within finance, the use of equal-weighted strategies has been proven to outperform value-weighted strategies (Malladi & Fabozzi, 2017). According to the equal-weighted strategy, every asset in a portfolio is assigned the same weighting independent of its market capitalization or any other fundamental variables. As a consequence, the portfolio's weighting of smaller firms, which are often underrepresented in value-weighted indexes, is increased, which may lead to greater returns.

This method may also be used for the computation of the CPI with technical variables included. By allocating equal weight to patent, TFP, and wages, the bias toward one variable over the others is removed, resulting in a more accurate representation of the CPI. With the incorporation of technology considerations, the equal-weighted approach is a more favored technique for computing the CPI. It is consistent with the ideals of fairness and objectivity and is backed by both theoretical concepts and real-world evidence. (Assessment of the weights will be calculated and analyzed in the validity chapter.)

The "new" CPI will be compared to the actual CPI given by the SCB using the different changes in % for both CPIs as an indexing mechanism. Beginning in the fourth quarter of 1980, a base value of 100 was established for both the "new" CPI and the actual CPI. This baseline value serves as a point of reference for comparison.

The index considers the percentage change in the "new" CPI and the percentage change in the actual CPI (inflation) for each period when calculating the values of the indexed CPIs throughout time. The weighted constant based on patents, TFP, and wages is included in the "new" CPI at time t, which is represented by the CPI_t %. The traditional CPI change (inflation) from the previous period, denoted as π%, is also considered. Using

the base value of 100 from the fourth quarter of 1980 (1981-01-01) as a starting point, we add the percentage change denoted by CPIt% to index the "new" CPI. In a similar manner, the real CPI in the base value of 100 will increase by the inflation rate (π%) in order to index the real CPI supplied by the SCB.

The expectations for the operators in equation (2) are based on a correlation matrix between the technical variables and CPI. (See Appendix Table 1)

5.3. ARIMA

After establishing the two CPIs, the ARIMA model was used to forecast the within data and analyze it by using the Box-Jenkins approach. The method consists of several steps covering model identification, model estimation, diagnostic testing, and forecasting. The statistical software STATA was used to calculate the following ARIMA model.

Model identification was the first step in the Box-Jenkins approach, and it involved picking out the right order for the ARIMA model (p, d, and q). This is by first checking for stability in the data using unit root testing. The paper used both the Dickey-Fuller and Phillips-Perron test when demeriting the appropriate differences in the data. This resulted in both CPIs having to be differentiated by 1 to satisfy the p-value for both tests. Indicating that the (d) was defined as (p,1,q). Then the autocorrelation function (ACF) and partial autocorrelation function (PACF) were used to determine q and p respectively. The PACF measures the correlation between the data after correcting for intervening observations while the ACF evaluates the correlation between the observations at various time lags.

Looking at the plotted output from STATA of the ACF and PACF, the determinations of the q and p were done by counting the number of plots outside the 95% confidence interval. For example, lag 5 from the ACF does lie within the 95% CI but lag 4 doesn’t indicating AC (q) of 4 is a potential model. The possible combination of the ARIMA model was then put into a table for estimation and diagnostic testing. Lag 40 of the PACF wasn’t considered. See Appendix Figure 1 – 4 and Table 2 – 3

The second stage was model estimation and model diagnostic testing, which required estimating and selecting the best model based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Singh et al., 2020). The AIC and BIC are both

used to determine the best ARIMA model. The model with the lowest AIC or BIC number is considered the best-fitted model (Akaike, 1978). See Appendix Table 2 and 3

The result from the estimation and diagnostic testing, the ARIMA model (4,1,4) was chosen for both the “new” CPI and the SCB CPI. Checking for the stability of the residuals around the mean and white noise by the Portmanteau test, both models satisfy the conditions. P-value 0.9943 > 0.05 for “new” CPI and 0.9968 > 0.05 for the SCB CPI (Box & Pierce, 1970). See Appendix Figures 5 and 6.

The stability of the AR and MA parameters can be plotted by STATA in a target diagram by the command “estat aroots”. Both CPIs satisfied the conditions for stability in both the AR and MA parameters. See Appendix Figure 7 and 8.

The last stage is the forecast of the predicted ARIMA model (4,1,4) on both the “new” CPI and the SCB CPI. This was done by first adding 4 years of periods using the “tsappend” command in STATA. Then running the “predict” command and specifying the prediction to consider quarterly predictions starting from 2020 Q1 to 2023 Q4. Given the results from STATA, an additional confidence interval of 95% was applied to give the forecast some room for the up and downside. This is by letting STATA predict the variance based on the mean square errors. Then calculating the lower and upper bound by multiplying the squared root variance and Z value 1.96 (for CI 95%) by +/- the forecasted values.

6. RESULTS

Based on the calculations for the “new” CPI, one can see from Figure 1 that the “new” CPI is showing an overall lower inflation. The θt is more negative over time and is shown as it becomes more negative around 2003. In the last data period (2019 Q4) the gap was -4.564%.

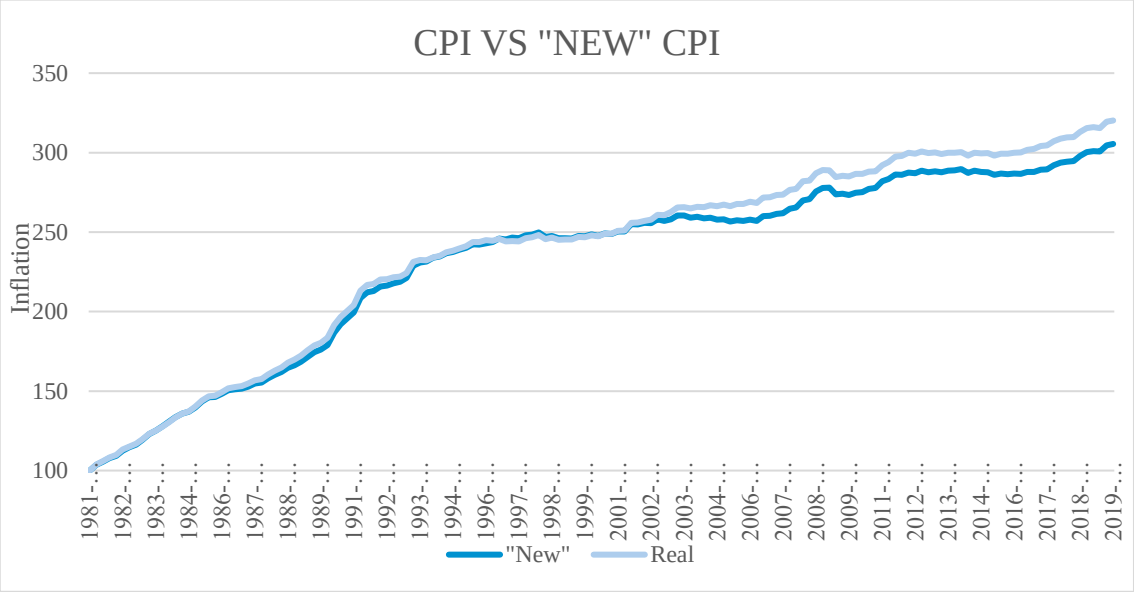

Figure 1: “New” CPI vs real CPI

Figure 2 below shows the outcome of the forecasted values for both the “new” CPI and SCB CPI against the real CPI (non-forecasted SCB). Up until 2003 Q3, the “new” CPI was in close proximity to the real CPI as it then started diverging away from the real CPI. Ever since 2003, Q3 the “new” CPI has shown a lower value compared to the real CPI.

