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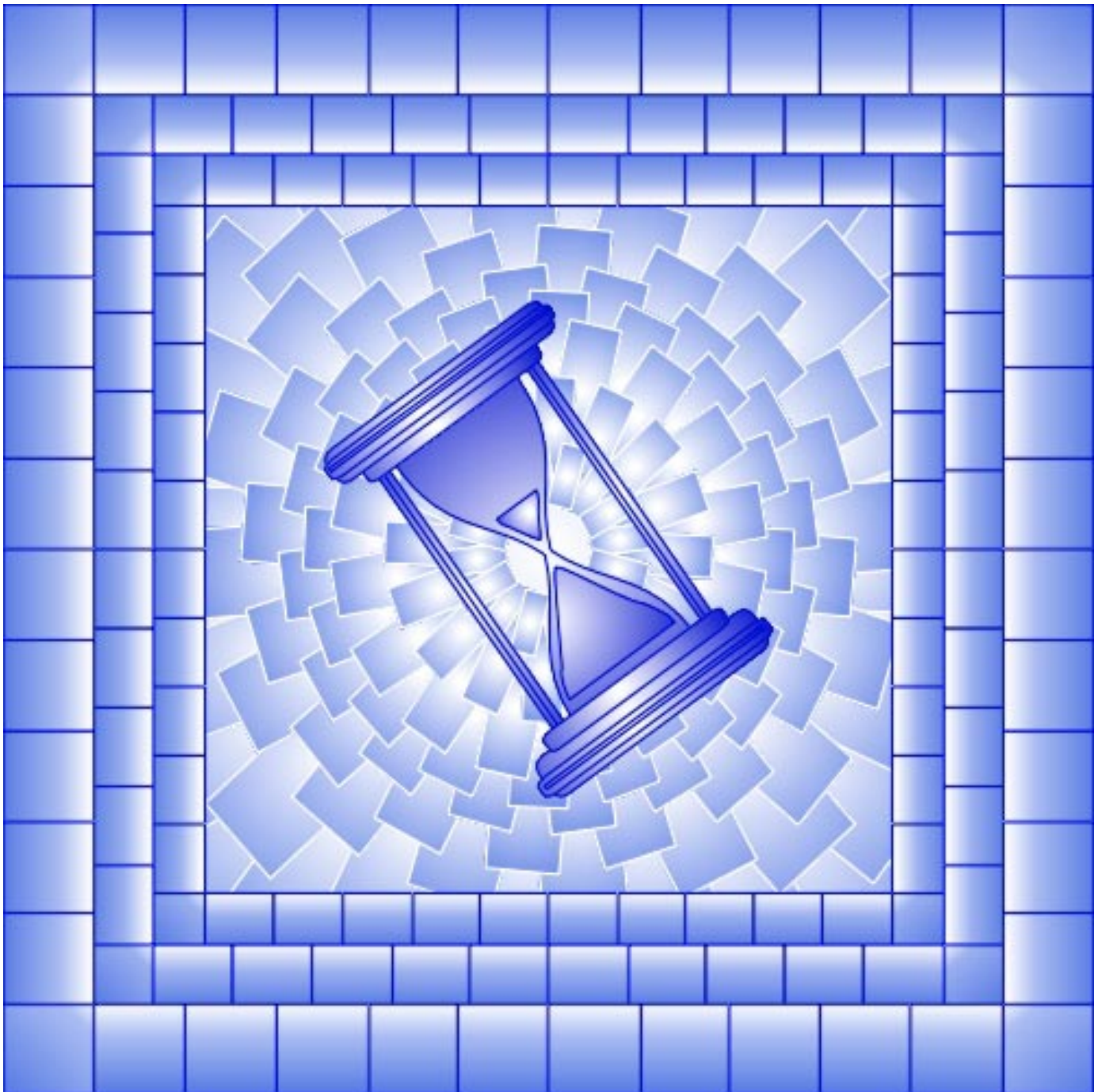
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Review of the Literature on Core Inflation

By Jacques Taillon

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Review of the Literature on Core Inflation

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Abstract

Over the years, the concept of core inflation has become of crucial importance for the central banks of various countries. Indeed, many of them have at some point been given the mandate to reduce inflation and achieve price stability. In Canada, this mandate was conferred on the Bank of Canada in February 1991.

