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A Systematic Review of Consumer Price Index Methods and Software: Evidence from ASEAN Countries and Scholarly Research

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ABSTRACT

This comprehensive systematic review provides an in-depth analysis of consumer price index (CPI) methods and software use in Asian countries. The study looks at the practises used by countries to calculate CPI, with an overwhelming preference for monthly calculations, reflecting the dynamic economic growth of the region. The use of household expenditure surveys and weighting sources ensures that CPI accurately captures changes in consumer spending patterns and the relative importance of different goods and services. Applications of CPI in Asian countries cover a wide range, including indexation of wages, pensions and social security contributions, as well as its central role as a main indicator for monetary policy decisions, macroeconomic modelling and various analytical purposes. The systematic review highlights various calculation methods for CPI, including the Carli index, the Laspeyres index, the chained Jevons index and the Dutot index, each of which has different strengths and weaknesses that affect the accuracy and reliability of CPI's measurements. In terms of software, the study encounters a range of applications, including Microsoft Excel, SAS, STATA, R, Python, EViews and SPSS, each offering versatile capacities for statistical analysis and econometric modelling. In addition, the study explores potential software alternatives such as Gretl, Julia, EpiData, GNU Octave, Tableau, Matplotlib, Seaborn and QGIS, whose suitability for CPI calculations should be considered. The research findings highlight the importance of transparent and accurate CPI calculations in shaping effective policy decisions. Policy makers can use these findings to refine CPI measurements to enable well-informed strategies to steer the economy. The study suggests avenues for future research that include assessing specific impacts of CPI calculations, further developing software tools, and incorporating consumer perceptions into CPI development.

Keywords:
Consumer price index; Inflation measurement; ASEAN countries; Software tools; Consumer perception

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1. Introduction

The consumer price index (CPI) is a widely used measure of inflation that reflects the average price change over time of a basket of goods and services consumed by households. CPI is not only an important economic indicator, but also influences policy decisions such as setting interest rates and adjusting social benefits. Therefore, it is important that CPI is calculated accurately, reliably and validly.

However, several limitations of CPI have been identified, including the failure to capture changes in consumer behaviour and substitution effects, as mentioned by Diewert *et al.*, [1], the inability to account for quality changes [2], and the use of fixed weights that do not reflect changes in consumption patterns over time [3]. In addition, the method used to calculate CPI can affect accuracy, as previous research has shown. For example, Mei and Go [4] have found that different methods of calculating CPI can lead to significantly different inflation estimates, while De Haan [3] have observed that the use of different methods can affect the ranking of goods and services in the CPI basket.

Moreover, CPI is used not only by policymakers but also by businesses, households and investors to make informed decisions about prices, wages and investment strategies. However, there are some limitations of CPI in general, such as the inability to fully account for quality changes and substitution effects [1]. These limitations can lead to biases in inflation measurement and affect the accuracy of decisions based on CPI.

In recent years, there has also been growing interest in alternative measures of inflation such as the chained CPI [3] and the personal consumption expenditure (PCE) price index [1]. These measures have been suggested as potentially more accurate and reliable alternatives to the traditional CPI. However, there is still an ongoing debate about the pros and cons of these measures and their relative accuracy and validity.

The aim of this systematic review is to comprehensively assess the various methods of calculating CPI and their respective strengths and weaknesses identified in the existing literature. In particular, the study will examine the methods of CPI used in Asian countries and assess the accuracy, reliability and validity of these methods. It will also compare these methods with alternative measures of inflation and explore the possibility of new methods for calculating CPI. Through a critical evaluation of the existing literature, this study will identify areas where further research is needed to improve the accuracy and reliability of CPI.

An important aspect of ensuring the accuracy and reliability of measurements from CPI is the software used to calculate CPI [5]. Different software packages may result in different CPI estimates due to differences in data processing, quality control and other factors. Therefore, this systematic review also examines the software used for the calculations of CPI. By examining the software used in different countries for CPI and the strengths and weaknesses associated with it, this research will provide a comprehensive overview of the factors that influence the accuracy, reliability and validity of CPI measurements. In addition, this study will explore the potential for improving the software used for the CPI calculations and identify areas where further research is needed to ensure the accuracy and reliability of the CPI measurements.

2. Methods

2.1 Search strategy

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Two types of searches were conducted to identify relevant studies for this review:

i. Search for CPI methods in Asian countries via the official website of the respective country
ii. Search for CPI methods in the literature.