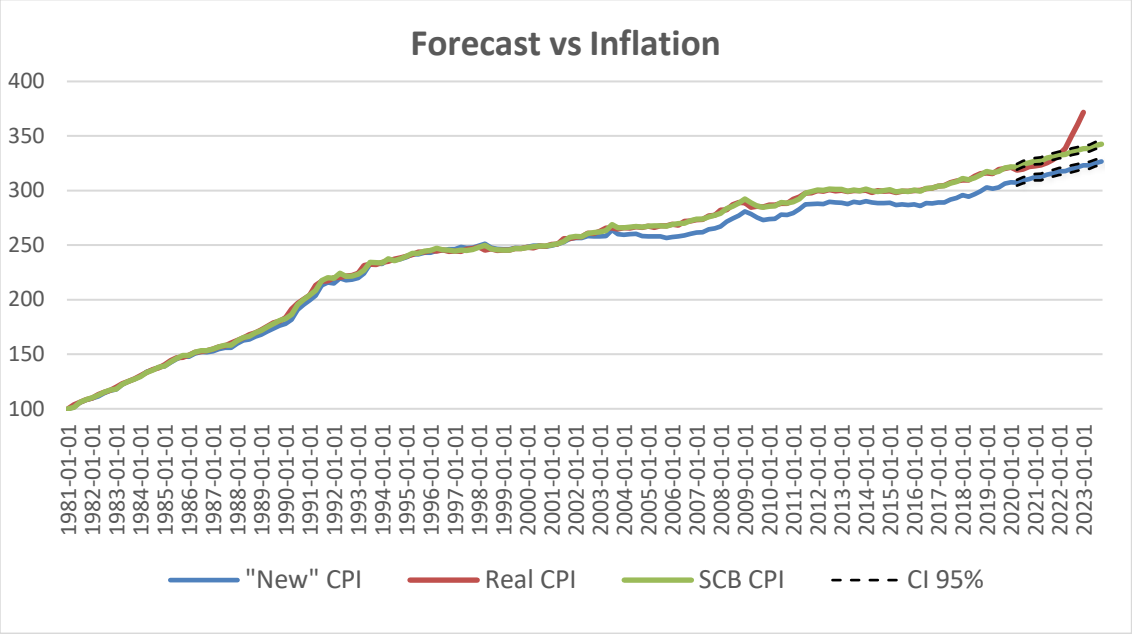

Figure 2: Forecasted CPIs vs real CPI with CI of 95%

Looking at Figure 3 showing the difference between the forecasted CPIs one can see the divergence between the two CPIs. From the figure, one can also see that the gap between the "new" CPI and SCB CPI was over -5 % between 2016 Q3 and 2018 Q3. The trend of the forecasted values from 2020 is upward-sloping. Meaning that the gap between the two forecasted CPIs will become larger over time. To quantify in terms of SEK, the paper calculated the given and forecasted difference between the "new" CPI and the real CPI on study grants, unemployment compensation, and total M3 money supply.

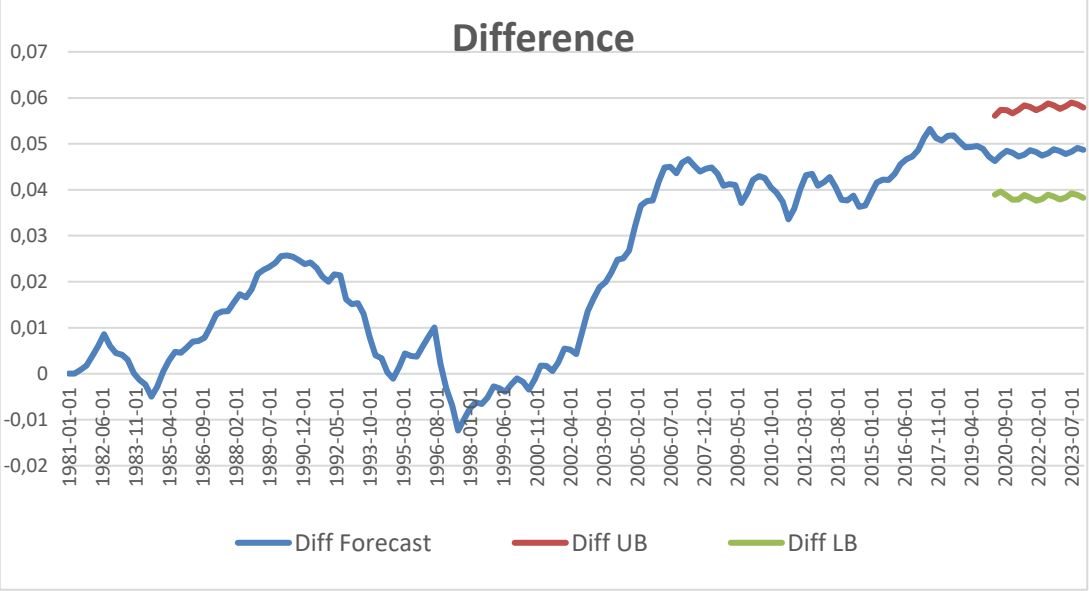

Figure 3: Difference between forecasted "new" CPI and SCB CPI.

Table 1 of the total amount of study grants the CSN has paid out, showed a total of 194072.2 MSEK or 194.0722 billion during the school years 2001/2002 and 2021/2022. This can be compared to 185652.48 MSEK or 185.65248 billion SEK of the total amount of study grants based on the "new" CPI calculation. This means that a total of 8.41972 billion SEK or 4.54 % differentiates the two CPIs in terms of study grants. The lower and upper bound is used just to clarify the margins for the "new" CPI as it is based upon the forecasted values of the "new" CPI and not the given values as in Figure 1. Given that the information on the amount of the study grants for 2022/2023 is not yet known, the number might be higher or lower depending on the lower and upper bound.