Core Inflation is often perceived as the trend in the movements of consumer prices. This review of the literature illustrates that more than one definition of core inflation exists. Then, a brief description of the different suggested methods to measure core inflation, as well as some of their results, are shown. Finally, this review offers a bibliography of articles on core inflation.

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Review of the Literature on Core Inflation

By Jacques Taillon

1.0 Introduction

Over the years, the concept of core inflation has become of crucial importance for the central banks of various countries. Indeed, many of them have at some point been given the mandate to reduce inflation and achieve price stability. In Canada, this mandate was conferred on the Bank of Canada in February 1991.¹

The Bank of Canada recognizes that *the range of public policies besides monetary policy make a significant contribution*. But it sees its role as central when it adds that *since inflation cannot persist over an extended period without monetary accommodation for price stability to be reached, it is essential for monetary policy to work firmly and consistently to the end*.²

The targets to be achieved have primarily been formulated on the basis of the overall consumer price index. However, the Bank of Canada has stated that *for practical reasons, it will focus on the consumer price index excluding the volatile food and energy components*.³ The Bank of Canada believes that its monetary policy should not *try to offset short-run movements in the CPI caused by these fluctuations in the prices of food and energy*.⁴ And indeed, when these two components are excluded, the volatility of the consumer price index is reduced. Thus, when bad weather conditions cause a major reduction in the supply of fruits and vegetables, prices tend to move sharply upward. This phenomenon is usually temporary, and prices soon return to approximately their former level. This, then, is not a long-term inflationary phenomenon, but rather a temporary and transient one. A body responsible for monetary policy, such as the Bank of Canada, therefore avoids basing its decisions on this type of phenomenon.⁵

Thus it becomes easier to *read* movements in the consumer price index when certain more volatile components are excluded. On the other hand, it should be emphasized that the outright elimination of food and energy from the calculation of inflation means that the long-term contribution of these two components also disappears. The Bank of Canada will also exclude indirect taxes when they cause sudden fluctuations in inflation.⁶

The question that many are asking is the following: is a measure such as the CPI excluding food and energy a good indicator of core inflation? And this raises another, even more fundamental question: What is inflation?

Pierre Fortin cites a definition that Irving Fisher offered long ago.

... what is the best measure of the general price level? The great American economist Irving Fisher long ago gave us the logical answer to this question: it is the average price of all transactions carried out in the economy in a given period, whether they involve consumption goods or capital goods, inputs or outputs, intermediate or final goods, real or financial

*exchanges, domestic or foreign purchases. In this ideal price measure, each transaction would receive a weight equal to its particular monetary requirement. However, the Fisher transactions price index is so broad and would be so costly to construct that it does not currently exist in any country. Our choice of broad price index is limited by what is available. In practice, this means the much narrower price indexes calculated for final consumption or final production by central statistical agencies such as Statistics Canada.*⁷

Thus, on the basis of this definition, inflation could be seen as the upward movement of the general price level. Among all the price indices provided by the different statistical agencies throughout the world, the consumer price index offers a number of advantages. It is a measure that enjoys wide public acceptance. It is available very soon after the reference period. It is subdivided into a great number of subcomponents, which means that it lends itself to more in-depth analyses. It applies to the final stage in the chain of consumption, which theoretically (implicitly) serves to take account, to some extent, of the inflationary effect during the intermediate stages. Lastly, the CPI takes account of goods and services consumed in the reference country, regardless of the country of origin of those goods and services. It therefore reflects the experience of the residents of the country in question. It is for these reasons that the CPI is invariably the basis for all practical measures of core inflation that have been developed in recent years.

