ISSN 1518-3548

BANCO CENTRAL DO BRASIL

Working Paper Series 266

Are Core Inflation Directional Forecasts Informative?

Tito Nícias Teixeira da Silva Filho

January, 2012

ISSN 1518-3548
CGC 00.038.166/0001-05

Working Paper Series	Brasília	n. 266	Jan.	2012	p. 1-35

Working Paper Series

Edited by Research Department (Depep) – E-mail: workingpaper@bcb.gov.br

Editor: Benjamin Miranda Tabak – E-mail: benjamin.tabak@bcb.gov.br
Editorial Assistant: Jane Sofia Moita – E-mail: jane.sofia@bcb.gov.br
Head of Research Department: Adriana Soares Sales – E-mail: adriana.sales@bcb.gov.br

The Banco Central do Brasil Working Papers are all evaluated in double blind referee process.

Authorized by Carlos Hamilton Vasconcelos Araújo, Deputy Governor for Economic Policy.

General Control of Publications

Banco Central do Brasil

Secre/Comun/Cogiv

SBS – Quadra 3 – Bloco B – Edifício-Sede – 1º andar

Caixa Postal 8.670

70074-900 Brasília – DF – Brazil

Phones: +55 (61) 3414-3710 and 3414-3565

Fax: +55 (61) 3414-3626

E-mail: editor@bcb.gov.br

Consumer Complaints and Public Enquiries Center

Banco Central do Brasil

Secre/Surel/Diate

SBS – Quadra 3 – Bloco B – Edifício-Sede – 2º subsolo

70074-900 Brasília – DF – Brazil

Fax: +55 (61) 3414-2553

Internet: <http://www.bcb.gov.br/?english>

Are Core Inflation Directional Forecasts Informative?*

Tito Nícias Teixeira da Silva Filho**

Abstract

The Working Papers should not be reported as representing the views of the Banco Central do Brasil. The views expressed in the papers are those of the author(s) and do not necessarily reflect those of the Banco Central do Brasil.

Core inflation is under attack. Empirically, experts have become increasingly disappointed with its actual performance. Theoretically, while some claim that it is a key inflation predictor others argue that, by construction, that cannot be one of its main properties, at least in the short run. Even if true, core inflation could still be useful if it provides good directional inflation forecasts. The evidence presented here using U.S., Canadian and Brazilian data shows that this does not seem to be the case. Directional forecasts are often no better than a coin toss, especially from the level model. The gap model's forecasts are wrong, on average, at least 20% of the time. More crucially, they are usually no better than a simple moving average of headline inflation.

Keywords: Core inflation, inflation, directional forecasts, supply shocks, relative prices, volatility.
JEL Classification: C43, E31, E52

* The author would like to thank Ricardo Reis, Fabio Araujo, Francisco Figueiredo, Benjamin Tabak and Wagner Gaglianone, as well as seminar participants at the XV Meeting of the Central Bank Researchers Network of the Americas in La Paz, at Gerzensee and of a workshop at the Central Bank of Brazil.
** Central Bank of Brazil. E-mail: tito.nicias@bcb.gov.br.

"It should be noted, however, that core inflation provides a useful guide to the extent that *total CPI inflation is expected to converge to core inflation*. If this were not expected to be the case, owing to anticipated persistent changes in the CPI components that are excluded from the core measure, total CPI inflation would take precedence"

(Bank of Canada (2006), page 7; emphasis added)

1 – Introduction

Despite its widespread use by both market analysts and central banks, the reputation of core inflation has been increasingly under attack among experts. Even though it has some distinguished supporters [e.g. Blinder (2006), Mishkin (2007)], a growing number of economists have become disenchanted with its actual performance. For example, after being one of its leading enthusiasts Cecchetti (2006) reached the conclusion that policymakers "… should turn their attention to forecasts of headline inflation and stop focusing on core measures." Some even claim that core inflation *cannot* be a good inflation predictor, a key property that it is supposed to have. For instance, Marques *et al*. (2003) argue that "By definition, a good predictor of future inflation must be able to account for the short-term movements on the price level, but this is exactly what we cannot or should not expect from a core inflation indicator, as it is just a summary measure of the long run characteristics of inflation." Clinton (2006) agrees and notes, for Canada, that "… after 1995, as a predictor of headline inflation, the constant 2 percent [the midpoint of the inflation target] easily beats core inflation, which has no predictive power."[1]

Indeed, the OECD (2005) analysed a variety of core measures in several countries and, in many cases, headline inflation was not even attracted to core inflation, a key property that the latter is supposed to have. Rich and Steindel (2005) found evidence for the U.S. that "… no core measure does an outstanding job forecasting CPI inflation.", while Bryan and Cecchetti (1994) found evidence that headline inflation is a better predictor of itself than the traditional (ex-food & energy) core. More disturbing evidence comes from Gavin and Mandal (2002), whose findings suggest that food prices do contain useful information about trend inflation in

[1] He argues that "Predictive power derives from ability to predict the *non-core* component. This is not a property that a useful measure of core inflation need have."

the U.S. Moreover, they find that food prices are a better inflation predictor (for inflation in the next two years) than the traditional core inflation, which exclude them. More recently, da Silva Filho & Figueiredo (2011) did not find evidence that core inflation measures calculated by the Central Bank of Brazil (BCB) add significant explanatory power over near term inflation beyond that already contained in lagged inflation. The same scepticism can be found in Bullard (2011) for the US, who argue emphatically that “It is time to drop the emphasis on core inflation as a meaningful way to interpret the inflation process in the United States.”

Not surprisingly, criticisms about the weight some central banks put on core inflation when assessing the inflationary outlook have also been growing. For example, Laidler and Aba (2000) criticised the supposedly complacent reaction of the Central Bank of Canada in face of rising headline inflation, since core inflation continued to be well behaved at the time. Buiter (2007) stated that “I believe the day is drawing closer when the Fed will recognise the folly of their focus on core inflation as a good measure of underlying inflation and as a good guide to headline inflation in the medium run. The discrepancy between reality and the Fed’s perception of reality is simply becoming too wide and obvious.” More recently, Trichet (2011) stated that “In the U.S. the Fed considers that core inflation is a good predictor for future headline inflation. In our case we consider that core inflation is not necessarily a good predictor for future headline inflation”.[2]

However, even assuming that core inflation has low explanatory power over future (magnitudes of) headline inflation its directional forecasts could still be useful. For example, if a rise in core inflation is usually followed by a rise in headline inflation, and that lead is sufficiently long so as to allow the central bank to take pre-emptive action, then it could endow policymakers with valuable information, even if it is not much of a help for quantifying those changes. In other words, if core inflation provides few false warnings about the future direction of inflation and the lead is long enough, then it could be a useful inflation leading indicator.

Policymakers value highly qualitative assessments when setting policies. Having a good idea whether inflation (or growth) will rise or not fall in the near future is crucial information in the policy-making process. For example, if inflation is near

[2] At this point it should also be noted that those few central banks that have initially set inflation targets in terms of core inflation measures have abandoned that practice and started targeting headline inflation instead, such as in Australia and New Zealand. As far as I am concerned no central bank sets its target in terms of core inflation today.

its target reliable directional forecasts are essential when the central bank decide whether it should move interest rates.

Despite the obvious importance of knowing how good core inflation's directional forecasts are, to my best knowledge such an analysis has not been done yet. This is unexpected since such type of simple "forecasting mechanism" is widely used in practice by economic agents.[3] Indeed, as argue Diebold & Lopez (1996) "Direction-of-change forecasts are often used in financial and economic decision-making." This paper fills some of that gap by trying to answer questions such as: does headline inflation rise whenever it is below core inflation, and vice-versa? Or, does an increase in core inflation *per se* precede an increase in headline inflation? If yes, how reliable is the link? And, how long is the lead? More crucially, do changes in core inflation act as a *useful* guide for monetary policy?

In order to test those hypotheses a large and rigorous forecasting exercise, which produced almost three thousand series of directional inflation forecasts, was carried out using U.S, Canadian and Brazilian data. The evidence shows that core inflation's directional forecasts are often no better than merely tossing a coin. This is particularly true when one reads changes in core inflation *per se* as signs of future developments in headline inflation. On the other hand, while forecasts based on the core gap (i.e. core inflation minus headline inflation) have better directional accuracy, in most situations they are no better than those from simple moving averages (MA) of headline inflation. More importantly, despite the superior performance of the gap model, its accuracy remains low: on average, in the best cases, forecasts are wrong at least 20% of the time, and often in 30% to 50% of the time, a dismal performance. Therefore, the evidence supports Cecchetti's (2006) and Bullard's (2011) advices.