Table 1: Total study grants paid and the difference with the "new" CPI. (*Source: SCB and own calculations*)

Year	Total CSN Payment in (MSEK)	Difference in MSEK	% Diff	Difference LB	Difference UB	"New" CPI (MSEK)
2001/2002	7195.80	80.84	1.12%			7114.96
2002/2003	7545.70	156.30	2.07%			7389.40
2003/2004	7511.30	226.12	3.01%			7285.18
2004/2005	7456.70	297.86	3.99%			7158.84
2005/2006	7252.70	325.64	4.49%			6927.06
2006/2007	7429.70	332.90	4.48%			7096.80
2007/2008	7472.30	313.60	4.20%			7158.70
2008/2009	7883.90	326.72	4.14%			7557.18
2009/2010	9029.60	357.95	3.96%			8671.65
2010/2011	8911.90	351.94	3.95%			8559.96
2011/2012	9103.20	383.54	4.21%			8719.66
2012/2013	9242.10	362.14	3.92%			8879.96
2013/2014	9583.70	377.55	3.94%			9206.15
2014/2015	9628.50	419.76	4.36%			9208.74
2015/2016	9335.90	455.45	4.88%			8880.45
2016/2017	9292.70	481.37	5.18%			8811.33
2017/2018	9448.60	480.59	5.09%			8968.01
2018/2019	10887.40	531.14	4.88%			10356.26
2019/2020	12193.80	407.42	3.34%	283.23	520.18	11786.38
2020/2021	14047.80	484.68	3.45%	547.42	837.15	13563.12
2021/2022	13618.90	1266.20	9.30%	1901.43	2210.76	12352.70
Total	**194072.20**	**8419.72**	**4.54%**			**185652.48**

Inspecting Table 2 instead of the total amount of unemployment compensation, a total of 17282 MSEK or 17.282 billion SEK differentiates the two CPIs. The percentage difference of 3.8% is lower than the study grants, this is due to the data having 2 more years of observations. The observed difference from 2020 to 2023 is based on the forecasted value and the difference with the real CPI. The result could therefore differ if the lower or upper bound is considered.

Table 2: Total unemployment compensation and the difference with the "new" CPI. (*Source: The Swedish Unemployment Insurance Inspectorate and own calculations*)

Year	Total Unemployment Payment in (MSEK)	Difference in MSEK	% Diff	Difference LB	Difference UB	"New" CPI (MSEK)
1999	30781.1	-67.1	-0.2%			30848.2
2000	27824.9	44.5	0.2%			27780.5
2001	22264.9	112.4	0.5%			22152.5
2002	22677.0	397.1	1.8%			22279.9
2003	28465.2	688.3	2.4%			27776.9
2004	32614.1	1169.4	3.6%			31444.7
2005	31188.6	1376.1	4.4%			29812.5
2006	26918.2	1231.3	4.6%			25686.8
2007	19437.5	861.6	4.4%			18576.0
2008	13591.8	533.8	3.9%			13058.0
2009	19561.5	848.8	4.3%			18712.7
2010	17615.4	635.9	3.6%			16979.5
2011	13111.8	564.3	4.3%			12547.5
2012	13710.2	565.0	4.1%			13145.1
2013	14632.9	543.8	3.7%			14089.1
2014	13385.2	555.4	4.1%			12829.8
2015	12738.5	583.5	4.6%			12155.0
2016	12516.7	649.4	5.2%			11867.4
2017	12245.0	633.4	5.2%			11611.6
2018	12826.2	639.4	5.0%			12186.8
2019	14317.9	684.7	4.8%			13633.2
2020	24595.1	808.0	3.3%	571.3	1049.2	23787.1
2021	21369.0	1050.9	4.9%	832.7	1273.4	20318.1
2022	14397.5	2172.0	15.1%	2010.1	2337.2	12225.5
Total	**472786.2**	**17282.0**	**3.8%**			**455504.2**

Finally reviewing Table 3 of the total M3 supply, the total difference of 34081907.1 MSEK or approximately 34.082 trillion SEK equals a percentage change of 4.923%. The tremendous amount stated isn't per se the main result. As stated before, the result could differ if the confidence interval is considered.

Table 3: Total M3 supply and the difference with the "new" CPI. (*Source: SCB and own calculations*)

Year	Total M3 Supply (MSEK)	Difference in MSEK	% Diff	Difference LB	Difference UB	"New" CPI (MSEK)
1995	8 585 209	74588.5	0.87%			8 510 621
1996	9 430 523	-86346.0	-0.92%			9 516 869
1997	9 809 042	-61915.6	-0.63%			9 870 958
1998	10 169 464	-30326.6	-0.30%			10 199 790
1999	12 797 836	-27900.7	-0.22%			12 825 737
2000	13 950 424	22301.5	0.16%			13 928 122
2001	14 184 898	71601.8	0.50%			14 113 296
2002	14 491 314	253753.7	1.75%			14 237 560
2003	15 111 321	365391.6	2.42%			14 745 929
2004	15 491 839	555469.7	3.59%			14 936 369
2005	16 895 467	745481.8	4.41%			16 149 985
2006	19 567 238	895075.9	4.57%			18 672 162
2007	22 754 125	1008596.6	4.43%			21 745 528
2008	24 795 602	973833.6	3.93%			23 821 768
2009	25 299 853	1097813.3	4.34%			24 202 040
2010	25 751 100	929636.8	3.61%			24 821 464
2011	26 610 361	1145274.7	4.30%			25 465 086
2012	28 346 985	1168244.7	4.12%			27 178 740
2013	29 018 686	1078350.0	3.72%			27 940 336
2014	30 203 511	1253293.0	4.15%			28 950 218
2015	32 224 863	1475992.9	4.58%			30 748 870
2016	34 917 571	1811542.3	5.19%			33 106 028
2017	38 322 302	1982343.7	5.17%			36 339 959
2018	40 417 799	2014871.8	4.99%			38 402 928
2019	43 258 274	2068671.5	4.78%			41 189 602
2020	49 269 664	1618591.2	3.29%	1144396.8	2101807.5	47 651 072
2021	55 396 951	2724386.8	4.92%	2158741.9	3301260.2	52 672 565
2022	59 347 594	8953288.5	15.09%	8285954.3	9633923.0	50 394 306
Total	**726 419 816**	**34081907.1**	**4.92%**			**692 337 909**

7. VALIDITY

Given the subjective nature of the method, this chapter will provide different calculations for the used method and analyze it further.

Given Table 1 in the appendix, the patent variable isn't significant and does give the method lower credibility. Despite this, the method gives reasonable arguments why this variable is included and important to consider.

Given the equal straight weights given in the method, one can change the weight and evaluate the impact of the "new" CPI. The weights that will be examined are the three variables: Patent, TFP, and Wage. Because the weights are divided into two time periods, the weight change will therefore be simple. The three variables will be given a strong weight in turn to compare the outcome. The weights will be specified in changes so that the first number of every weight is the first change and so on. These weights will be specified as:

$\omega p_t = weight\ of\ patent\ 1981 - 1993\ Q1 = 0{,}9; 0{,}1; 0{,}5$

$\omega f_t = weight\ of\ TFP\ 1981 - 1993\ Q1 = 0{,}1; 0{,}9; 0{,}5$

$\rho w_k = \ weight\ of\ wage\ 1993\ Q1 - 2020 = 0{,}05; 0{,}05; 0{,}9$

$\rho p_k = \ weight\ of\ patent\ 1993\ Q1 - 2020 = 0{,}9; 0{,}05; 0{,}05$

$\rho f_k = \ weight\ of\ TFP\ 1993\ Q1 - 2020 = 0{,}05; 0{,}9; 0{,}05$

The result from the different weights is shown in Figure 4 – 6. Looking at Figure 4 showing the first change we can see that giving the patent more weight would result in a bias towards a higher inflation measurement. This is mainly because of the positive correlation (see Equation 2 and Table 1 in the Appendix) but also the increases in patents over time. The difference between the two CPI resulted in a positive difference of 8.984% in 2019 Q4.