The CPI is not a perfect measure of the evolution of the cost of living for consumers. For example, because of the concept of the fixed basket, the CPI implicitly contains a bias due to the possible substitution made by consumers when a good or service becomes more or less expensive relative to other goods or services. However, most experts are generally prepared to state that the CPI is a good measure of inflation. Even Quah and Vahey, who question the CPI as an inflation measure, use it as the basis for their method.⁸

But the most important point is that, at present, there are no other measures which would be as well-accepted and which at the same time would give a more accurate picture of the evolution of prices for society as a whole. The Australian Bureau of Statistics and Britain's Central Statistical Office are currently attempting to define a broader price index framework that would provide a measure of inflation for the whole economy. However, much work remains to be done.⁹ That approach is not dealt with in this review of the literature.

2.0 Definitions of core inflation

As we saw in the introduction, the practical definition of inflation is not as obvious as it might seem at first glance. The definition of the concept of core inflation becomes even less obvious. The Bank of Canada seems to define it by extension as being the trend in the movements of consumer prices in Canada. In effect, the Bank of Canada wants to remove volatility and seasonal fluctuations. As to indirect taxes, it wants to remove their effect because of their largely unforeseeable nature.¹⁰

The various researchers who have examined the subject of core inflation give roughly similar definitions, a sample of which follows.

Bryan and Cecchetti state outright that a clear, precise and generally accepted definition of core inflation has yet to see the light of day.

*While the term core inflation enjoys widespread common use, it appears to have no clear definition. In general, when people use the term they seem to have in mind the long-run, or persistent component of the measured price index, which is tied in some way to money growth. But a clear definition of core inflation necessarily requires a model of how prices and money are determined in the economy.*¹¹

Otto Eckstein, considered by David Laidler¹² as being the originator of the term core inflation, explains the role played by demand, shocks and the evolution of production costs on core inflation.

The aggregate inflation rate has proved volatile and dominated by "surprises". Variations in aggregate demand have long been known to affect the price level, yet other factors have frequently obscured this relationship. Such shocks as energy and food price explosions or government micro policies of regulation and taxation have been seen as alternative theories of inflation...

A satisfactory theory of the inflationary process must make room for three kinds of effects. First, the state of demand affects short-term price behaviour. Second, shocks, i.e., sudden changes in particular costs, can add to the short-term inflation rate. Third, the succession of short-term demand and shock effects produces a core inflation rate which has a great propensity to persist...

*The core rate is a trend increase of the cost of the factors of production. It originates in the long-term expectations of inflation in the minds of households and businesses, in the contractual arrangements which sustain the wage-price momentum, and in the tax system.*¹³

*The core rate of inflation can be viewed as the rate that would occur on the economy's long-term growth path, provided the path were free of shocks, and the state of demand were neutral in the sense that markets were in long-run equilibrium. The core rate reflects those price increases made necessary by increases in the trend costs of the inputs of production.*¹⁴

*To have meaning, core inflation must imply persistence, for if core inflation were highly variable in response to variations in aggregate demand or aggregate supply, there would be no core on which to focus the analysis.*¹⁵

David Laidler, citing Purvis, explains that core inflation is closely related to monetary policy.

*The core inflation rate, Purvis argues, can be controlled by policy and, more specifically, by monetary policy, even though the vast majority of the literally thousands of individual pricing decisions whose outcomes it summarizes are taken without conscious reference to the stance of policy.*¹⁶

Quah and Vahey, for their part, link core inflation to the real output of the economy.

*Core inflation is defined as that component of measured inflation that has no medium- to long-run impact on real output. This definition captures the commonly held view that (moderate) movements in inflation can be benign for the real economy once financial and wage contracts have been written taking it into account.*¹⁷

In turn, Roger links the importance of core inflation to the role that New Zealand's Central Bank must play in maintaining price stability.