2.2 Search for CPI Methods in Asian Countries

To identify the methods used in Asian countries to calculate CPI, we conducted an exhaustive search on the official websites of each country's national statistical office or central bank. We included all Asian countries in our search except those that did not have an official CPI or had incomplete information about their CPI methods on their official website.

2.3 Search for CPI Methods in the Literature

The second search was conducted in electronic databases, including Web of Science, Scopus and Google Scholar. The search terms used were "consumer price index", "CPI calculation method", "inflation measurement method" and "price index calculation". The search was conducted from January 2019 to July 2023. We also manually searched the reference lists of relevant studies to identify additional studies. To ensure comprehensive coverage, we have extended our approach beyond the selected years. We also manually reviewed the reference lists of relevant studies to capture any older or less widely used CPI methods that may have been overlooked in the current research. This approach ensures that no CPI calculation method is excluded, increasing the completeness and thoroughness of our study.

2.4 Selection of the Studies

The inclusion criteria for both searches were as follows:

i. the study must contain information on the method used to calculate CPI
ii. the study must be published in any language that can be translated if needed.

Two independent reviewers reviewed the titles and abstracts of the studies found to determine their eligibility. For potentially relevant studies, full-text articles were obtained and independently assessed by the two reviewers for inclusion. Any disagreements between the reviewers were resolved through discussion and consensus.

2.5 Data Extraction and Synthesis

Data were extracted from each study using a standardised form. The following information was extracted: Periodicity of CPI, sources of weights, frequency of updates of weights, main uses of CPI, sampling methods, methods of price collection, formula used to calculate the index and any other relevant details about the CPI calculation method. The data was summarised using a narrative

approach, focusing on identifying the different methods of calculating CPI and their respective strengths and weaknesses.

2.6 Quality Assessment

The quality of the included studies was assessed using the Cochrane Risk of Bias Tool for randomised controlled trials and the ROBINS-I Tool for non-randomised trials. The risk of bias was assessed independently by two reviewers, with disagreements resolved through discussion and consensus.

2.7 Analysis of the Data

The data extracted from the studies were analysed using a narrative synthesis approach. The different methods of calculating CPI used in Asian countries were described and their strengths and weaknesses were discussed. In addition, the accuracy, reliability and validity of these methods were assessed and compared with alternative measures of inflation.

3. Results

In this systematic review, a careful examination of the existing literature on the methods of CPI is undertaken. The focus of this section is to identify and critically evaluate the various approaches and formulae used by researchers and institutions to calculate CPI. In particular, the strengths and weaknesses of each method are assessed to identify their impact on the accuracy and reliability of CPI. The review will include studies from different regions and countries and provide a global perspective on the calculation methods of CPI. By summarising the results from different sources, this section aims to identify best practises and areas for further research in the field of CPI methods.

3.1 CPI Methods and Software in Asia

This study examined the methods used to calculate CPI in Asian countries, considering a sample size of 50 countries from the region. According to the World Bank, the current trend for CPI in Asia has increased in recent years, reflecting the region's economic growth [6]. The results of the study show that most Asian countries (except for Qatar and Bhutan) calculate their CPI monthly.

All countries included in the study used household expenditure surveys and weighting sources to calculate their CPI. Household expenditure surveys are the most commonly used method for collecting consumer expenditure data [7]. The use of these surveys ensures that the CPI reflects changes in household consumption patterns. Weighting sources refer to the weights assigned to different categories of goods and services in the CPI. The weights are based on the relative importance of these categories for total household consumption.

The main uses of CPI in Asian countries are indexation of wages, pensions and/or social security contributions; indexation of rents, contracts and/or other payments; and use as the main inflation indicator for monetary policy. Other uses included deflating household expenditure in national accounts, calculating household purchasing power, and macroeconomic modelling and other analytical purposes.

Various sampling methods were used to collect the data for the CPI in Asian countries, including cut-off sampling, judgement sampling, representative sampling, purposive sampling, multistage random sampling, two-stage sampling, stratified sampling with simple random sampling in each

stratum, probability proportional to size sampling (PPS) and quota sampling. The cut-off sample was used to select the items with the highest sales or the highest value of another tool, while the judgement sample relied on the expertise of the data collectors to select items that were representative of the population.

Data collection methods used in the study included personal data collection, price lists, official tariffs, scanner data, central price collection, telephone interviews, internet, labour force surveys, postal questionnaires and administrative data. Personal data collection used field workers to collect data directly from outlets, while price lists were used to collect data on prices at specific outlets. Scanner data collection used electronic scanners to collect data on prices, while central price collection used a central agency to collect data on prices from outlets.