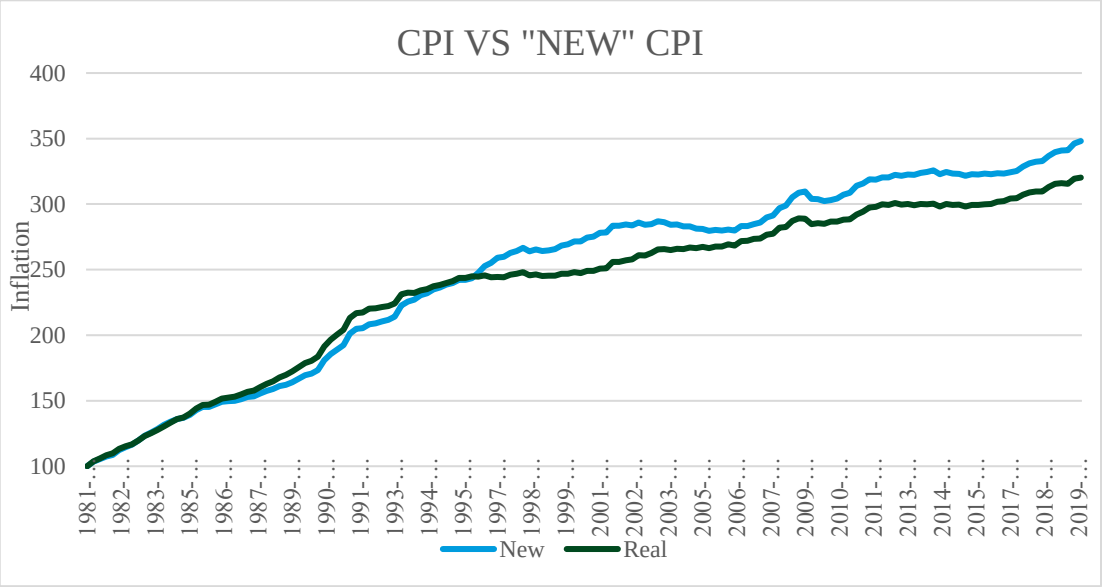

Figure 4: "New" CPI with weight change 1 vs real CPI. (*Source: Own calculations*)

Looking at Figure 5 shows the second change of weights, giving the most weight towards TFP, resulting in a smoother CPI. The smoothness indicates that the change in TFP is very close to the change in CPI. The gap of -2.087% demonstrates that the "new" CPI was lower than the real CPI at the end of 2019.

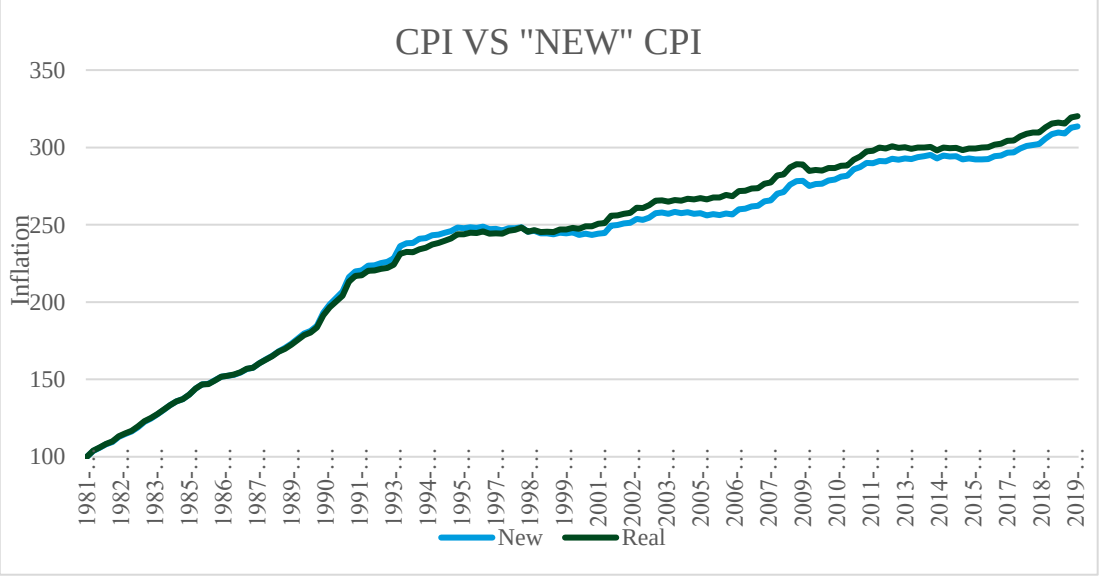

Figure 5: "New" CPI with weight change 2 vs real CPI. (*Source: Own calculations*)

Finally reviewing Figure 6 showing the last change of weight giving the most weight towards wages the result is very different. Because the data started from 1993, the previous data (patent and TFP) was weighted the same but was changed when the wage data started. The result shows how the wage has a very negative impact on the calculation, giving a bias to the downside. The gap extended to -18.623% and does confirm the correlation table (Table 1 Appendix).

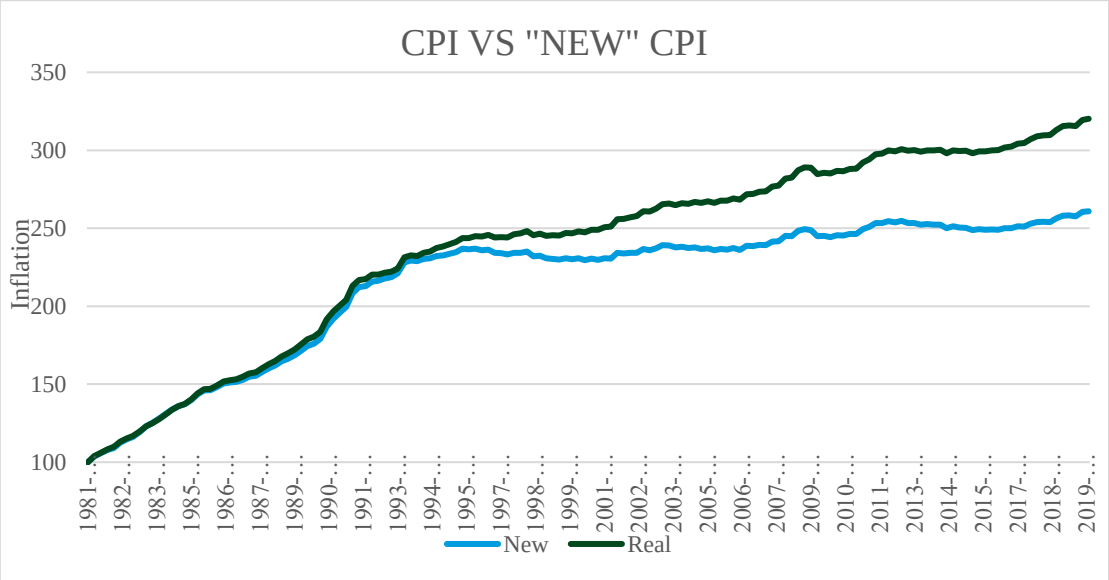

Figure 6: "New" CPI with weight change 3 vs real CPI. (*Source: Own calculations*)

An important choice is whether to apply equal weight or weight of the components. It is crucial to note that the "new" CPI only considers three aspects: patents, TFP, and wages. Even if the variables might not be ideal technical considerations for the CPI, the "new" CPI is a step to capture more. The variables were chosen subjectively and might not accurately reflect how much technology has improved products and services. The effect of technology on pricing could be better explained by other factors and should be evaluated in further studies.