The results are robust to different forecasting horizons, conditioning information sets, core inflation measures and countries. Also, threshold effects are taken into consideration but do not seem to be relevant to the results. Finally, combination of forecasts is also assessed but do not change the conclusions either. This is true even when all core inflation measures give the same prediction, an unexpected result.

The paper is organised as follows: Section 2 lays out the "forecasting mechanisms" behind core inflation's directional forecasts, and analyses the implicit

[3] This is particularly true when economic agents analyse gap variables. Section 2 provides other examples in this regard.

assumptions and main limitations underlying them. Section 3 uncovers key statistical evidence on the link between headline and core inflation for the U.S., Canada and Brazil and checks if they are in line with what one expects from core inflation's directional forecasts. Section 4 carries out a large and rigorous directional forecasting exercise and assesses the performance of core inflation's directional forecasts for those countries. Section 5 concludes the paper.

2 – What to Expect from Core Inflation Directional Forecasts?

In a multivariate and non-stationary world even directional forecasts often go astray. Nonetheless, this is a very common way by which economic agents forecast since it is simple and, hopefully, intuitive. For example, most economists would take for granted that inflation will rise if unemployment falls below its natural rate (i.e. negative gap) ignoring the possibility that, say, benign supply shocks could offset or even overturn the inflation pressures from a tight labour market, at least during some time.

Directional forecasting is largely employed with core inflation also, albeit there is some variation in the precise way it is used. Clark (2001, page 18; emphasis added), for example, notes that "But this simple formulation captures the predictive content of core inflation indicators ***as they are often used***. Some policymakers and analysts take movements in core inflation, by themselves, as signals of how inflation is likely to change in the future."[4]

In theory, core inflation's directional forecasts make more sense than other directional forecasts. The reason is that core inflation is *supposed* to get rid of all the inflation noise, thus controlling for the effects of short-run inflation shocks. This logic implies that one must look for a robust link between core and headline inflation in the medium-run but not in the short-run, when inflation is heavily under the influence of several idiosyncratic shocks. In the longer term, due to temporal aggregation, the effects of temporary shocks are smoothed or even cancelled out. Thus, this reasoning implies that the directional accuracy of a particular core inflation measure can provide essential clues on how well designed it is. For example, if a given core inflation

[4] The simple formulation he refers to is the following: $\pi_{t+h} - \pi_t = \alpha + \beta(\tilde{\pi}_t - \pi_t) + \varepsilon_{t+h}$, where π_t and $\tilde{\pi}_t$ are headline and core inflation, respectively. This equation is known in the literature as Cogley's equation.

measure successfully strips out the most volatile – and non-persistent – price changes then one *should* expect that it anticipates changes in *medium-term* inflation (i.e. changes in trend inflation).

Hence, even if one agrees with Marques *et al*. (2003) and Clinton (2006) on the (short-run) forecasting limitations of core inflation, it could still have relevant explanatory power over medium-long term inflation, which, in fact, is the most relevant horizon for monetary policy. Nevertheless, as already mentioned, the evidence shows that core inflation does not seem helpful as an inflation predictor even at longer horizons. Yet, as argued above, it might well be the case that core inflation's directional forecasts can still be useful to policymakers. For example, assume that inflation is closer to the lower or upper limit of a given inflation target tolerance interval. In this case having reliable information about the likely direction of inflation could be very valuable if the target is to be met.

The core inflation literature lists several desirable features and properties that a good measure of core inflation should have [see, for example, Silver (2007) and Wynne (1999)]. Overall, the literature allows one to make some simple directional statements, such as:

$$\frac{\partial \pi_{t+i}^{k}}{\partial \tilde{\pi}_{t}^{l}} > 0 \qquad (1)$$

$$\frac{\partial \pi_{t+i}^{k}}{\partial (\tilde{\pi}_{t}^{l} - \pi_{t}^{l})} > 0 \qquad (2)$$

$$\frac{\partial \tilde{\pi}_{t+i}^{k}}{\partial \pi_{t}^{l}} = 0 \qquad (3)$$

$$\frac{\partial \tilde{\pi}_{t+i}^{k}}{\partial (\tilde{\pi}_{t}^{l} - \pi_{t}^{l})} = 0 \qquad (4)$$

where $\pi_t^k \equiv \Delta_k lnP_t \equiv lnP_t - lnP_{t-k}$ and $\tilde{\pi}_t^l \equiv \Delta_l lnP_t \equiv lnP_t^c - lnP_{t-l}^c$ are headline and core inflation during period *k* and *l*, respectively, for $k, l, i = 1, 2, \ldots$, where *k* refers to the forecasting horizon, *l* refers to the conditioning period and *i* to the point in time where the forecast is made.[5] P_t and P_t^c are, respectively, headline and core inflation monthly price levels.

[5] For example, π_t^3 is quarterly headline inflation measured at period *t*, while $\tilde{\pi}_{t+3}^6$ is semi-annual core inflation measured at period *t*+3.

The first statement simply says that whenever core inflation rises (falls) an increase (decrease) in headline inflation should ensue, since core inflation captures the "true" trend of inflation and trends are, to a lesser or greater degree, persistent. On the other hand, according to statement three, the opposite is not true, that is, increases (decreases) in headline inflation do not signal future increases (decreases) in core inflation. The second statement is more restrictive: inflation will rise (fall) only if core inflation lies above (below) headline inflation. In this case a rise in core inflation will not necessarily imply an increase in headline inflation. Finally, statement four says that discrepancies between core and headline inflation are uninformative about future core inflation, since it must be temporary and, therefore, unlikely to affect the trend. The idea behind conditions two and four is that core inflation should act as an attractor to headline inflation, but not the reverse.

As argued above, and also noted by Clark (2001), such inflation forecasting mechanisms, albeit simplistic, are widely used by economists. Two obvious related questions at this point are: What are the shortcomings of such types of mechanisms? How reliable forecasts from such mechanisms are in practice? Appendix 1 shows the implicit assumptions (and limitations) behind equations (1) to (4).

3 – Preliminary Statistical Evidence

What kind of statistical patterns one should or could expect from directional predictions such as above? The claim that core inflation is a lousy headline inflation predictor in the short run but a good one in the medium run suggests a hump-shaped cross-correlation function (CCF). In the same way, the claim that core inflation should not respond to lagged inflation would imply no significant cross-correlation between core inflation and lags of inflation. The same reasoning applies to conditions (2) and (4) above, except that one should look now at the relation between inflation (core inflation) and the core gap (i.e. core inflation minus headline inflation).

In order to check if this is really the case evidence from three different countries is assessed. The first is the U.S., where core inflation is closed watched by both the Fed and the market. The second is Canada where it acts as the operational target for monetary policy, attesting its utmost importance. The third one is Brazil, which sharply differs from the other two countries by its history of high and volatile inflation. The period analysed for the U.S. and Canada goes from 1995.1 to 2008.12, while for Brazil it begins in 1996.1 and ends in 2008.12.[6]

Since in addition to the CPI (CPIUS) the PCE (PCEUS) also plays a central role in Fed's monetary policy their cores will be analysed. More precisely, the ex-food and energy (CPIUS-EX) and the median (CPIUS-MED) cores are evaluated for the CPI, while the ex-food and energy core (PCEUS-EX) is assessed for the PCE. As to the Canadian CPI (CPICAN), the core that excludes its eight most volatile items as well as the effect of changes in indirect taxes (CPICAN-EX) – used as the operational target for the Canadian inflation targeting regime (see Macklem, 2001) – is analysed. Finally, for Brazil six cores are analysed: the first three measures originally calculated by the BCB, named here EXCORE (exclusion core), TMCORE (trimmed mean core), and STMCORE (smoothed trimmed mean core), and three other measures calculated by da Silva Filho and Figueiredo (2011), named IPCAEX1, IPCAEX2 and IPCADW.[7,8]

Figure 1 in Appendix 3 plots the cross-correlations between the PCEUS and the PCEUS-EX for the U.S, between the CPICAN and CPICAN-EX for Canada, and between the IPCA and both the STMCORE the IPCAEX2 for Brazil.[9] As can be seen, none of the four CCFs are hump-shaped. On the contrary, the correlation between inflation and lagged core inflation is initially high and dies out very quickly, with the exception of the STMCORE, which has longer memory.[10]

However, one marked difference between the U.S. and Canada on the one hand and Brazil on the other hand is the degree of "inflation persistence". While in Brazil inflation is significantly cross-correlated with lagged core inflation up to around the fourth or fifth lag (the STMCORE is more persistent), in the U.S. and

---

[6] Although the sample refers to the post-stabilisation period in Brazil, in which inflation was much lower than historical levels, it remained well above rates found in industrial countries. Indeed, while the annual average inflation rate in Brazil was 6.7% during that period, it was 2.4% in the U.S. (CPI) and 2.0% in Canada.