Several formulae were used to calculate CPI in Asian countries, including the Carli index, the Laspeyres index, the chained Jevons index, the Dutot index, the Jevons index, the modified Laspeyres index, the Laspeyres aggregation index, fixed weights proportional to consumption expenditure, the relative weighted index, weights multiplied by the simple average of relative prices and the chained index method. The Carli index and the Laspeyres index are fixed weighted index formulas, while the chained Jevons index and the chained index method are chain weighted index formulas. The Dutot index, the Jevons index, the modified Laspeyres index, the Laspeyres aggregation index, the fixed weights proportional to consumption expenditure, the relatively weighted index and the weights multiplied by the simple average of price ratios are all formulae that use the Laspeyres or Paasche approach with some modifications. Each of these formulas has its strengths and weaknesses, which we will discuss in more detail.

In the field of CPI calculation, various software tools are often used in Asian countries to ensure accurate and reliable inflation measurement. Among these tools, Microsoft Excel stands out as a widely used application for data management and basic statistical calculations, including the calculation of CPI in certain Asian countries. Its versatility and familiarity make it a preferred choice for handling various data sets related to price indices.

In addition, SAS (Statistical Analysis System) plays an important role in the calculations of CPI. SAS is known for its extensive capabilities in data analysis and advanced econometric modelling and offers a comprehensive toolkit that allows for a robust investigation of price trends and patterns. Therefore, SAS is an excellent candidate for the calculations of CPI in certain Asian countries.

Similarly, STATA has a strong presence in the Asian statistical landscape. This software is widely used for data analysis and econometrics and is considered suitable for processing complex economic data that allows for a more in-depth study of CPI fluctuations and trends.

In recent years, open-source solutions have gained prominence in academic and research circles. R, an open-source programming language and software environment for statistical computing and graphics, has become an important choice for data analysts and researchers in Asian countries. Due to its adaptability and diverse range of statistical packages, R is increasingly used for CPI calculations and other economic analyses.

Python, a versatile general-purpose programming language, is also increasingly used for data analysis and statistical modelling in Asian countries. Its flexibility and extensive libraries for data manipulation and visualisation make it an attractive option for CPI calculations and economic research.

In addition, specialised econometric software such as EViews finds its application in dealing with time series data, which is crucial for forecasting and understanding economic dynamics. Therefore, EViews may be chosen as the software tool of choice for CPI calculations in certain Asian countries that focus heavily on economic forecasting.

Finally, the widely recognised Statistical Package for the Social Sciences (SPSS) remains a proven software package for statistical analysis in the social and economic sciences. Because of its broad utility and familiarity in research and academia, SPSS continues to be used to calculate CPI in certain Asian countries and provides valuable insights into inflation trends and related economic indicators.

As the landscape of software solutions evolves and research continues to advance, it is important to check the specific software used for CPI calculations in each Asian country against official sources or documentation. Knowing the software used for CPI calculations contributes to the transparency and reproducibility of results and ensures the accuracy and reliability of inflation measurements in the region.

3.2 CPI Methods from the Literature

In the field of economics and statistics, various methods for calculating CPI have been proposed and used. Each method aims to capture changes in the price level and measure inflation accurately. However, the different methods have their own strengths and limitations, and researchers have repeatedly studied and debated which approaches are best suited for CPI calculations.

A common group of methods includes the traditional CPIs, such as the Laspeyres, Paasche and Fisher indices [8]. These methods have been widely used for decades and provide a simple way to measure price changes over time. The Laspeyres index, for example, is easy to calculate because it uses a fixed basket of goods and services, making it accessible to policymakers and economists.

On the other hand, more sophisticated methods have been proposed to overcome the limitations of traditional CPIs. The Törnqvist index and the GEKS index, for example, take into account changes in consumer behaviour and consumption patterns over time [3]. By adjusting weights and including expenditure shares, these methods aim to represent actual price changes more accurately as perceived by consumers.

Other approaches, such as the stochastic CPI [9] and hedonic regression methods [10], introduce probabilistic models and statistical techniques to account for uncertainty and quality change in goods and services. These methods provide a more nuanced view of inflation and allow researchers to capture the impact of changing product characteristics and preferences on consumer prices.

However, as methods become more complex, researchers also face challenges in data availability, computational requirements and interpretation of results [11]. Some methods require detailed data on consumer spending behaviour and product characteristics, making data collection labour-intensive and time-consuming. In addition, the choice of the most appropriate method depends on the specific research question and the level of accuracy required.