Additionally, not every case will call for an equally weighted approach. As mentioned in Malladi and Fabozzi (2017), it has been demonstrated to perform better than a value-weighted strategy in some situations, however, the ideal weighting strategy may change depending on the context and the analysis's objective. As a result, it's crucial to consider various weighting systems and investigate the possible effects of extra variables when including technical aspects in the CPI. Reflecting on the influence of technology on pricing, this might result in a more precise and thorough assessment of inflation.

8. DISCUSSION

To arrive at reasonable monetary policy decisions, an accurate inflation assessment is required. This paper contributes to the current research on inflation measurement by presenting a new Consumer Price Index (CPI) for Sweden. The purpose of this study is to compare the traditional CPI to a self-created CPI in the short and long-run to effectively monitor inflation and assess the "new" CPI's effects on Swedish monetary policy choices. The research contributes by evaluating a potential inflation measurement index, which may increase the accuracy of inflation measurement, and provide policymakers with more data to make successful monetary policy decisions.

8.1. COMPARISON OF THE MORE ACCURATE CPI

While using the "new" CPI may give a more accurate indication of inflation in Sweden, the effects of this move will rely on how policymakers interpret and apply it. The lower inflation rate suggests a more cautious approach to monetary policy, which might be useful in reducing inflationary pressures.

Even though the "new" CPI differs from the conventional CPI, its primary focus is still on consumer prices. One can argue that the “new” CPI is closer to the PPI than the CPI, due to the "new" CPI having some underlying features that act more towards a PPI. However, the two indexes do have some notable differences from one another.

While the “new” CPI measures the prices consumers pay, the PPI measures the prices that producers receive for their goods and services. As a result, the “new” CPI is primarily concerned with changes in pricing for completed products and services, and the PPI is more directly linked to changes in input costs, such as raw materials and labor.

8.2. IMPLICATIONS ON NKPC

The findings of the "new" CPI research may have consequences for the NKPC. If the "new" CPI proves to be a more accurate indicator of inflation, the link between inflation and unemployment suggested by the NKPC may need to be reevaluated. If the "new" CPI regularly registers lower levels of inflation than the conventional CPI, it may suggest that the economy can support lower rates of unemployment without provoking inflationary pressures.

This might have a significant impact on monetary policy. If the NKPC relationship is weaker than previously believed, central banks could be able to sustain lower

unemployment rates for longer periods without running the danger of rising inflation. On the other hand, if the conventional CPI is a stronger indicator of inflation, the NKPC may still hold, and central banks would have to act more swiftly to raise interest rates to counter inflationary pressures.

8.3. IMPACT ON MONETARY POLICY

In recent years, the inflation in Sweden has been very high and caused Riksbanken to make necessary decisions to control inflation. The "new" CPI's lower estimate of inflation means that the Riksbank wouldn't have to increase interest rates as rapidly or much as it would have with the current CPI. This might result in long-term growth from this conservative approach, which might keep the economy from overheating and facing inflationary pressures.

The inflation target set by the Riksbank would also be questioned if the “new” CPI was used as the measurement of inflation. If a new inflation goal lower than 2% is chosen, the adoption of the "new" CPI might have substantial impacts on monetary policy. As previously indicated, compared to the previous CPI, the "new" CPI predicts a lower estimate of inflation. This suggests that if a lower inflation target was established, it could be simpler to achieve with the "new" CPI as it would imply that inflation is already lower than expected.

It's however feasible that the "new" CPI will understate inflation even more if a lower inflation target is established. A lower inflation goal would suggest that central banks would have less ability to cut interest rates in reaction to economic shocks, which might have detrimental effects on the economy.

If policymakers set a new inflation target greater than 2%, the "new" CPI may also have implications. Because the "new" CPI estimates lower inflation than the traditional CPI, it may imply that the central bank may be more flexible in its monetary policy. For example, by maintaining interest rates lower for longer periods without inducing inflationary pressures.

However, setting the new inflation target too high may have negative consequences also. A weakening in the central bank's credibility and a raising danger of inflation expectations becoming unstable. A higher inflation goal may also result in higher nominal

interest rates and a decline in the real value of savings, all of which could be harmful to the economy in the long run.

8.4. GOVERNMENT BUDGET IMPLICATIONS

The difference between the two CPIs may also have consequences for the government budget. For instance, the variance in the cost of study grants between the two CPI computations may indicate that there is room in the budget for a potential saving. The savings might be used for other purposes within the government budget, such as infrastructure or healthcare spending. The reallocation of such resources would need to be decided politically, which could lead to conflicting objectives for government spending.

8.5. EFFECTS ON DIFFERENT SEGMENTS OF SOCIETY

Moreover, the use of the "new" CPI may have varying effects on various segments of society, leading to biases. Those who receive study grants, for example, may be negatively influenced by the lower inflation rate because the value of their grants may decrease over time relative to the actual cost of living. Those who own assets such as stocks and real estate, on the other hand, may gain from the reduced inflation rate since their holdings may increase more in real terms.

8.6. BIASES IN THE “NEW” CPI

Because the "new" CPI calculations are subjective, they may add biases of their own. As discussed in the previous chapter, the variables and weights assigned cause changes in the computed inflation rate. Furthermore, the "new" CPI can underestimate inflation since it may not truly represent changes in consumer preferences and the quality of products and services purchased.

The implementation of the "new" CPI may also influence household and corporate inflation expectations. If the "new" CPI is universally accepted, people's inflation expectations may be adjusted to match the lower rates suggested by the "new" CPI, resulting in lower inflation expectations and perhaps lower actual inflation. As a result, the economy could become more stable and monetary policy more predictable.

Although the subjective character of the "new" CPI computations may lead to biases, the possible benefits of this technique must be considered. The traditional CPI is frequently criticized for not accurately reflecting the real cost of living since it does not consider changes in the quality of goods and services or changes in consumption habits. This might

lead to an overestimation or underestimating of inflation, which can have major ramifications for monetary policy choices.