[7] IPCAEX1 and IPCAEX2 are two others exclusion cores built upon sounder statistical and economic foundations. The IPCADW is a double weighted core. For details about their construction as well as about the first three cores see da Silva Filho and Figueiredo (2011). The acronym IPCA comes from the broad consumer price index, which is the official inflation targeting index in Brazil.

[8] As of 2010 the Central Bank of Brazil has stopped calculating the EXCORE and the TMCORE, and replaced them by the IPCAEX2 and the IPCADW, which have begun to be officially calculated.

[9] For the US, the evidence is similar for the CPIUS-EX and CPIUS-MED. For Brazil, the evidence for the EXCORE, TMCORE, IPCAEX1 and IPCADW is similar to that from the IPCAEX2. Therefore, those cases are not presented here.

[10] The longer memory of the STMCORE is due, to a large extent, to the fact that infrequent and *relatively* large price changes are smoothed along the current and next eleven months. For further details on that measure see Figueiredo (2001).

Canada correlations longer than the first lag are insignificant (apart from some disperse – and difficult to interpret – significant lags elsewhere).[11] Moreover, in the latter cases they alternate in sign (although the bulk of the negative correlations are insignificant). Those differences suggest very different statistical properties for inflation (and, therefore, core inflation) in Brazil compared to the U.S. and Canada.

This could be, for example, due to inflation behaving more like a MA process (or a higher-order autoregressive process, which could produce oscillatory dynamics) in the U.S. and Canada, while in Brazil it seems to be a low order (i.e. short memory) highly auto-correlated (i.e. persistent) process.[12]

Finally, note that in Brazil the correlation between core inflation and lagged inflation is significant, albeit being weaker and becoming insignificant earlier than in the opposite direction. This feature seems to conflict with the view that headline inflation should convey little information about core inflation, since in the short run its signal to noise ratio is low.

Thus, the evidence so far suggests that one should be sceptical about using the level model to make directional statements about future headline inflation. Moreover, if there is any predictive content, it seems to be in the very short-run. So, what about the gap model? Is it more in accordance with what the theory predicts?

Figure 2 shows the results of the same exercise carried out above, but now replacing the core inflation by the core gap. The evidence is similar to that of Figure 1 in the sense that in all three countries the core gap seems to be not very informative about future headline inflation. The evidence is particularly poor for the PCEUS-EX – the most important U.S. core –, since no useful information is apparently stemming from it.[13] Moreover, in the cases of the CPICAN-EX, STMCORE and IPCAEX2 if there is any predictive content it seems to be small and for the short-run only, exactly the same evidence found before. In fact, the size of the significant cross-correlations is very small and the temporal precedence is usually no longer than 6 or 7 months.[14]

---

[11] The significant cross-correlation at lag 12 suggests some seasonality left in the core measures, which, by the very concept of core inflation, is not supposed to exist. This problem is more intense in the CPIUS-EX (not shown).

[12] Thus, the evidence suggests that inflation remains highly persistent in Brazil, more than ten years after the stabilisation of the economy.

[13] The evidence for the EXCORE and TMCORE is similar from the PCEUS, except from the fact that first two correlations are significant.

[14] The same evidence was found for both the CPIUS-EX and the CPIUS-MED.

Note that in the latter cases the CCFs do show a hump-shaped pattern now. However, the first two cross-correlations are significantly negative, which is an apparently unexpected result since it implies that, in the very short run, whenever the core gap is positive inflation is expected to fall, being repelled rather than attracted towards core inflation.[15] Subsequently, normally from the fourth to the seventh lag, the cross-correlations turn out to be significantly positive. Appendix 2 goes deeper into the reasons between that negative sign as well as the significant cross correlation between Brazilian core inflation and lagged headline inflation.

In a nutshell, the evidence so far suggests that directional forecasts based on the core inflation level are likely to produce poor results. There apparently remains some possibility that forecasts based on the core gap could be useful to monetary policy. However, both the small size of the significant correlations (especially for the U.S. and Canada) and the tight temporal precedence (around six months) are unlikely to allow those forecasts to be used effectively in a pre-emptively manner.

4 – Directional Forecasting Using Core Inflation

This section carries out a large directional inflation forecasting simulation exercise in order to assess how well core inflation anticipates the *direction of change* of inflation according to both the level and gap models (equations 1 and 2, respectively). The results provide non parametric estimates of the probability of forecasting success for each measure of core inflation, for each model.

The simulation produces *pseudo* out-of-sample forecasts, since no future information is used when forecasts are made.[16] Thus, the results should provide a fairly reliable assessment of the real directional forecasting capabilities of core inflation using such types of simple, but widely used, forecasting mechanisms.

Preliminary evidence from Section 3 suggests that forecast accuracy is likely to be poor. However, note that there are many variations in the precise way equations (1) and (2) could be used. Not only one could focus at different forecasting horizons (i.e. different k) – and forecast accuracy is likely to vary with them – but the conditioning period could vary as well [i.e. both the core change and the core gap

[15] One hypothesis that could help explaining this dynamics is that, at higher frequencies, core inflation is also picking up transitory inflation movements, hindering the expected one-way convergence.
[16] Moreover, inflation is an indicator that is rarely revised, meaning that one does not have to deal with vintage data issues here, improving the reliability of inference.

could be calculated for different conditioning periods (different *l*)]. Hence there are a large number of possible combinations, and any meaningful result has to take them into account.

Hence, for each measure of core inflation four forecast horizons are focused: headline inflation over the next 1, 2, 3 and 4 quarters (i.e. k = 3, 6, 9 and 12).[17] Also, four conditioning periods are used: the latest 1, 2, 3 and 4 (i.e. l = 3, 6, 9 and 12) quarters.[18] Moreover, in order to avoid the overlapping forecast problem only non-overlapping forecasts are analysed.[19] Finally, the performance of mechanisms (1) and (2) is confronted against that of a simple moving average (MA). More precisely, core inflation ($\tilde{\pi}_t^l$) is replaced by a one-sided MA of headline inflation ($^{ma}\pi_t^l$).[20] Three different MAs are computed: 12, 18 and 24 months.[21] Overall the simulation generated almost three thousand series of forecasts.

The goal of the simulation is twofold: first, to provide an accurate idea of how reliable directional forecasts from models (1) and (2) are. In other words, how frequently are they wrong? second, to get an *approximate* idea of how they fare against a simple benchmark "model" (i.e. the MA). Hence no mean equality test is carried out in order to check if performances are statistically different from either a MA or a coin toss. If, for example, the core inflation's performance is close to that of a "MA core" that evidence is already meaningful. It would indicate, for example, that the large amount of time and effort spent by both central banks and market analysts in building and analysing core inflation is probably unnecessary an unproductive.

The exercise begins by assessing first the country with the lowest signal-to-noise ratio: Brazil, where forecast accuracy is expected to be lower. Figure 3A shows the directional performance of the level model in that case. As can be seen, in almost all situations directional forecasts are worse than a simple coin toss. Moreover, with the exception of the 2-quarter ahead horizon, simple MAs of headline inflation beat

[17] For Brazil the focus is on the 1996.1–2008.12 period, while for the U.S. and Canada the assessed period is 1995.1–2008.12.
[18] Hence, each measure of core inflation produces 32 series of forecasts, half for each model, for each type of simulation.
[19] That is, in simulations $i = k$. Therefore, four datasets are constructed from monthly data – as explained in Section 2 – one for each frequency.
[20] Therefore, the MA is calculated using only information available at the time of the forecast.
[21] After calculating the monthly *pro rata* value of the MA that figure is raised to 3 to build the inflation forecast for the next quarter, to six for the next six months forecast, and so on. Note that the gap is zero by construction when the one-year ahead inflation is being forecast using the last four quarters as the conditioning period. Hence in this case no forecast is made.

core inflation. Those results suggest the complete uselessness of such type of forecasting mechanism for Brazil.

Figure 3B shows that the gap model fares much better than the level model, as one would expect. Yet, note that in many cases – mostly in the 3 and 4-quarter ahead horizons – its accuracy is only slightly better than a coin toss. More importantly, the 4-quarter ahead forecasts – which policymakers have greater interest on – are worse than a simple coin toss forecast in practically all cases. Furthermore, even those models that perform better than a random guess produce forecasts whose accuracy is similar to those of simple MA model of inflation. More crucially, even in the best cases (e.g. STMCORE, two-quarter ahead horizon), forecasts are usually wrong around 30% of the time. Typically, forecasts go astray, on average, in about 35% to 50% of the time, a poor performance. Finally, note that forecast accuracy has a hump-shaped pattern, peaking at the 2-quarter ahead horizon. This is bad news for monetary policy, given that even if forecast accuracy had been commendable monetary policy needs a longer lead to work effectively.