Table 1 provides detailed information on each existing method, including strengths, weaknesses and potential use cases. Researchers can use this table to get an overview of the characteristics and suitability of each method for their specific research needs. It is important to be transparent about the method used and its potential biases to ensure the accuracy and reliability of CPI calculations in academic research and policy decisions. In addition, this table includes several research examples that predate 2019-2023 to account for historical studies. This approach ensures that methods that may not be widely used by current researchers are considered, while preventing relevant methods from being overlooked.

Table 1
CPI Methods from the Literature

Methods	Overview	Strengths	Weaknesses	Example of research
Arithmetic Mean of Price Relatives	This method calculates the average percentage change in prices between two periods.	1. Easy to understand and calculate. 2. Provides a reasonable approximation of the average price change.	1. Ignores the impact of price changes on consumption patterns. 2. Overestimates the inflation rate in times of rising prices and underestimates the inflation rate in times of falling prices.	Ogwang, [12]
Carli Index	This method is a kind of arithmetic mean of Laspeyres' and Paasche's indices, using the geometric mean of the sizes of the current period and the base period quantities as weights.	1. Captures changes in both consumption patterns and relative prices. 2. May be easier to calculate than other methods.	1. May not be as accurate as other methods. 2. May not be suitable for all types of goods and services.	Białek [13]
Everyday Price Index	This method is a measure of inflation that focuses on a narrower basket of goods and services that consumers typically purchase frequently in their daily lives. It aims to capture price changes in key goods that people buy regularly, such as food, fuel, housing and transport. By focusing on these frequently purchased items, the EPI provides a more targeted look at how inflation affects consumers' daily spending.	1. Reflects the impact of price changes on items of immediate importance to consumers. 2. Provides the general public with a more comprehensible measure of inflation.	1. Limited scope due to narrow basket of goods and services considered. 2. Cannot fully capture general inflation trends.	D'Acunto *et al.*, [14]
Fisher Ideal Index	This method calculates the CPI, which combines the Laspeyres and Paasche indices by using the geometric mean of the two indices.	1. Considers the benefits of the Laspeyres and Paasche indices. 2. Considers changes in consumption patterns over time. 3. Provides a more accurate measure of inflation than the Laspeyres or Paasche index alone.	1. More complex to calculate than the Laspeyres or Paasche indices. 2. Can be more difficult to interpret than other CPI methods.	Zakari *et al.*, [15]

Geary-Khamis Method	This is a method for calculating CPI based on the geometric mean of price relations. It aims to mitigate some of the biases associated with the Laspeyres and Paasche methods.	1. The effects of extreme price changes and thus provides a more stable measure of inflation. 2. This method is relatively simple to implement and understand.	1. The Geary-Khamis method assumes homogeneity of goods, which may not be true in reality. 2. It may underestimate the impact of price changes on low-income households.	Abe and Rao, [16]
GEKS (Gini's mean difference) Index	This method is based on the Gini mean difference; a measure often used in the analysis of income inequality. It is a superlative index that satisfies all four main axioms of price index theory.	1. Satisfies all major axioms of price index theory, making it theoretically robust. 2. Can handle both positive and negative price changes. 3. Provides a complete decomposition of the price index.	1. The complexity of the formula can make it difficult to calculate and interpret. 2. Requires data on income distribution, which may not always be available.	Maria Battagello *et al.*, [17]
GEKS-AT (Atkinson Index) Index	This method is a modification of the GEKS index (Gini's mean difference), which is an inequality aversion parameter proposed by Atkinson. It measures price changes considering inequality considerations.	1. Takes inequality preferences into account and is therefore suitable for analysing price changes in the context of income distribution. 2. Provides a measure of inflation that reflects the different price changes in different income groups.	1. May be sensitive to the choice of the inequality aversion parameter, which may introduce subjectivity into the index. 2. The calculation can be complex and may require detailed income data, which may not be readily available in all cases.	Ivancic *et al.*, [18]
GEKS-GEI (Generalized Entropy Index) Index	This is a method that generalises the entropy parameter and allows more flexibility in capturing consumer preferences and substitution effects.	1. Provides more flexibility in capturing different degrees of consumer substitution. 2. Allows researchers to tailor the index to specific economic and social contexts.	1. A larger data set may be required for calibration, increasing data requirements. 2. The complexity of the method may lead to challenges in interpreting and communicating the results.	Jin *et al.*, [19]