*A measure of underlying inflation has an important role to play both as a guideline for monetary policy and as a benchmark against which to assess the Bank's performance in maintaining price stability... The appropriate measure of underlying inflation for policy purposes, therefore, is one which is able to distinguish between one-off shocks to price arising from supply-side developments as opposed to shocks to the ongoing inflation rate arising from demand-side development.*¹⁸

*... a number of different practical definitions of underlying inflation may satisfy any reasonable interpretation of the concepts embedded in the PTA (Policy Targets Agreement).*¹⁹

*... in arriving at any practical or operational definition of underlying inflation, some elements of judgement - however sensible - are unavoidable.*²⁰

Sargent explains that core inflation is seen by some as the trend included in the inflation process.

*The first group of theories ("momentum" or "core inflation" theories) posits that there is some inherent momentum in the process of inflation itself, and that this momentum or persistence is neither superficial nor merely a reflection of slowly moving deeper forces that themselves cause inflation to behave as it does. Two distinct possible sources of sluggishness in inflation have been proposed. One is the notion of adaptive or autoregressive expectations. According to this doctrine workers and firms form expectations about future rates of inflation by computing a moving average of current and lagged rates of inflation... The other main determinant of inflation is the unemployment rate with which, by means of a Phillips curve mechanism, inflation varies inversely.*²¹

We could also apply to inflation the approach followed by Velleman in analysing data, when he states that *Much of data analysis ... consists of looking for patterns in data.*²² Velleman's approach is based on that of John W. Tukey.²³ Thus, research on core inflation could, in this case, be summarized as the search for the trend of the official measure of inflation.

And lastly, referring to Eckstein, Wilson defines core inflation as follows: *Core inflation: defined as the trend increase of the cost of the factors of production or the wage trend less the productivity trend equals the trend of unit labour cost.*²⁴ But he specifies that a major factor in

inflation (and hence of core inflation) is the belief held by the different economic actors that an inflationary trend will continue.

But a one- or two-point rise in some price index would not constitute what is generally meant by inflation, nor would its consequence be particularly serious if the change in the price index quickly reversed itself and price stability ensued. People ride out temporary storms. Thus, inflation means more than a single rise in a price index. To become and remain a problem warranting concern, inflation must involve a long succession of increases in a price index... Intuitively, however, when inflation... persists so long that the principal economic actors in the economy believe it will continue, that will define "long" or "persistent".²⁵

3.0 Measures of core inflation

The Bank of Canada uses the CPI minus food, energy and indirect taxes as its definition of core inflation. Is this the only way to estimate it? Are there other possible approaches? The fact is that this trend can be measured in various ways. Different techniques have been proposed in recent years. Some are based on economic hypotheses, others on hypotheses of a more statistical or mathematical nature. All of them call for making more or less arbitrary decisions.

Roger specifies a sizeable number of desirable characteristics of a measure of core inflation for use by a central bank.

For the Bank's internal purposes, it is important that the measure of underlying inflation does reasonably faithfully represent the concept of price stability expressed in the PTA (Policy Targets Agreement). But it is not necessary for these purposes that the measure be well understood by the public at large nor is it essential that the measure be extremely timely, as long as some timely intermediate indicator of underlying inflation exists... By contrast, for external purposes, it is very important that the measure of underlying inflation be well accepted, and that it be available in a fairly timely way... With a measure of underlying inflation in which there was a high degree of general credibility, expectations in financial and other price-setting markets will tend to be anchored better than if the measure lacks credibility... Four of the most commonly employed means of establishing credibility are: direct verifiability, indirect verification... internal incentives... track record...²⁶

These constraints should always be kept in mind by those looking for new approaches to measure core inflation. Those who do not do so will make their measure less useful in operational terms. It should also be emphasized that it is possible to have more than one measure of core inflation, each meeting different needs.

The consumer price index is always the basis for all approaches aimed at determining core inflation. Some approaches use only the CPI. Others call for the addition of other variables in their study of core inflation.

3.1 *Specific adjustment*

The goal here is to eliminate identifiable shocks that have nothing to do with the upward pressure of demand. Adjustments are made on an ad hoc basis.