The "new" CPI tries to address some of these issues by using a more subjective methodology. The "new" CPI may provide a more reliable estimate of inflation and a better understanding of the real cost of living by considering additional components reflecting changes in the quality of products and services. By continuing to develop and enhance the methodology behind the "new" CPI, it may be able to reduce this bias and provide a robust way of measuring inflation.

9. CONCLUSION

This paper's study shows that the "new" CPI has lower overall inflation than the traditional CPI adopted by the SCB. Based on the findings, the "new" CPI has a larger negative θt over time, implying lower inflation. The trend of the forecasted values from 2020 is upward-sloping, implying that the difference between the two forecasted CPIs would widen with time. This would make the current CPI forecast more inflationary than the “new” CPI. In terms of student loans, unemployment benefits, and the overall M3 money supply, the analysis demonstrates that there is a sizable difference between the "new" CPI and the conventional CPI. The current CPI leads to more costs for the government and influences inflation further.

Answering the paper's questions regarding if and how the use of the “new” CPI influences monetary policies in Sweden, one can conclude that it will have a conservative approach. Indicating that not considering technology will lead to over-estimation of inflation and incorrect monetary policy. Using the “new” CPI may lead to a more stable monetary policy as the view changes.

Some potential recommendations to policymakers and SCB would be that the SCB should update the CPI regularly to ensure that it remains an accurate estimate of inflation. Ideally having a composite technology and quality index to adjust the CPI, but also assessing the weights assigned to various components and adjusting the basket of products and services.

Because inflation expectations have a big influence on actual inflation, policymakers should keep a careful eye on them. Inflation may decrease if individuals and companies change their behavior under the expectation that inflation would remain low.

Policymakers should also acknowledge the natural uncertainty in projecting inflation and adjust their approach appropriately. This includes being willing to change direction if fresh data contradicts their initial assumptions, as well as being open with the public about the limits of their forecasting models.

APPENDIX

Table 1

Variables	(1)	(2)	(3)	(4)
(1) CPI	1.000			
(2) Patent	0.081	1.000		
(3) TFP	-0.210*	-0.004	1.000	
(4) Wage	-0.552*	0.041	0.420*	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Table 1: Correlation matrix of technology indicators (eqn 2) variables (*Source: STATA*)

Figure 1

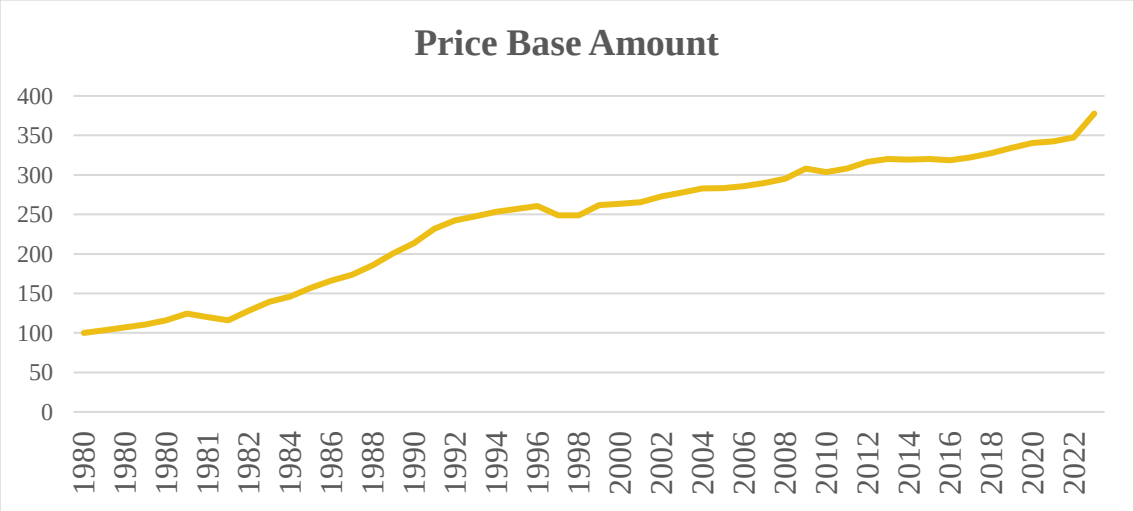

Figure 1: Price Base Amount in Sweden from 1980 – 2023 (*Source: SCB*)

Figures 2-4

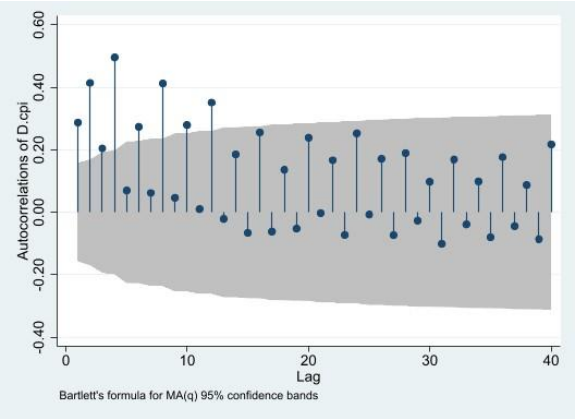

Figure 2: ACF of the "new" CPI (*Source: STATA*)

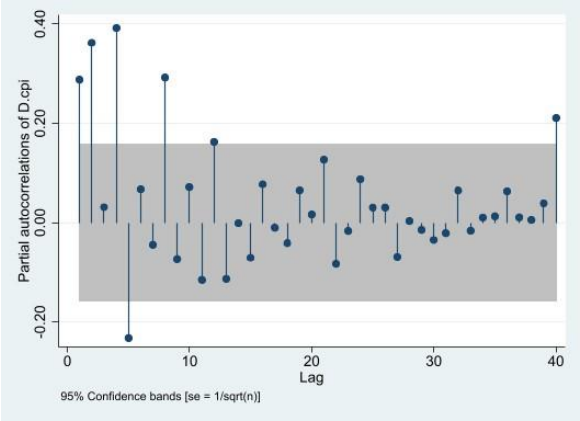

Figure 3: PACF of the "new" CPI (*Source: STATA*)

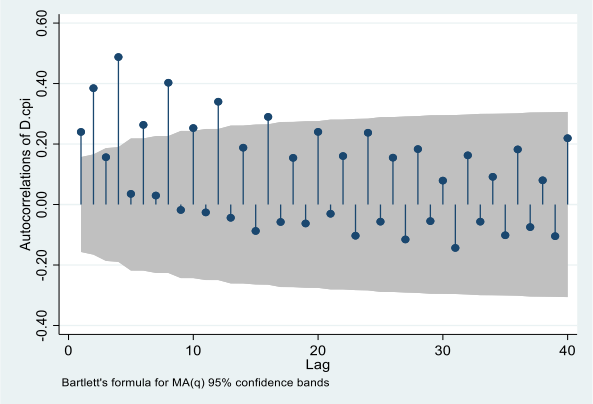

Figure 3: ACF of the SCB CPI (*Source: STATA*)