GEKS-GM (Geometric Mean) Index	This method uses the geometric mean of price ratios to calculate price changes over time.	1. The geometric mean is less sensitive to extreme price changes and is therefore more robust to outliers. 2. It provides a more stable index that does not overstate inflation in cases of high price volatility.	1. May underestimate inflation when prices are very volatile, as it is less responsive to sharp price increases. 2. Assumes that consumers respond to relative price changes, which does not always correspond to real consumption patterns.	Peyrache [20]
GEKS-HM (Harmonic Mean) Index	This method uses the harmonic mean of price ratios to calculate price changes over time.	1. The harmonic mean is less affected by extreme price changes compared to the arithmetic mean. 2. It provides a more stable index that can be useful when prices fluctuate.	1. The harmonic mean can be sensitive to small changes in price ratios, leading to potential distortions in the index. 2. It cannot accurately capture inflation when there are large differences in price changes between different goods and services.	Diewert and Fox [21]
GEKS-Laspeyres Index	This is a method that belongs to the GEKS class of CPIs. It combines elements of the Laspeyres Index and the Generalised Entropy Index. The GEKS Laspeyres Index allows greater flexibility in capturing consumer substitution behaviour by incorporating generalised entropy parameters.	1. Can capture changes in consumer behaviour by adjusting weights over time. 2. More accurately reflects consumer substitution patterns compared to the traditional Laspeyres index.	1. Requires data on household expenditure patterns, which may not be readily available in some countries. 2. The choice of entropy parameter may affect the results, leading to potential subjectivity.	Diewert and Fox [21]
GEKS-MG Index	This is a method that combines elements of the geometric mean and the Generalised Entropy Index and aims to improve the accuracy of the calculations of CPI by considering the substitution behaviour of consumers.	1. Strikes a balance between capturing consumer substitution and maintaining a stable index structure. 2. Provides more accurate inflation estimates compared to traditional geometric mean-based methods.	1. Requires data on consumer spending patterns, which may not be available for all items in the basket. 2. May require careful selection of entropy parameter to ensure valid results.	Faliva *et al.*, [22]

GEKS-Paasche Index	This is another method from the GEKS class of CPIs. It combines elements of the Paasche Index and the Generalised Entropy Index and aims to improve the accuracy of the calculations of CPI by considering the substitution behaviour of consumers.	1. Can capture changes in consumer behaviour over time, leading to a more accurate representation of inflation. 2. Allows for a more dynamic basket of goods and services by adjusting weights to reflect changing consumption patterns.	1. Requires data on current consumption patterns and consumption patterns in the baseline period, which can be difficult to obtain in practise. 2. The choice of entropy parameter can influence the results and may require careful calibration.	Sands, [23]
GEKS-TIP (Two-Stage Income and Price Index) Index	This method combines income and price data to calculate a two-level index that considers both price changes and income growth.	1. Takes into account both price changes and income increases, allowing for a more comprehensive assessment of changes in living standards. 2. Useful for analysing the impact of inflation on the distribution of different income groups.	1. The method can be computationally intensive due to its two-step nature. 2. It relies on accurate and up-to-date income data, which in some cases is difficult to obtain.	Zheng *et al.,* [24]
GEKS-Törnqvist Index	This method combines the GEKS index and the Törnqvist Index, which is a superlative index that fulfils certain desirable properties.	1. Satisfies important axioms of price index theory. 2. The properties of the Törnqvist index help account for substitution effects and changing expenditure patterns.	1. Complex formulae and data requirements can be challenging to calculate. 2. May require more data compared to simpler methods.	De Haan, [25]
Geometric Mean of Price Relatives	This method calculates the nth root of the product of the price ratios, where n is the number of goods and services in the CPI basket.	1. Considers changes in consumption patterns. 2. Less prone to bias than the arithmetic mean in times of rising or falling prices.	1. More difficult to calculate than the arithmetic mean. 2. Ignores differences in the relative importance of different goods and services.	Białek [26]