How the evidence above compares to that from the U.S. and Canada? Since inflation has been both lower and more stable in those countries one would expect a better outcome given the higher expected signal-to-noise ratio. Figures 5A and 5B show the results for the U.S. For both the CPI and the PCE the evidence from the level model remains the same: it is worse than a simple coin toss in almost all cases.

Although better, the results for the gap model are similar to those found for Brazil, especially in the CPI case: the directional performance has a hump-shaped pattern peaking at the 2-quarter ahead horizon, there is a marked deterioration of forecast accuracy at longer horizons and the accuracy rate is usually no better than a simple MA model of inflation. On average, forecasts are wrong in about 25% to 50% of the time, a lousy performance.

Forecast accuracy is equally poor for the PCE core – the most closely watched core measure in the U.S. However, in this case there are two noteworthy differences. First, the increasing forecast accuracy at longer horizons.[22] Indeed, the one-year ahead forecasts emerge as being more accurate than shorter term forecasts. At least from this point of view, the evidence suggests that the Fed's decision to put more weight on the PCE core rather than on the CPI core is correct. Second, the PCE core easily beats the

[22] This holds for the PCE core, but not for the MAs.

benchmark models in the 4-quarter ahead horizon. That is, it apparently adds relevant information over simple MAs at longer forecast horizons.

Finally, the evidence for Canada – where the core CPI plays a major role in monetary policy, being the operational target – remains unchanged, as Figure 7 shows. The level model produced the worst performance among all three countries. As to the gap model, note that apart from the 3-quarter ahead case the accuracy of the CPI core's forecasts is either similar or worse than simple MA models. In this regard is worthwhile to call to attention the good performance of the MA12 model for the 2-quarter ahead forecasts, when average forecast is above 90%. Note also that, as in the U.S. PCE case, the forecast accuracy of the Canadian CPI core is higher at longer horizons and, as in the U.S CPI and Brazilian cases, the MA models' accuracy has a hump-shaped pattern, peaking at the 2-quarter ahead horizon. Finally, although the average accuracy is better in Canada compared to the U.S. and Brazil, it remains well below what one needs for the core to become a reliable predictor of the direction of change of inflation.

One hypothesis for such a poor performance witnessed so far – especially in the case of the U.S. and Canada – could be due to the existence of some kind of threshold effect. For example, in the gap model it might well be the case that predictions are more accurate once one allows for a minimum gap size. In the same way, in the level model higher accuracy could follow once we allow for a minimum size in core inflation's change. This is a sensible hypothesis since small differences could be mainly reflecting noise rather than signal.

Hence, the hypothesis that core inflation's directional forecast accuracy have been hindered by the existence of some kind of threshold effect is tested. Note that this possibility implies a "range of inaction" whenever the size of the core change or the core gap fall within the $|\delta|$ p.p. interval, where δ is the chosen threshold value. Likewise, inflation is considered to have remained constant if the magnitude of its change falls within that same interval.

For each frequency, the size of the (maximum) threshold was determined to reflect the interval encompassed by 25% of the observations around the mean of the distribution of changes in inflation during the sample, assuming that they are normally distributed.[23,24]

The results are shown in the same Tables 3, 5 and 7 for Brazil, U.S. and Canada, respectively, in the following way: the entries that are outlined by a thin line indicate those cases in which allowing for threshold effects led to higher accuracy. The entries that are outlined by a thick line indicate, conditional on greater accuracy, an accuracy rate greater than 50% for the level model, and 60% for the gap model. As can be seen threshold effects do not seem to be relevant, especially for the gap model. And, in those cases where forecast accuracy is improved, the improvement is not large. Therefore, not taking threshold effects into account does not explain the failure of (1) and (2).

As a final attempt to improve directional forecast accuracy, the performance of combination of forecasts is also assessed.[25] In the U.S. CPI case, for example, when two cores are analysed (median and exclusion), predictions that inflation will rise, fall or remain constant only take place if both measures point to the same direction (i.e. if there is unanimity). When individual predictions are in conflict the result is read as inconclusive and, therefore, inflation is assumed to remain constant.

In the Brazilian case – where more than two cores are analysed – two groups of three cores are assessed: the three measures that were originally calculated by the Central Bank of Brazil (called here the old cores) and the three calculated by da Silva Filho and Figueiredo (2011) (called the new cores). Note that in this case forecasts could be combined in more than one way, so that four criteria were chosen. In the first criterion, a simple "majority" rule is applied. That is, predictions that inflation will change (i.e. rise or fall) require that at least two cores' forecasts are in agreement, otherwise a "random walk" prediction (i.e. no change) is assumed.[26]

[23] The interval is defined as the difference between (the corresponding values of) the 62.5th-percentile and the 37.5th-percentile of the distribution of changes in the inflation rate. Since the distribution is assumed to be normal, that distance can be directly calculated as $2\ \Phi^{-1}(0.625) \approx 0.64\sigma$, where $\Phi^{-1}(.)$ refers to the inverse of a standard normal cdf (cumulative distribution function).

[24] This criterion implied (maximum) thresholds values for the 1, 2, 3 and 4 quarter ahead forecasts equal to, respectively, 0.3, 0.6, 1.0 and 0.9 p.p. for Brazil; 0.3, 0.6, 0.7 and 0.2 p.p. for the U.S. CPI; 0.2, 0.2, 0.4 and 0.3 p.p. for the U.S PCE; and 0.3, 0.5, 0.5 and 0.4 p.p. for Canada. Calculated values were rounded to the nearest decimal. Threshold effects were tested beginning in 0.1 p.p. and increased by 0.1 p.p. until the above limits were reached.

[25] Given that only one core is analysed for both the U.S. PCE and the Canadian CPI it is not possible to combine core's forecasts in those cases, except for the MAs models.

[26] That is, inflation is also expected to remain constant if one core points to an increase in inflation, the other to a decrease and the last one to stability.

An interesting possibility that arises when more than two forecasts are involved is the emergence of different "classes" of directional predictions (e.g. weak, strong and very strong forecasts). For example, it seems natural to claim that the signal stemming from a situation when two out of three cores indicate that inflation will rise is weaker than the signal produced when all three measures are in agreement. Therefore, besides the intuitive majority criterion above, three other types of forecasts combination based on the *strength* of the directional signal are also assessed. Strength is calculated as follows

$$S_t = n^{-1} \sum_{i=1}^{n} sgn_\delta(X_t^i)$$

Where S_t stands for the strength of the signal, X_t^k denotes either $\Delta\tilde{\pi}_t^k$ (i.e. the change in core inflation) or $(\tilde{\pi}_t^k - \pi_t)$ (i.e. the core gap), $sgn_\delta(X) = \begin{cases} -1, & X < \delta \\ 0, & |X| \leq \delta \\ 1, & X > \delta \end{cases}$, where δ is the chosen threshold value, and *i* indexes the core inflation measure. That is, for each type of directional outcome a different value is assigned according to whether inflation is expected to fall (-1), remains constant (0) or rise (1).

Hence, in the first case (i.e. the second criterion), inflation is expected to fall, remain constant or rise whenever $S_t < 0$, $S_t = 0$ or $S_t > 0$, respectively. In the second case (i.e. the third criterion), forecasts that inflation will change (i.e. rise or fall) only take place when the signal is strong enough, $|S_t| \leq ⅔$, otherwise inflation is expected to remain constant.[27] In the third case (i.e. the fourth criterion), unanimity is required for a forecast to be *made*. That is, if the signal is not overwhelmingly convincing no forecast is made, which means that forecasts are carried out only in certain situations.[28] This exercise tries to gauge if directional performance increases once forecasts are made only in (supposedly) less uncertain scenarios. Finally, the

[27] In the current case S_t could take the following values: – 1, -⅔, -⅓, 0, ⅓, ⅔ or 1.

[28] Note, therefore, that this criterion is slightly different from the unanimity criterion used for the US CPI, when only two forecasts are combined. In that case, when the cores are in disagreement a no change prediction is made.

benchmark models' (i.e. the MAs) forecasts are also combined and their precision are assessed, for all price indices.[29]

The results are shown in Tables 4, 6 and 8 for Brazil, U.S. and Canada, respectively. The column named "Major" stands for the majority criterion, "Signal 1" and "Signal 2" stand for the first two signal strength criteria, respectively, while "Unam" refers to the unanimity criterion as just explained.[30] The evidence is uniform among all three countries.