According to Roger, the goal of specific adjustment is to

*purge the **headline series** of the estimated effects of specific types or sources of disturbance when they occur... (e.g. GST - Goods and Services Tax).²⁷*

Advantages

- This method will work fairly well when the relevant information is quickly available on the effects of the shock (in terms of timing and magnitude) on the general movement of prices.²⁸
- The task of eliminating “undesirable” components can be better targeted. Indeed, the effect of a shock on a subcomponent can be removed without affecting the movement of prices in the rest of the component, since the latter results from “normal” market conditions.²⁹
- The measure can be made available at the same time as the official inflation measure (the CPI).

Disadvantages

- *The method of specific adjustment... is probably better suited to dealing with generalized price level shocks than with shocks to particular prices... The more indirectly that shocks feed into the price level, the more difficult it is to make specific adjustments.³⁰*
- There is an arbitrary element to identifying supply shocks. At what point, for example, is a shock considered to be sufficiently powerful to be given special treatment?³¹

3.2 *Exclusion*

This method is used by a number of central banks in their efforts to identify core inflation. Exclusion does not necessarily apply to the same components from one country to another. In Canada, food and energy account for roughly 26% of the CPI basket. Referring to the New Zealand experience, Roger has the following to say about the subject:

***Adjustment by exclusion or replacement:** ... adjustment by exclusion lends itself to dealing with particular subcomponents of the aggregate price index whose behaviour is judged to differ frequently and significantly from the concept of trend or underlying inflation... Adjustment by exclusion, however, is not suited to purging the effects of generalized price disturbances. Nonetheless, adjustment by exclusion is the most commonly used method of defining measures of trend or underlying inflation.*

- *In the case of food, the rationale for systematic exclusion tend to rest on their susceptibility to seasonal supply disturbances making them particularly erratic or*

volatile. By excluding such prices, therefore, the remainder of the CPI should be less volatile and more representative of the general trend of prices.

- *Although energy prices and prices essentially determined by government policy may not be highly volatile, their movements, like those of food prices, may be only loosely related to demand pressures in the economy. By excluding such prices, therefore, the remaining CPI should be more representative of inflation driven by the state of excess demand pressures in the economy.*³²

Advantages

- This method is predictable, systematic and easy to understand.
- Because it is completely specified in advance, the exclusion method has great transparency; verification of the results by others is relatively easy; and analysis and forecasts are facilitated.³³
- *... may be better suited to eliminating 'noise' arising from relative price disturbances...*³⁴
- The measure can be made available at the same time as the official inflation measure (the CPI).

Disadvantages

- The exclusion method does not allow for adjustments for sudden changes in supply in components not already excluded.
- There are no objective criteria for determining which components will be systematically excluded.
- When a component is excluded, we eliminate not only the “noise” associated with this component but also the contribution of this series to the medium to long-term trend.
- *... while such a measure may be credible in the sense of being immune to central bank manipulation, it may not be credible in the sense of being widely accepted as a reliable measure of the underlying inflation concept ...*³⁵

In the case of Australia, this approach excludes 49% of the initial basket of the consumer price index. The Australian Bureau of Statistics also sees a number of advantages and disadvantages to this official measure which are basically the same as those presented by Roger.

3.3 Trimmed mean

This approach looks at the distribution of price movements at a highly disaggregated level. It excludes movements that are too extreme, leaving only those that are typical for the period concerned. It re-aggregates goods and services whose movements are typical, and the result is a measure of core inflation. This approach is fairly recent, and it appears to be attracting the interest of the official bodies of a number of countries. It is suggested by Bryan and Cecchetti.³⁶

Roger explains that

... it excludes (i.e., zero-weights) extreme, or outlier, CPI sub-component price changes... The interpretation of the trimmed-mean as a measure of underlying inflation hinges on the proposition that the extreme price movements excluded from the measure primarily reflect

*supply disturbances, while price movements closer to the centre of the price distribution primarily reflect demand pressures and inflation expectations.*³⁷

This approach will yield different results from the official inflation measure only if the movement of prices of the subcomponents exhibits an asymmetrical distribution.