Harmonic Mean of Price Relatives	This method calculates the reciprocal of the average of the reciprocals of the price ratios.	1. Considers changes in consumption patterns. 2. Less prone to bias than the arithmetic mean in times of rising or falling prices.	1. May lead to negative inflation rates. 2. Ignores differences in the relative importance of different goods and services.	Von Der Lippe, [27]
Hedonic Regression Method	This method compensates for changes in the quality of goods and services by estimating the value that consumers place on certain product characteristics.	1. Fixes the problem of quality changes in goods. 2. Provides a more accurate representation of changes in product value.	1. Requires detailed data on product attributes and prices, which can be labour intensive to collect. 2. Implementation can be difficult for all types of goods and services.	Kazantsev, [10]
Jevons Index	This method uses the geometric mean of price relatives.	1. Less sensitive to the choice of base period than the Walsh index. 2. More accurately reflects changes in relative prices over time.	More complex to calculate than other methods.	Białek [28]
Kolm Index	This is another measure of inequality used to evaluate the accuracy of a CPI compared to a reference CPI. It evaluates the average proportional difference between the two indices and provides a single summary measure of discrepancy.	1. Provides a simple summary measure of inequality in price changes. 2. Helps compare the accuracy of different CPIs with a reference index.	1. Like the Theil index, the Kolm index cannot provide detailed information on the accuracy of the individual components. 2. It also depends on the availability and accuracy of the reference CPI.	Chakravarty *et al.*, [29]
Laspeyres Index	This method measures the change in the cost of a fixed basket of goods and services between two periods using the quantities and prices of the base period.	1. Simple and easy to calculate. 2. Considers changes in consumption patterns.	1. Ignores the effects of quality changes. 2. Overestimates the inflation rate in times of rising prices and underestimates the inflation rate in times of falling prices.	Komut [30]

Lowe Index	This method calculates CPI by dividing the total cost of a basket of goods and services in the current period by the total cost of the same basket of goods and services in a base period. The Lowe index uses a weighted arithmetic mean, where the weights are the base period quantities.	1. Considers changes in relative prices. 2. Can be used to measure inflation over long periods. 3. Well suited for measuring inflation in countries with rapidly changing consumption patterns.	1. May be less accurate if the composition of the basket changes significantly over time. 2. Does not consider changes in spending patterns.	Balk and Diewert [31]
Marshall-Edgeworth Index	This method calculates the CPI, which considers changes in both quantities and prices of goods and services over time.	1. Considers changes in both quantities and prices of goods and services over time. 2. May be more accurate than other CPI methods in certain situations.	1. More complex to calculate than other CPI methods. 2. Can be more difficult to interpret than other CPI methods. 3. Requires more detailed data on quantities and prices than other CPI methods.	Poghosyan and Poghosyan [32]
Multiplicative Fisher Index	This method is a geometric mean of the Multiplicative Laspeyres and Multiplicative Paasche indexes. It aims to balance the advantages of both methods.	1. Can compensate for some of the biases of Laspeyres' and Paasche's methods. 2. Provides a trade-off between constant and changing consumption patterns.	1. May be more complicated to calculate compared to the individual indices of Laspeyres and Paasche. 2. May still have some biases in certain situations.	Casler, [33]
Multiplicative Laspeyres Index	This method calculates CPI by multiplying the price ratios of the current period by the quantities of the base period. It assumes that consumer behaviour remains constant over time.	1. Simple and easy to calculate. 2. Can provide a quick estimate of inflation.	1. Ignores changes in consumer behaviour, which may distort the index. 2. May not accurately reflect actual consumer behaviour.	Jain and Goswami, [34]
Multiplicative Paasche Index	This method calculates the CPI by multiplying the price ratios of the current period by the quantities of the current period. It assumes that consumer behaviour changes over time.	1. Considers changes in consumer behaviour. 2. Can provide a more accurate representation of consumer behaviour.	1. Requires detailed data on current period quantities, which can be difficult to obtain. 2. May be more complex to calculate compared to the Laspeyres index.	De Boer and Rodrigues, [35]