Concerning the level model, first and most importantly, forecast accuracy remains poor. Indeed, interestingly, in all cases but the four-quarter ahead forecasts for the Canadian CPI, the combination of directional (qualitative) level forecasts were unable to produce more accurate forecasts than before, in sharp contrast to what usually happens when *quantitative* forecasts are combined. Perhaps even more striking, the precision of the unanimity criterion – when uncertainty is supposedly smaller *ex-ante* – is lower than before, showing that it is nothing but an illusion to assume that forecasts are more reliable when all cores point to the same direction. Indeed, in several cases precision was much lower than when other criteria were used.

As to the gap model, although there are some differences, conclusions remain basically the same. Once again, first and most importantly, combination of directional forecasts do not increase forecast accuracy in almost all cases. Second, the unanimity criterion now seems to produce more accurate forecasts in many cases, even though in most of them the gains are small. Noteworthy exceptions are the two-quarter ahead forecasts for Brazil, for the new cores, when forecast accuracy is above 70%, and for Canada, when forecast accuracy reaches 80%. However, it should be noticed that when the unanimity criterion is used forecasts are not always made, which means that in many occasions there are no forecasts available. The percentage of times that a forecast is made is shown between parentheses Therefore, higher accuracy should be put into perspective.

[29] Since no MA forecast is made for the one-year ahead horizon using the last four quarters as the conditioning period (see footnote 21), in that case only two MA forecasts (MA18 and MA24) are combined, and the unanimity criteria used is the same one used for the US CPI.
[30] See footnote 28.

5 – Conclusion

Many economists read recent increases in core inflation as a reliable sign that headline inflation will rise in the near future (level model). Others consider that the trigger is pulled only when core inflation is above headline inflation (gap model), since core inflation is thought to be an attractor of headline inflation as it (should) reflect the true underlying inflation trend.

Despite the immense popularity *in practice* of such types of "forecasting mechanisms" to my best knowledge the accuracy of core inflation directional forecasts has not yet been investigated in the core inflation literature. This paper tries to fill some of that gap by analysing the directional forecast accuracy of core inflation in the United States, Canada and Brazil, providing non parametric estimates of the probability of forecasting success for the two types of models cited above.

In order to accomplish that a large and rigorous forecasting simulation exercise, that ended up producing almost three thousand series of directional forecasts, was carried out. The overall evidence was quite uniform among countries, different measures of core inflation and forecasting horizons. Some of the main results are as follows: first, and most importantly, forecast accuracy was low throughout, although there were relevant differences in accuracy between the level and gap models, with the latter being clearly more accurate than the former. While the level model's forecasts are usually no better than a simple coin toss, those from the gap model are usually off-track, on average, at least 20% of the time. For Brazil, where inflation's signal-to-noise ratio is lower than in Canada and the U.S, accuracy is worse.

Given the above disappointing results, the hypothesis that some kind of threshold effect could have hindered forecast accuracy was taken into consideration. However, even taking into account those effects accuracy remained low. Then, as a final attempt to increase precision, directional forecasts from different core inflation measures were combined in different ways. Although in some cases (for the gap model) forecast accuracy increased, it remained well below what is needed for one to claim that such models could be useful for monetary policy. Indeed, accuracy remained low even in those cases in which the forecasts from all types of core inflation pointed to the same direction. In other words: contrary to common intuition, unanimity does not seem to increase reliability and, therefore, accuracy.

Moreover, even if precision had been higher, in most cases there is a sharp deterioration of forecast accuracy beyond the 2-quarter ahead horizon. This is bad news for monetary policy since it needs a longer lead to work effectively. Another important result is that directional forecasts from simple – one-sided – moving averages "models" of headline inflation are usually at least as accurate as those from core inflation.

Hence, this paper takes a sceptical view about using core inflation for predicting headline inflation, whether quantitatively or qualitatively (i.e. directionally). Consequently, it gives support to Trichet's (2011) statement that "… [in the ECB] we consider that core inflation is not necessarily a good predictor for future headline inflation", or the scepticism of Cecchetti's (2006) and Bullard's (2011). However, if one remains willing to use the information provided by core inflation, then it is both more simple and at least as (in)effective to use simple MAs of headline inflation.

References

Bank of Canada (2006). "Renewal of the Inflation-Control Target: Background Information". Ottawa: Bank of Canada, November.

Blinder, Alan S. (1997). "Commentary on Measuring Short-Run Inflation for Central Bankers", Federal Reserve Bank of St. Louis *Review* (May/June).

Blinder, Alan S. (2006). "Monetary Policy Today: Sixteen Questions and about Twelve Answers", CEPS Working Paper N^{o} 129, July 2006.

Bryan, Michael F. and Stephen M. Cecchetti (1994). "Measuring Core Inflation". In N. Gregory Mankiw (ed.), *NBER Studies in Business Cycles*, vol. 29: *Monetary Policy*. Chicago: University of Chicago Press.

Buiter, Willem H. (2007). Comments on Martin Wolf's article "Villains and victims of global capital flows." Financial Times Economists Forum, June 16. http://blogs.ft.com/economistsforum/2007/06/villains-and-vihtml/.

Bullard, James (2011). "Measuring Inflation: The Core is Rotten", Federal Reserve Bank of St. Louis *Review* (July/August).

Cecchetti, Stephen G. (2006). "Core Inflation is an Unreliable Guide", Financial Times 9/12/2006.

Clark, Todd E. (2001). "Comparing Measures of Core Inflation". Federal Reserve Bank of Kansas City *Economic Review*, Second Quarter.

Clinton, Kevin (2006). "Core Inflation at the Bank of Canada: A Critique" Queen's Economics Department Working Paper N^{o} 1077. Kingston, ON, Canada: Queen's University (May).

Da Silva Filho, T. N. T. and F. M. R. Figueiredo (2011). "Has Core Inflation Been Doing a Good Job in Brazil?" Revista Brasileira de Economia, Vol. 65, N^{o}2.

Diebold, Francis X. and José A. Lopez (2011). "Forecast Evaluation and Combination", in G.S. Maddala and C.R. Rao (eds.), *Handbook of Statistics*. Amsterdam: North-Holland, 241-268.

Figueiredo, Francisco M. R**. (2001)**. "Evaluating Core Inflation for Brazil". Central Bank of Brazil Working Paper N^{o} 14.

Gavin, William and Rachel Mandal (2002). "Predicting Inflation: Food for Thought," Federal Reserve Bank of St. Louis, *Regional Economist*, January.

Laidler, David and Shay Aba (2000). "It´s Time to Ignore Core Inflation". C.D. Howe Institute, *Backgrounder*, vol. 2001 (November).

Macklem, Tiff (2001). "A New Measure of Core Inflation?" Bank of Canada Review, Autumn.

Marques, Carlos R., Pedro D. Neves and Luis M. Sarmento (2003). "Evaluating core inflation indicators". Economic Modelling, Elsevier, vol. 20(4), July.

Mishkin, F. S. (2007). "Headline versus Core Inflation in the Conduct of Monetary Policy". Speech delivered at the Business Cycles, International Transmission and Macroeconomic Policies Conferences, HEC Montreal, Montreal, Canada, October 20.

OECD (2005). "Measuring and Assessing Underlying Inflation". *Economic Outlook* N° 77, May.

Rich, Robert and Charles Steindel (2005). "A Review of Core Inflation and an Evaluation of Its Measures." Federal Reserve Bank of New York Staff Report N° 236.

Silver, Mick (2007). "Core Inflation: Measurement and Statistical Issues in Choosing Among Alternative Measures". IMF Staff Papers, Vol. 54, N° 1.

Trichet, Jean-Claude (2011). "Jean-Claude Trichet: Interview in *The Wall Street Journal*". 19 January.

Wynne, Mark A. (1999). "Core Inflation: A Review of Some Conceptual Issues". ECB Working Paper N° 5, Frankfurt, European Central Bank.

Appendix 1

In practice, several reasons can prevent equations (1) to (4) to hold. As says Blinder (1997; italics added) "The name of the game then was distinguishing the signal from the noise, *which was often difficult*. The key question on my mind was typically: What part of each monthly observation on inflation is durable and what part is fleeting?" Thus, if core inflation is not able to successfully disentangle temporary from persistent or permanent shocks, then it will be less informative about the current inflation trend and, as a consequence, about future inflation.