Advantages

- Unlike the exclusion method, this method does not automatically exclude certain components every month.
- The calculations are simple.
- It is relatively easy to gain an intuitive grasp of this method.
- The measure can be made available at the same time as the official inflation measure (the CPI).
- The trimmed mean method is noticeably less subjective than the exclusion method. The choice of the components to be excluded is less arbitrary, since it is made on the basis of their statistical behaviour.³⁸

Disadvantages

- As in the exclusion method, part of the information in the official measure is disregarded each month.³⁹
- This method can make it more difficult to interpret core inflation in economic terms, since the mix of components included in it is never the same from one month to another.
- Deciding on the exclusion threshold is fairly arbitrary.
- This method depends on the level of disaggregation to which it is applied. As may be imagined, results may differ if highly disaggregated levels are chosen, since there is a higher likelihood of observing greater price volatility.

3.4 Weighted median

Bryan and Pyke suggested this method in 1991. It is similar to the preceding one. Both are based on the observation that the movement of prices of the different CPI components is asymmetrical.⁴⁰ The weighted median method takes the median price movement of the subcomponents of the official measure (CPI). As Bryan and Cecchetti explain, the weightings are interpreted as follows:

*... in computing the histogram for inflation in each month, we assume that the weight represents the percentage of the distribution of all prices that experienced that amount of inflation.*⁴¹

Advantages

- The weighted median method uses all the subcomponents of the CPI rather than eliminating some of them, as the trimmed mean method does.⁴²
- The calculations are simple.
- In dealing with the effects of outliers, methods based on medians are generally more robust than methods based on arithmetic means.
- The measure may be made available at the same time as the official inflation measure (the CPI).
- *Evidence suggests that periods where significant deviations of the mean from the median inflation rate are observed, are often periods where price or supply shocks are known to have occurred (Ball and Mankiw, 1992). The weighted median... may therefore be very effective in removing the volatility of such shocks.*⁴³

Disadvantages

- This method depends on the level of disaggregation to which it is applied. As may be imagined, results may differ if highly disaggregated levels are chosen, since there is a higher likelihood of observing greater price volatility.
- The use of the median is less intuitive than that of the arithmetic mean. It may be more difficult to gain public acceptance of this method.

3.5 *Vector autoregression system*

As noted earlier, Quah and Vahey define core inflation as being the component of inflation that has no impact on real output in the medium to long run. They advocate the following approach:

*The estimate of core inflation is obtained using a vector autoregression (VAR) system. We assume that observed changes in the measure of inflation (derived from the RPI - retail prices index) are affected by two types of disturbance, each uncorrelated with the other. The first of these disturbances has no impact on real output in the medium to long run. The second has unrestricted effects on measured inflation and real output, but does not affect core inflation.*⁴⁴

Advantages

- None of the preceding methods establishes a direct link with other variables of the economy. By factoring in real output, Quah and Vahey take account of the role of inflation in the economy.

Disadvantages

- Statistics on output come out after the CPI. A measure of core inflation based on the Quah and Vahey method will therefore exhibit a lag in relation to the other methods described above.
- The model is not within the grasp of the general public.

-
- As Quah and Vahey observe: *The assumption that the concept of core inflation is meaningful at all is an assumption that there is a unique core inflationary process in a macroeconomy - across all sectors and all regions. While this might, at first, seem improbable, that a common monetary base exists, provides some basis for such an assumption. That the various other shocks to the economy can be represented by one type of disturbances is, probably, a greater leap of faith. The hope is that this other type of shock represents an average of the dynamic effects of the (potentially many) underlying shocks.*⁴⁵

3.6 Core inflation model - Eckstein

Eckstein developed an econometric model of the US economy. In it, the measured inflation rate is divided into three components: core inflation, inflation related to supply shocks, and demand-driven inflation. Core inflation is represented as follows:

*The core inflation rate, or the trend in the aggregate supply price, is the weighted average of the trend rates of increase of the rental price of capital and unit labour cost.*⁴⁶

Advantages

- None of the preceding methods (except for the vector autoregression system) establishes any direct link with other variables of the economy. By adding a great number of variables such as the price trend expectation, employment, the unemployment rate, interest rates, investment, the price-dividend ratio, energy prices and investment demand ..., Eckstein takes account of the role of inflation in the economy.