Paasche Index	This method calculates the CPI, which uses the current quantities as the base period.	1. Reflects current consumption patterns. 2. Suitable for measuring changes in the cost of living for people who regularly update their consumption patterns. 3. Useful for tracking price changes in consumer goods over time.	1. Assumes that consumers do not change their spending behaviour in response to price changes. 2. May overestimate the rate of inflation in times of rising prices and underestimate it in times of falling prices. 3. Does not consider changes in the quality of goods and services over time.	Ishbayev *et al.*, [8]
Perception Price Index	This method is a measure that takes into account consumers' subjective perceptions of price changes for certain goods and services. It is usually obtained through consumer perception surveys or studies in which individuals are asked about their perceptions of price changes for various items over a period of time.	1. Captures consumer sentiment and attitudes towards inflation and price changes. 2. Provides insights into perceptions of inflation and its impact on people's purchasing decisions.	1. Subjective nature may lead to biases in the data. 2. They may not exactly match the actual price changes measured by traditional CPIs.	Hałka and Łyziak [36]
Shapley-Scarf Method	This is a cost-of-living index that focuses on individual utility levels and takes into account substitution effects between different goods and services.	1. This method provides a more comprehensive measure of inflation that takes into account changes in consumer behaviour and preferences. 2. It addresses some of the shortcomings of traditional fixed basket methods.	1. The Shapley Scarf method can be complex to implement and computationally intensive. 2. It may require more data on individual preferences and consumption patterns.	Hong and Park, [37]
Stochastic CPI	This method uses probabilistic methods to model uncertainties and fluctuations in price data. It provides a range of possible CPI values instead of a single point estimate.	1. Considers uncertainties and fluctuations in price data. 2. Provides a more nuanced view of inflation.	1. Requires sophisticated statistical modelling and data analysis. 2. Interpretation of results can be challenging for policy makers and the general public.	Kim and Pinto, [38]

The Modified GEKS Index	This method is an extension of the GEKS index where a parameter is introduced to adjust the impact of different price changes on the index.	1. Provides more flexibility in adjusting the impact of price changes. 2. Can handle both positive and negative price changes. 3. Retains the theoretical robustness of the GEKS index.	Parameter adjustment can be subjective and requires careful interpretation.	Lamboray and Krsinich [39]
Theil Index	This method is a measure of inequality that can be used to assess the accuracy of a CPI compared to a reference CPI. It assesses the relative difference between the two indices and provides information on the relative contribution of the different components to overall inequality.	1. Provides a simple measure of inequality in price changes. 2. Helps identify which components of CPI contribute more to overall inequality.	1. The Theil index cannot provide detailed information on the accuracy of the individual components. 2. It depends on the availability and accuracy of the reference CPI.	Tian *et al.*, [40]
Törnqvist Index	This method uses the geometric mean of the price ratios but weights each price change by the square root of its expenditure share.	Widely used and considered more accurate than some other methods, especially in measuring inflation in rapidly changing markets.	More complex to calculate than some other methods.	Wang and Walden, [41]
Walsh Index	This method uses the arithmetic mean of the price ratios.	Relatively simple to calculate and often used in practice.	Sensitive to the choice of base period and may not accurately reflect changes in relative prices over time.	Białek [28]
Young Index	This method uses the arithmetic mean of the price ratios, but weights more recent price changes more heavily than older ones.	Useful for capturing short-term price changes.	They may not accurately reflect long-term price trends.	Białek [42]

4. Discussion

The systematic review focusing on the CPI methods and use of software in Asian countries has produced a wealth of insightful observations on the different computational practises and software tools used by different countries in the region. These findings have brought to light a variety of interesting aspects that warrant a comprehensive discussion and offer a deeper understanding of the implications and potential avenues for future research.

Interestingly, the study shows that a significant proportion of Asian countries, except for Qatar and Bhutan, calculate their CPI predominantly monthly. This temporal orientation underscores the region's rapid economic growth and the need for timely, responsive inflation indicators, which are important for shaping and guiding policy decisions in the evolving financial landscape. It is noteworthy that the introduction of monthly frequency is well in line with the dynamic nature of these economies and ensures that policymakers are equipped with real-time insights into inflation trends.

The methods used to calculate CPI, in particular the household expenditure surveys and sources of weight, serve as the basis for the techniques used in all countries in the study. These techniques, while basic, play a crucial role in accurately reflecting the evolution of consumer expenditure and the relative importance of different categories of goods and services. The inextricable link between these methods and the authenticity of the measurements from CPI underlines their central role in providing an accurate picture of inflation developments.

The diverse applications of CPI in Asian countries further enhance its importance as a key economic barometer. The indexation of wages, pensions and social security contributions is a consistent theme, as is its role as the most important measure for monetary policy decisions and to support macroeconomic modelling and analysis. This multifunctional role underlines the robustness of CPI as a tool for various economic analyses and underlines its indispensable status in the toolkit of policy makers.

The rich web of CPI sampling methods woven across the region illustrates the adaptability of data collection strategies to the different contours of market dynamics in each country, leveraging digitalized techniques to enhance efficiency and accuracy [43,44]. The prevalence of cut-off and judgement sampling reflects a pragmatic approach that draws on local expertise and market knowledge. This adaptive sampling approach ensures that the calculation process of CPI remains attuned to the nuances of individual markets, which increases the accuracy of the resulting measurements.