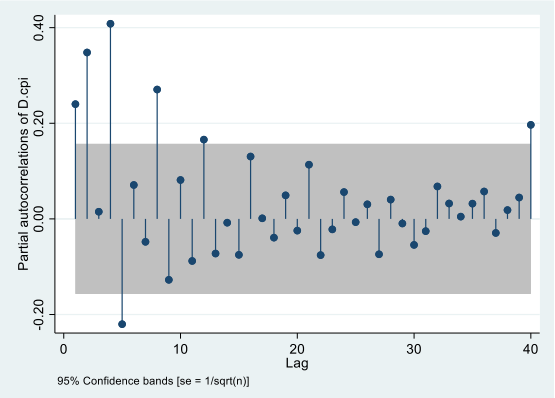

Figure 4: PACF of the SCB CPI (*Source: STATA*)

Table 2: Model estimation and model diagnostic testing “new” CPI

ARIMA	SigmaSQ	Log-likelihood	Akaike	Bayesian
1,1,1	1.604	-295.2658	598.5315	610.731
1,1,2	1.504	-285.8331	581.6662	596.9155
1,1,4	1.519	-286.9518	587.9037	609.2527
2,1,1	1.48	-283.1833	576.3667	591.6159
2,1,2	1.445	-279.4738	570.9477	589.2468
2,1,4	1.394	-274.157	564.3141	588.7129
4,1,1	1.39	-273.6859	561.3719	582.7209
4,1,2	1.387	-273.2682	562.5363	586.9352
4,1,4	1.343	-269.5254	559.0507	589.5493
BEST	4,1,4	4,1,4	4,1,4	4,1,1

(*Source: STATA*)

Table 3: Model estimation and model diagnostic testing SCB CPI

ARIMA	SigmaSQ	Log-likelihood	Akaike	Bayesian
1,1,1	1.611	-295.9295	599.8591	612.0585
1,1,2	1.486	-283.886	577.7721	593.0214
1,1,4	1.529	-287.9546	589.9092	611.2582
2,1,1	1.474	-282.5455	575.091	590.3403
2,1,2	1.444	-279.4162	570.8324	589.1315
2,1,4	1.39	-273.6611	563.3222	587.7211
4,1,1	1.388	-273.4105	560.821	582.17
4,1,2	1.38	-272.8178	561.6355	586.0344
4,1,4	1.35	-269.2651	558.5302	589.0287
BEST	4,1,4	4,1,4	4,1,4	4,1,1

(*Source: STATA*)

Figures 5 and 6

```
Portmanteau test for white noise
---------------------------------------
Portmanteau (Q) statistic =     19.8780
Prob > chi2(40)           =      0.9968
```

Figure 5: Portmanteau test SCB CPI (*Source: STATA*)

```
Portmanteau test for white noise
---------------------------------------
Portmanteau (Q) statistic =     20.9647
Prob > chi2(40)           =      0.9943
```

Figure 6: Portmanteau test "new" CPI (*Source: STATA*)

Figures 7 and 8

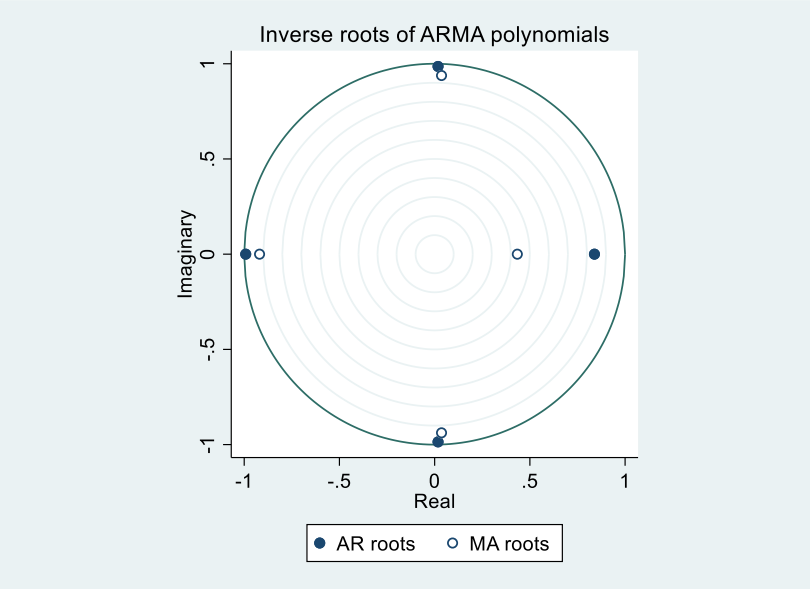

Figure 7: AR stability and MA invertibility test SCB CPI (*Source: STATA*)

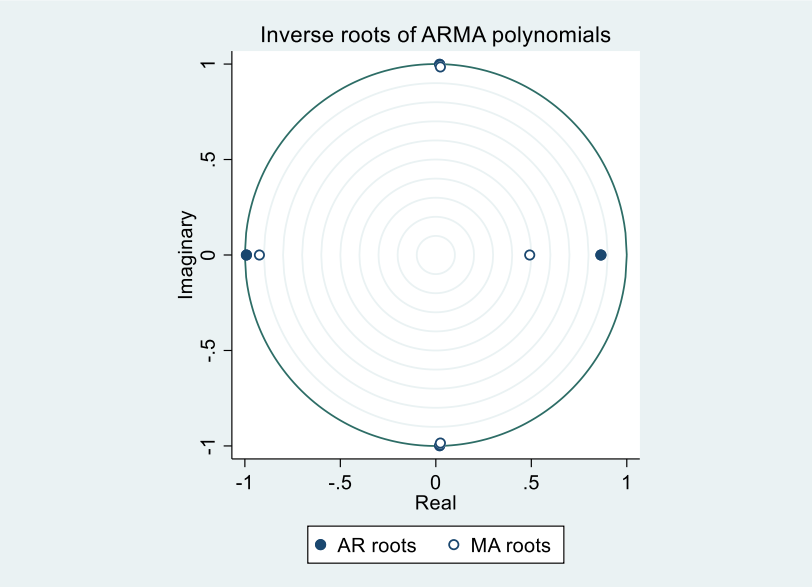

Figure 8: AR stability and MA invertibility test "new" CPI (*Source: STATA*)

Mathematical Formulas for the Indices

Laspeyres Price Index Formula

$$P_L = \frac{\sum Pi_t \times Qi_0}{\sum Pi_0 \times Qi_0} \times 100$$

Paasche Price Index Formula

$$P_P = \frac{\sum Pi_t \times Qi_t}{\sum Pi_0 \times Qi_t} \times 100$$

Fisher Price Index Formula

$$P_F = \sqrt{P_L \times P_P}$$

Where Pi equals the price of the observed item i, Qi equals the quantity of the observed item i, and t is the observed time period.