Disadvantages

- As with the preceding approach, this model uses a fairly large number of variables. The results will therefore become available several periods after the reference period.
- The model is not within the grasp of the general public.

3.7 Smoothing

Different smoothing techniques may be used to identify the trend of a series. One of the best-known is the X11-ARIMA seasonal adjustment program.

Advantages

- Easy to use.
- The measure may be made available at the same time as the official inflation measure (the CPI).

Disadvantages

- The understanding of the technique is not necessarily within the grasp of the general public.
- While it is possible to use techniques based primarily on moving arithmetic means (such as X11-ARIMA), it is preferable not to do so. These techniques are heavily influenced by outliers (shocks). One way to get around this problem is to employ non-linear smoothing techniques using medians.⁴⁷
- Bryan and Cecchetti point out that

Solutions to the problem of high-frequency noise in the price data include calculating low-frequency trends over which this noise is reduced. But from a policymaker's perspective, this greatly reduces the timeliness, and therefore, the relevance of the incoming data.⁴⁸

This problem may be avoided by making forecasts at the end of the series. If these forecasts are used, the estimate of the points at the end of the series of the trend component will be current.

4.0 Some results of techniques used

In his study, Roger used several of the methods described above and obtained interesting results. He chose the following variables:

- CPI,
- CPI excluding credit service charges and changes to the Goods and Services Tax (PXIG),
- PXIG excluding the prices of fresh fruits and vegetables, fresh meat, electricity, natural gas, gasoline and other fuels,
- a trimmed mean of 10% calculated on the basis of the PXIG excluding each quarter the upper and lower 5% of the distribution of the changes of prices of subcomponents,
- a trimmed mean with 1.5 times the standard deviation calculated on the basis of the PXIG excluding each quarter the subcomponents whose price movements were greater or lesser than the mean plus or minus 1.5 times the standard deviation,
- a weighted median calculated each quarter using the 50th percentile of the price movements of the PXIG components, and
- the current core inflation measure of the Reserve Bank of New Zealand.⁴⁹

Roger obtained the following results:

The measures have all moved quite similarly over the period... all the measures show very similar turning points of inflation - none clearly leads or lags the others... Most of the measures show inflation rates nearly always below the PXIG inflation rate. The exception is the CPI excluding food and energy prices which tends to track slightly above PXIG.⁵⁰

Bryan and Cecchetti found that

Among the three limited-influence estimators we consider - the CPI excluding food and energy, the 15-percent trimmed mean, and the median - we find that the median has the strongest relationship with past money growth and provides the most accurate forecast of future inflation.⁵¹

Quah and Vahey, for their part, noted that for the vector autoregression system,

With our theory-based definition and the identifying restrictions, the following characterization of underlying inflation is obtained: first, core inflationary disturbances have little impact on the real economy even in the short run; second, 'headline' inflation (the 12-month change in the RPI) overstated inflationary pressures in the late 1980s; and third, core inflation has responded more quickly to the recent inflationary tendencies within the economy than other commonly used measures.⁵²

5.0 Conclusion

The consumer price index cannot give us more than it is capable of giving. If the CPI is not accepted at the outset as a satisfactory measure of inflation, any technique for determining core inflation on the basis of this measure will be doomed to failure.

Once we are relatively satisfied with the initial measure (that is, the CPI), there are numerous methods for extracting the essence of inflation (that is, core inflation). All these methods have their advantages and disadvantages. None seem to be unanimously accepted. It might therefore be possible to construct a measure that would be based on several of these methods or would use several of them simultaneously so as to verify that the results of these different methods are consistent with each other.

A major debate is beginning on the development of a new price index for the economy as a whole, in response to a certain dissatisfaction with the measures currently available from statistical agencies. The issue of core inflation will have to take into account that debate.

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