A very common way of thinking about core inflation is to assume that inflation can be divided into two parts: a durable – or more persistent one – represented by the trend, or core inflation, and a transitory – or temporary one – represented by deviations around that trend, or noise. Such decomposition can be characterized in the following way

$$\pi_t = \tilde{\pi}_t + \varepsilon_t, \qquad \varepsilon_t = \sum_{i=0}^{I} \theta_i \varepsilon_{t-i} + \upsilon_t \qquad \upsilon_t \backsim NID(0, \sigma_\upsilon^2) \qquad (5)$$

$$\tilde{\pi}_t = \tilde{\pi}_{t-1} + \eta_t, \qquad \eta_t \backsim NID\left(0, \sigma_\eta^2\right) \qquad (6)$$

where it is usually assumed that $\theta = 0$ and $cov(\upsilon_t, \eta_t) = 0$. In other words, it is usually assumed that temporary shocks have no persistency and, hence, that the distinction between temporary and permanent shocks is clear-cut. However, if this is not the case, that is, if $cov(\upsilon_t, \eta_t) \neq 0$ and $\theta \neq 0$, which is likely to happen, then building a good measure of core inflation pose real challenges in practice.[31]

For example, a temporary, yet persistent shock, could not only make core inflation deviates from headline inflation for an extended period of time, hampering its forecasting capabilities, but if the central bank puts too much emphasis on core inflation it will accommodate a sizable part of those deviations adding fuel to the latent inflationary process. In that case the supposedly temporary shock will end up having some permanent effects. In other words, shocks are not exogenously temporary or permanent, since their nature depend, to some degree, on the very reaction of policymakers. Indeed, since policymakers give importance to other variables besides inflation or yet can misjudge the persistency of some shocks (e.g. oil

[31] The model above assumes that inflation has a unit root. However, one could also think of it as having a stationary, yet very persistent trend.

shock), in practice temporary shocks end up being accommodated to some extent, becoming, in part, permanent.

On practical grounds, a common difficulty with those core measures that exclude pre-determined groups of goods is that the volatility and persistence among groups can change markedly over time. Even when the criterion for exclusion is based on the cross-section item or group's volatility, persistent price changes could still be systematically excluded.[32] In both cases the result is the emergence of bias during extended periods of time, hampering both core inflation's forecasting capabilities and its usefulness to monetary policy. In a nutshell, the task of identifying temporary from permanent shocks to inflation is a challenging one not only due to the changing nature or source of shocks but also because the reaction of the central bank is ultimately an important determinant of such a distinction. This fact jeopardizes the idea of temporary and permanent shocks that underpins the core inflation theory.

Notice that since core inflation is supposed to uncover the "true" inflation trend, the qualitative statements above could also be read as particular cases of a cointegrating system between inflation and core inflation, such as:

$$\Delta\pi_t^k = \alpha_0 + \sum_{i=1}^{p} \beta_{0,i}\Delta\pi_{t-i}^k + \sum_{j=0}^{q} \delta_{0,j}\Delta\tilde{\pi}_{t-j}^k + \gamma_0\left(\tilde{\pi}_{t-i}^k - \pi_{t-i}^k\right) + \varepsilon_{0,t} \qquad (7)$$

$$\Delta\tilde{\pi}_t^k = \alpha_1 + \sum_{i=0}^{m} \beta_{1,i}\Delta\pi_{t-i}^k + \sum_{j=1}^{n} \delta_{1,j}\Delta\tilde{\pi}_{t-j}^k + \gamma_1\left(\tilde{\pi}_{t-i}^k - \pi_{t-i}^k\right) + \varepsilon_{1,t} \qquad (8)$$

For example, the assumption that inflation will rise whenever core inflation is above headline inflation requires that $\gamma_0 > 0$, along with the restriction that $\beta_{0,1} = \cdots = \beta_{0,p} = \delta_{0,1} = \cdots = \delta_{0,q} = 0$. The idea that the opposite does not hold requires that $\gamma_1 = 0$ as well as $\beta_{1,1} = \cdots = \beta_{1,m} = 0$. The assumption that an increase in core inflation *per se* signals future increases in headline inflation requires that $\sum_{j=0}^{q} \delta_{0,j} > 0$ and $\beta 0,1=\cdots=\beta 0,m=\gamma 0=0$. Thus, whenever one uses (1) to (4) to make directional predictions about inflation one is implicitly assuming that all the associated restrictions are valid, which is unlikely. In other words, one is ignoring the short-run dynamics. More importantly, one is also assuming that other variables' effects on inflation are negligible, even in the short-run, what explains the absence of a vector of exogenous variables in the system above.

[32] For an unfortunate actual example of that phenomenon see da Silva Filho and Figueiredo (2011).

Appendix 2

Although the negative cross-correlations in the first lags of Figure 2 seems to be at variance with the theory, this result is to be expected, as equation (9) shows

$$\rho_{\pi,gap}(i) = \frac{\sigma_{\pi_t gap_{t-i}}}{\sigma_{\pi_t}\sigma_{gap_{t-i}}} = \rho_{\pi\pi^c}(i)\frac{\sigma_{\pi^c}}{\sigma_{gap}} - \rho_{\pi}(i)\frac{\sigma_{\pi}}{\sigma_{gap}} \quad \text{for } i = 0, 1, \cdots, T \qquad (9)$$

where $gap_t = \pi_t^c - \pi_t$. Notice that the cross-correlation at lag zero has to be non-positive since $\rho_{\pi\pi^c}(0) < \rho_{\pi}(0)$ and $\sigma_{\pi^c} < \sigma_{\pi}$. Indeed, the case in which core inflation does not purge any temporary shocks (i.e. $\pi = \pi^c$) provides an upper bound equal to zero for the cross-correlation at lag zero, while the case in which core inflation and headline inflation are orthogonal to each other provides a lower bound equal to $-\sigma_{\pi}/\sigma_{gap}$. Moreover, since inflation is usually positively auto-correlated adjacent cross-correlations are likely to be negative. Subsequently, as the auto-correlation fades away, the second term in the r.h.s. could be offset or overcome by the first.

The higher the volatility of inflation relative to core inflation the more likely the cross-correlations are to be initially negative (and the less likely to be significantly positive later on). That implies that in an economy which inflation is subjected to large or frequent temporary shocks the core inflation gap will have low predictive power over headline inflation. This result provides some support to the claims of Marques *et al*. (2003) and Clinton (2006). Equation (9) has other interesting implications. For example, as central banks become successful in achieving price stability (i.e. low and stable inflation), then the core gap is more likely to be informative about future inflation, since inflation persistence will become smaller. In other words, core inflation is likely to be most useful when inflation is less persistent and volatile, exactly when it is less needed.

Moreover, the significant positive correlation between core inflation and lagged headline inflation, displayed in Figure 1, is to be expected in many cases as well. Headline inflation can be decomposed into a permanent (core) component and a transitory (temporary) one, $\pi_t = \pi_t^c + \varepsilon_t$, which are assumed to be uncorrelated. If this is the case then one has that

$$\rho_{\pi^c \pi}(i) = \frac{\sigma_{\pi_t^c(\pi_{t-i}^c + \varepsilon_{t-i})}}{\sigma_{\pi_t^c}\sigma_{\pi_t}} = \rho_{\pi^c}(i)\,\frac{\sigma_{\pi^c}}{\sigma_\pi} \quad \text{for } i = 0, 1, \cdots, T \qquad (10)$$

That is, the contemporaneous cross-correlation is given by the relative volatility of core inflation, which is a positive number less than one. Moreover, since core inflation is supposed to be a highly persistent process, adjacent cross-correlations are also expected to be positive. Therefore, their size depends on two opposing forces: one the one hand, the more persistent a given core inflation is the higher its degree of auto-correlation and the greater its cross-correlation with lagged inflation. On the other hand, the more persistent a given core inflation is the lower its relative volatility and the lesser its cross-correlation with lagged inflation. Hence, unless the signal-to-noise ratio is very low (i.e. actual inflation is frequently very apart from trend inflation) one should expect significant correlations between core inflation and lagged headline inflation in the short-run.

Finally, both equations (9) and (10) imply that in an economy subjected to frequent and large price shocks (i.e. low signal-to-noise), core inflation (or the core gap) is likely to have low predictive power over headline inflation.