REFERENCE LIST

Akaike, H. (1978). On the Likelihood of a Time Series Model. *Journal of the Royal Statistical Society. Series D (The Statistician)*, *27*(3/4), 217-235. https://doi.org/10.2307/2988185

Box, G. E. P., & Pierce, D. A. (1970). Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models. *Journal of the American Statistical Association*, *65*(332), 1509-1526. https://doi.org/10.1080/01621459.1970.10481180

Braithwait, S. D. (1980). The substitution bias of the Laspeyres price index: An analysis using estimated cost-of-living indexes. *The American Economic Review*, *70*(1), 64-77.

Clarida, R., Gali, J., & Gertler, M. (1999). The Science of Monetary Policy: A New Keynesian Perspective. *Journal of Economic Literature*, *37*(4), 1661-1707. https://doi.org/10.1257/jel.37.4.1661

Dalén, J., & Haglund, M. (1999). *Betänkande av Utredningen om översyn av konsumentprisindex Stockholm 1999* (1999:124). KB. https://weburn.kb.se/metadata/933/SOU_7652933.htm

Diewert, E. (2004). The economic approach to index number theory: the single-household case. *Consumer Price Index Manual–Theory and Practice, Genève*, 313-335.

Edvinsson, R., & Söderberg, J. (2010). *The evolution of Swedish consumer prices, 1290–2008*. Riksbanken. https://www.riksbank.se/globalassets/media/forskning/monetar-statistik/volym1/8.pdf

Eliasson, J., Hillström, E., Nordin, M., Ottosson, M., & Tongu, C. (2021). *Prisindex för mobiltelefoner och datorer med fast korg*. SCB. Retrieved 2023-02-15 from https://www.scb.se/contentassets/1b48f2064ebd46a78eda4d68d51c0403/prisindex-for-mobiltelefoner-och-datorer-med-fast-korg.pdf

Eliasson, J., & Nordin, M. (2022). *Ändringar i KPI från och med 2022*. SCB. Retrieved 2023-02-15 from https://scb.se/contentassets/d1f974c3e55d4ff39fa6314fc211980c/andringar-i-kpi-fran-och-med-2022_220218.pdf

Eurostat. (2018a). *Glossary: Laspeyres price index*. Retrieved 2023-03-29 from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Laspeyres_price_index

Eurostat. (2018b). *Glossary: Paasche price index*. Retrieved 2023-03-29 from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Paasche_price_index

Eurostat. (2023). *Harmonised Indecies of Consumer Prices (HICP)*. https://ec.europa.eu/eurostat/web/hicp/faq

Graf, B. (2020). *Consumer Price Index Manual, 2020: Concepts and Methods*. International Monetary Fund. https://doi.org/10.5089/9781484354841.069

Groshen, E. L., Moyer, B. C., Aizcorbe, A. M., Bradley, R., & Friedman, D. M. (2017). How Government Statistics Adjust for Potential Biases from Quality Change and New Goods in an Age of Digital Technologies: A View from the Trenches.

Journal of Economic Perspectives, *31*(2), 187-210. https://doi.org/10.1257/jep.31.2.187

International Labour, O., Organisation for Economic Co-operation and, D., International, M., World, B., & United, N. (2004). *Producer price index manual: Theory and practice*. International Monetary Fund.

Malladi, R., & Fabozzi, F. J. (2017). Equal-weighted strategy: Why it outperforms value-weighted strategies? Theory and evidence. *Journal of Asset Management*, *18*(3), 188-208. https://doi.org/10.1057/s41260-016-0033-4

Menz, J.-O., Wieland, E., & Mehrhoff, J. (2023). Estimating the impact of quality adjustment on consumer price inflation.

Regeringskansliet. (2022). *Prisbasbelopp för 2023 fastställt*. Retrieved 2023-03-14 from https://www.regeringen.se/artiklar/2022/09/prisbasbelopp-for-2023-faststallt/

Riksbanken. (1990). *Riksbankens inflationsmål – förtydliganden och utvärdering*. Retrieved 2023-03-29 from https://archive.riksbank.se/pagefolders/2012/inflationsmal.pdf

Riksbanken. (2015). *Digitiasion and inflation*. Retrieved 2023-02-25 from https://archive.riksbank.se/Documents/Rapporter/PPR/2015/150212/rap_ppr_ruta4_150212_eng.pdf

Riksbanken. (2023). *ARTICLE – The new Riksbank Act and the monetary policy framework*. Retrieved 2023-03-14 from https://www.riksbank.se/globalassets/media/rapporter/ppr/fordjupningar/engelska/2023/230209/the-new-riksbank-act-and-the-monetary-policy-framework-article-in-monetary-policy-report-february-2023.pdf

SCB. (2023a). *Quality declaration, Consumer Price Index*. Retrieved 2023-03-02 from https://www.scb.se/contentassets/a1e257bb3a574420b9d3f2ff59851c0a/pr0101_kd_2023-eng.pdf

SCB. (2023b). STATISTIKENS FRAMSTÄLLNING Konsumentprisindex. https://www.scb.se/contentassets/a1e257bb3a574420b9d3f2ff59851c0a/pr0101_staf_2023.pdf

Shapiro, M. D., & Wilcox, D. W. (1996). Mismeasurement in the Consumer Price Index: An Evaluation. *NBER Macroeconomics Annual*, *11*, 93-142. https://doi.org/10.1086/654295

Singh, V. P., Pandey, M. K., Singh, P. S., & Karthikeyan, S. (2020). An Econometric Time Series Forecasting Framework for Web Services Recommendation. *Procedia Computer Science*, *167*, 1615-1625. https://doi.org/https://doi.org/10.1016/j.procs.2020.03.372

SOU. (1943). *Betänkande angående levnadskostnadsindex*. Retrieved 2023-02-16 from https://weburn.kb.se/metadata/694/SOU_1428694.htm

The Swedish Social Welfare Board. (1961). *Consumer Prices And Index Computations 1931-1959*. Retrieved 2023-02-20 from https://share.scb.se/OV9993/Data/Historisk%20statistik/SOS%201911-/Priser%20och%20konsumtion/Konsumentpriser%20och%20indexber%C3%A4kningar%20(SOS)%201931-1994/Konsumentpriser-och-indexberakningar-1931-1959.pdf

Triplett, J. E. (2002). The mismeasurement hypothesis and the productivity slowdown: The evidence. *Productivity, Inequality, and the Digital Economy: A Transatlantic Perspective*, 19-46.

Tsay, R. S. (2000). Time Series and Forecasting: Brief History and Future Research. *Journal of the American Statistical Association*, *95*(450), 638-643. https://doi.org/10.2307/2669408

Turvey, R. (1989). *Consumer price indices : an ILO manual*. ILO.

U.S. BUREAU OF LABOR STATISTICS. (2020). *Frequently Asked Questions about Hedonic Quality Adjustment in the CPI*. Retrieved 2023-06-05 from https://www.bls.gov/cpi/quality-adjustment/questions-and-answers.htm

Viet, V. Q. (2011). A review of the Use of Price Index in National Accounts. *Vientiane: United Nations Statistics Division*.

Chapter 2, Section 1, Sveriges Riksbank Act (2022:1568).

https://rkrattsbaser.gov.se/sfst?bet=2022:1568