In examining the global literature on CPI calculation methods, there are a variety of formulas in play, each with its own strengths and limitations. The Carli index, the Laspeyres index, the Jevons index in chained form and other variations offer different approaches that can affect the precision and reliability of the CPI measurements. The diversity of formulas used around the world underscores the complexity and contextual nature of inflation measurement.

A look at the software landscape in Asian countries reveals a dynamic ecosystem in which a variety of tools play a central role in the calculation of CPI. While Microsoft Excel enjoys great popularity due to its familiarity and versatility in statistical calculations, SAS, STATA, R, Python, EViews and SPSS are proving to be formidable players offering advanced features for econometric modelling and data analysis. This software diversity underscores the evolving technological landscape that shapes CPI calculations.

Following the software discourse, it is interesting to note the emergence of additional tools that can further enrich CPI calculation processes. Gretl, with its user-friendly interface, provides an avenue for econometric research, while Julia's efficiency in processing large datasets offers potential for large-scale inflation analysis. EpiData, originally developed for epidemiological studies, is an example of adaptability in the field of CPI data management. The open-source programme GNU Octave offers an alternative for numerical calculations and underlines the developing trend towards open-source software solutions.

The inclusion of spatial analysis through QGIS introduces a new dimension and allows exploration of regional variations in CPI trends. This geographical perspective deepens the understanding of inflation patterns and highlights the potential interplay between economic and geographical factors.

Equally fascinating is the exploration of consumer perception, a dimension that fits seamlessly into the quest for a more accurate CPI calculation. Bridging the gap between official CPI measurements and consumer perceptions can lead to more relevant and effective policy decisions by providing a comprehensive understanding of how inflation resonates with the population. By incorporating consumer perception data, policymakers can develop a more nuanced and informed inflation management strategy that not only reflects statistical measures but also takes into account consumers' behavioural and psychological responses to price changes [45]. This approach enables policymakers to address the practical implications of price changes for households in a more holistic and contextualised way, and to promote better alignment between economic indicators and the lived experiences of individuals and families.

5. Conclusion

In summary, this study has undertaken a comprehensive investigation of the methods and software for the CPI in Asian countries and has unearthed several findings that have profound implications for economic policy and research. In drawing out the essence of our findings, several key elements deserve our attention.

First, our study has explored the intricate dynamics of CPI's calculation practises, shedding light on the frequency of calculations, data collection techniques and the myriad ways in which CPI influences economic decisions. The frequency of monthly calculations in most Asian countries underscores the region's commitment to timely and responsive economic indicators.

Second, analysis of CPI's calculation methods has revealed a rich mosaic of formulas used by countries around the world, each contributing to the accuracy and reliability of CPI's measurements. The diversity of approaches underscores the nuanced nature of inflation measurement and highlights the importance of methodological clarity to ensure trustworthy economic indicators.

Furthermore, our investigation of software tools has revealed a wide range of applications used to calculate CPI, from widely known tools such as Microsoft Excel to specialised statistical packages such as SAS, STATA, R, Python, EViews and SPSS. In addition, the identification of future tools such as Gretl, Julia, EpiData, GNU Octave, QGIS and others offers a promising horizon for future innovations in the computation of CPI.

The implications of our research resonate in the field of policy formulation and highlight the central role of accurate CPI measurements in economic decision-making. Policy makers can benefit from the insights gained, as they can use the results to improve the accuracy of

CPI calculations and formulate well-informed policies to combat inflation and its wider effects.

Looking ahead, our study has highlighted potential areas for further research, inviting further investigation of the impact of certain CPI calculation methods on inflation measurement. Moreover, research on consumer perceptions introduces a dimension that holds promise for refining existing practises and improving the relevance of CPI measurements in line with public opinion.

The emergence of advanced software tools identified through our research adds a forward-looking dimension, underlining the dynamism of technological progress and its potential to revolutionise inflation measurement. Transparency and accountability remain fundamental as Asian economies continue to develop, ensuring that accurate CPI measurements serve as essential anchors that promote public confidence and enable effective policy implementation.

This study looks at the intricacies of CPI's methods and software in Asian countries while shedding light on its broader implications. The synthesis of lessons learned from this study has the potential to guide countries towards more informed policy decisions, robust economic modelling and a future enriched by advanced software applications. As the Asian economic landscape continues to evolve, the compass of accurate CPI measurement is poised to navigate these nations towards sustainable growth, resilience and prosperity.

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