Appendix 3

Figure 1

Monthly Cross Correlation Function: Headline Inflation and Core Inflation

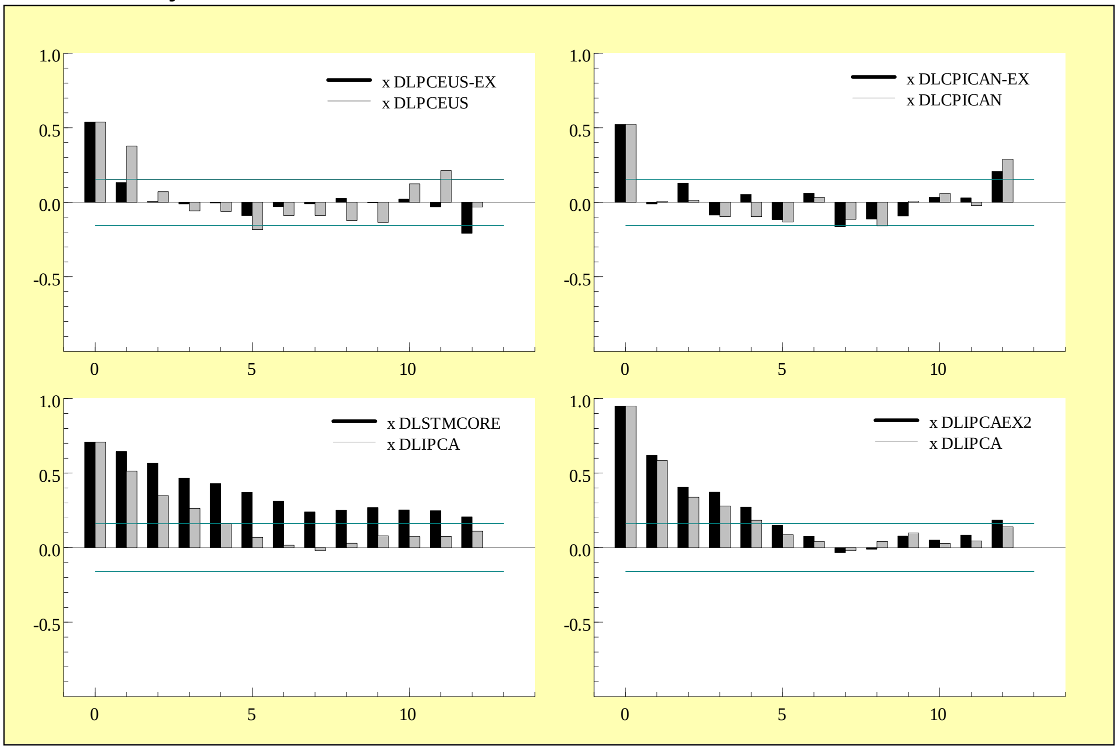
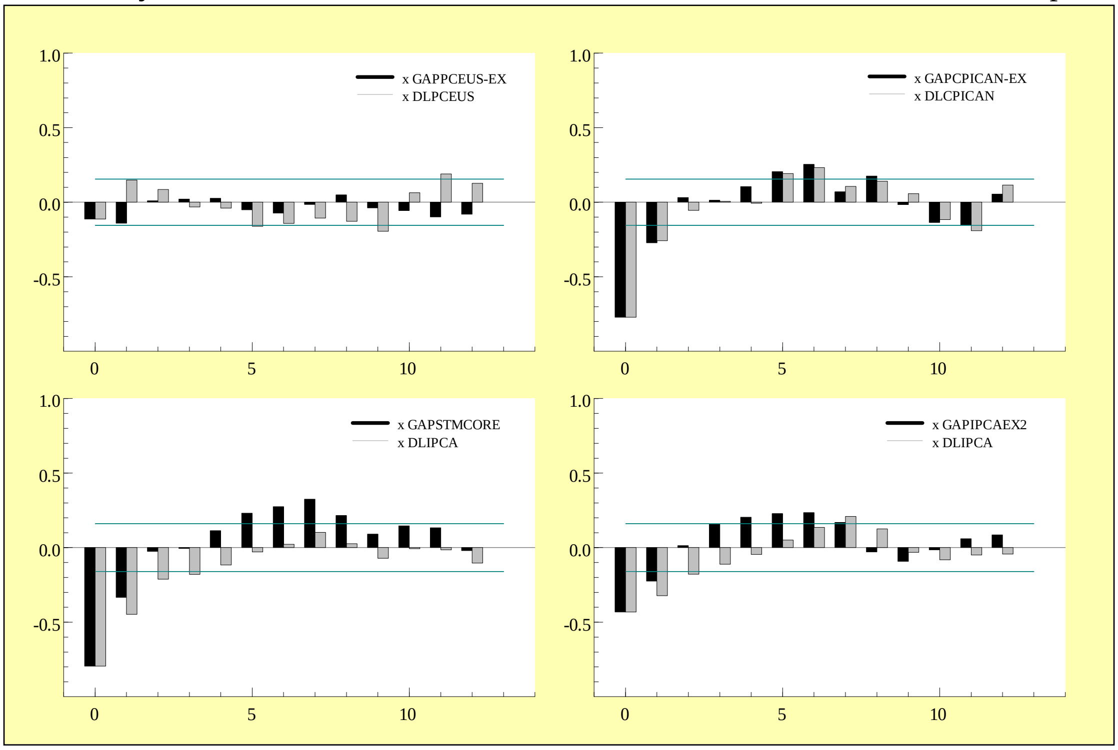


Figure 2

Monthly Cross Correlation Function: Headline Inflation and Core Inflation Gap



Appendix 4[33]

Figure 3A: Brazil (1996.1–2008.12)

Qualitative Forecasting Performance: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
1	**53%**	34%	45%	44%	40%	40%	40%	40%	32%	43%	45%	40%
2	**53%**	34%	45%	44%	36%	36%	34%	35%	30%	40%	34%	35%
3	**53%**	34%	45%	44%	43%	51%	43%	45%	45%	43%	47%	45%
4	**53%**	34%	45%	44%	49%	45%	45%	46%	43%	51%	45%	46%
	53%	34%	45%	44%	42%	43%	40%	42%	37%	44%	43%	42%

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
1	39%	30%	35%	35%	**52%**	43%	39%	45%	39%	43%	43%	44%
2	39%	30%	35%	35%	**52%**	39%	30%	41%	30%	26%	39%	37%
3	39%	30%	35%	35%	**52%**	35%	39%	42%	35%	30%	30%	38%
4	39%	30%	35%	35%	35%	35%	**43%**	38%	39%	39%	35%	38%
	39%	30%	35%	35%	**48%**	38%	38%	41%	36%	35%	37%	39%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
3	47%	**53%**	50%	50%	27%	47%	33%	36%	33%	40%	40%	37%
6	47%	**53%**	50%	50%	47%	40%	40%	42%	40%	47%	40%	42%
9	47%	**53%**	50%	50%	47%	33%	40%	40%	47%	47%	33%	41%
12	47%	**53%**	50%	50%	**53%**	47%	47%	49%	47%	40%	47%	47%
	47%	**53%**	50%	50%	43%	42%	40%	42%	42%	43%	40%	42%

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
3	**55%**	**55%**	36%	48%	45%	45%	**55%**	48%	36%	45%	45%	46%
6	**55%**	**55%**	36%	48%	45%	45%	**55%**	48%	45%	45%	45%	47%
9	**55%**	**55%**	36%	48%	45%	45%	**55%**	48%	**55%**	45%	45%	48%
12	**55%**	**55%**	36%	48%	**55%**	**55%**	36%	48%	45%	45%	**55%**	48%
	55%	**55%**	36%	48%	48%	48%	50%	48%	45%	45%	48%	48%

Figure 3B: Brazil (1996.1–2008.12)

Qualitative Forecasting Performance: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
1	**68%**	60%	62%	63%	55%	55%	64%	58%	57%	60%	62%	59%
2	**66%**	60%	62%	62%	62%	60%	**66%**	62%	57%	55%	62%	61%
3	53%	55%	53%	54%	55%	53%	**60%**	56%	55%	55%	57%	56%
4	-	57%	57%	57%	55%	49%	55%	53%	51%	51%	**62%**	54%
	62%	58%	59%	59%	57%	54%	61%	57%	55%	55%	61%	57%

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
1	65%	61%	61%	62%	61%	48%	65%	58%	**70%**	61%	**70%**	62%
2	65%	65%	65%	65%	70%	61%	**78%**	70%	65%	57%	70%	67%
3	61%	65%	61%	62%	52%	52%	**70%**	58%	61%	61%	65%	60%
4	-	61%	61%	61%	57%	52%	61%	57%	57%	57%	**65%**	58%
	64%	63%	62%	63%	60%	53%	**68%**	61%	63%	59%	67%	62%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
3	**67%**	47%	47%	53%	53%	53%	67%	58%	53%	53%	**67%**	58%
6	60%	60%	53%	58%	**67%**	**67%**	**67%**	**67%**	53%	33%	**67%**	60%
9	**60%**	**60%**	**60%**	**60%**	40%	**60%**	47%	49%	47%	47%	53%	49%
12	-	**60%**	53%	57%	47%	53%	40%	47%	**60%**	40%	**60%**	50%
	62%	57%	53%	57%	52%	58%	55%	55%	53%	43%	**62%**	54%

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	EXCORE	TMCORE	STMCOR	Average	IPCAEX1	IPCAEX2	IPCADW	Average
3	50%	50%	42%	47%	42%	**58%**	50%	50%	50%	50%	50%	50%
6	33%	42%	33%	36%	50%	**58%**	42%	50%	50%	33%	**58%**	49%
9	33%	50%	42%	42%	42%	50%	42%	44%	42%	42%	**58%**	46%
12	-	**58%**	42%	50%	50%	**58%**	42%	50%	33%	25%	50%	44%
	39%	50%	40%	44%	46%	**56%**	44%	49%	44%	38%	54%	47%

[33] The entries that are outlined by a thin line indicate those cases in which, allowing for threshold effects, led to higher accuracy. The entries that are outlined by a thick line indicate, conditional on greater accuracy, an accuracy rate greater than 50% for the level model, and 60% for the gap model.

Figure 4A: Brazil (1996.1–2008.12)

Combination of Qualitative Forecasts: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]	
1	**47%**	**47%**	19%	35%	(49%)	35%	35%	24%	**38%**	(62%)	**39%**	**39%**	27%	36%	(77%)
2	**47%**	**47%**	19%	35%	(49%)	**33%**	**33%**	22%	31%	(70%)	33%	33%	31%	**36%**	(87%)
3	**47%**	**47%**	19%	35%	(49%)	**47%**	**47%**	29%	39%	(66%)	**49%**	**49%**	29%	41%	(70%)
4	**47%**	**47%**	19%	35%	(49%)	**47%**	**47%**	35%	43%	(77%)	**47%**	**47%**	37%	45%	(81%)
	47%	**47%**	19%	35%	(49%)	**41%**	**41%**	27%	**38%**	**(69%)**	**42%**	**42%**	31%	39%	(79%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam		Major	Signal 1	Signal 2	Unam[1]	
1	**30%**	**30%**	13%	25%	(52%)	**48%**	**48%**	30%	41%	(75%)	**43%**	**43%**	35%	40%	(88%)
2	**30%**	**30%**	13%	25%	(52%)	**39%**	**39%**	22%	36%	(63%)	**35%**	**35%**	17%	24%	(75%)
3	**30%**	**30%**	13%	25%	(52%)	**43%**	**43%**	30%	39%	(75%)	**30%**	**30%**	17%	25%	(71%)
4	**30%**	**30%**	13%	25%	(52%)	**39%**	**39%**	26%	33%	(75%)	**39%**	**39%**	30%	35%	(83%)
	30%	**30%**	13%	25%	(52%)	**42%**	**42%**	27%	37%	(72%)	**37%**	**37%**	25%	31%	(79%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam		Major	Signal 1	Signal 2	Unam[1]	
3	**50%**	**50%**	29%	44%	(64%)	**33%**	**33%**	20%	30%	(64%)	**40%**	**40%**	27%	33%	(79%)
6	**67%**	**67%**	40%	55%	(64%)	40%	40%	33%	**42%**	(79%)	**40%**	**40%**	33%	42%	(79%)
9	**50%**	**50%**	29%	44%	(64%)	**40%**	**40%**	27%	36%	(71%)	**40%**	**40%**	33%	42%	(79%)
12	**50%**	**50%**	29%	44%	(64%)	**53%**	**53%**	27%	44%	(64%)	**47%**	**47%**	40%	43%	(93%)
	54%	**54%**	31%	47%	(64%)	**42%**	**42%**	27%	38%	(70%)	42%	42%	33%	40%	(82%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam		Major	Signal 1	Signal 2	Unam[1]	
3	**55%**	**55%**	27%	43%	(58%)	**45%**	**45%**	**45%**	50%	(83%)	**45%**	**45%**	36%	40%	(83%)
6	**55%**	**55%**	27%	43%	(58%)	45%	45%	45%	**50%**	(83%)	**45%**	**45%**	45%	**45%**	(92%)
9	**55%**	**55%**	27%	43%	(58%)	45%	45%	36%	**50%**	(67%)	**45%**	**45%**	**45%**	50%	(83%)
12	**55%**	**55%**	27%	43%	(58%)	**55%**	**55%**	36%	44%	(75%)	**55%**	**55%**	36%	44%	(75%)
	55%	**55%**	27%	43%	(58%)	**48%**	**48%**	41%	49%	(77%)	**48%**	**48%**	41%	45%	(83%)

(1) Forecasts are made only when there is unanimity.

Figure 4B: Brazil (1996.1–2008.12)

Combination of Qualitative Forecasts: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]	
1	65%	65%	52%	**68%**	(77%)	54%	54%	40%	**68%**	(63%)	58%	58%	44%	**62%**	(75%)
2	54%	54%	40%	**68%**	(63%)	62%	62%	40%	**68%**	(63%)	56%	56%	33%	**63%**	(54%)
3	58%	58%	44%	**62%**	(75%)	54%	54%	35%	**61%**	(56%)	56%	56%	27%	**58%**	(48%)
4	64%	64%	47%	**67%**	(71%)	**56%**	56%	31%	52%	(54%)	48%	48%	33%	**61%**	(56%)
	60%	60%	46%	**66%**	(71%)	56%	56%	37%	**62%**	(59%)	54%	54%	34%	**61%**	(58%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]	
1	**67%**	**67%**	54%	65%	(83%)	**63%**	**63%**	38%	60%	(60%)	**71%**	**71%**	50%	**71%**	(52%)
2	**71%**	**71%**	50%	**71%**	(71%)	71%	71%	50%	**80%**	(60%)	63%	63%	42%	**77%**	(52%)
3	63%	63%	46%	**73%**	(63%)	54%	54%	38%	**69%**	(52%)	67%	67%	29%	**78%**	(36%)
4	63%	63%	33%	**67%**	(50%)	**63%**	63%	29%	58%	(52%)	58%	58%	42%	**67%**	(60%)
	66%	66%	46%	**69%**	(67%)	63%	63%	39%	**67%**	(56%)	65%	65%	41%	**73%**	(50%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]	
3	53%	53%	40%	**55%**	(73%)	50%	50%	38%	**75%**	(53%)	56%	56%	38%	**67%**	(60%)
6	**67%**	**67%**	40%	**55%**	(73%)	69%	69%	44%	**78%**	(60%)	**50%**	50%	19%	**50%**	(40%)
9	60%	60%	47%	**64%**	(73%)	44%	44%	31%	**63%**	(47%)	44%	44%	25%	**50%**	(53%)
12	53%	53%	33%	**56%**	(60%)	**50%**	**50%**	25%	43%	(47%)	**56%**	**56%**	25%	50%	(53%)
	58%	**58%**	40%	57%	(70%)	53%	53%	34%	**65%**	(52%)	52%	52%	27%	**54%**	(52%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	MOVING AVERAGES					OLD CORES					NEW CORES				
Lag	Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]		Major	Signal 1	Signal 2	Unam[1]	
3	**50%**	**50%**	42%	45%	(92%)	42%	42%	42%	**56%**	(69%)	**50%**	**50%**	33%	**50%**	(62%)
6	**42%**	**42%**	25%	30%	(77%)	**50%**	**50%**	33%	**50%**	(62%)	42%	42%	25%	**50%**	(46%)
9	**42%**	**42%**	25%	38%	(62%)	42%	42%	25%	**43%**	(54%)	42%	42%	17%	**50%**	(31%)
12	**50%**	**50%**	25%	43%	(54%)	**58%**	**58%**	17%	40%	(38%)	**33%**	**33%**	17%	**29%**	(54%)
	46%	**46%**	29%	39%	(71%)	**48%**	**48%**	29%	47%	(56%)	42%	42%	23%	**45%**	(48%)

(1) Forecasts are made only when there is unanimity.

Figure 5A: U.S. (1995.1–2008.12)

Qualitative Forecasting Performance: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
1	**47%**	39%	40%	*42%*	25%	31%	*28%*	29%	31%	35%	*32%*	**37%**
2	47%	39%	40%	*42%*	**52%**	32%	*42%*	30%	31%	35%	*32%*	**44%**
3	**47%**	39%	40%	*42%*	22%	38%	*30%*	30%	31%	35%	*32%*	**44%**
4	**47%**	39%	40%	*42%*	42%	42%	*42%*	30%	31%	35%	*32%*	**34%**
	47%	39%	40%	*42%*	35%	36%	*36%*	30%	31%	35%	*32%*	**40%**

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
1	42%	13%	33%	*29%*	**58%**	50%	*54%*	42%	38%	48%	*42%*	**54%**
2	42%	13%	33%	*29%*	8%	**46%**	*27%*	42%	39%	48%	*43%*	**54%**
3	42%	13%	33%	*29%*	4%	**54%**	*29%*	42%	39%	**48%**	*43%*	33%
4	42%	13%	35%	*30%*	40%	**58%**	*49%*	42%	39%	**48%**	*43%*	25%
	42%	13%	34%	*29%*	28%	**52%**	*40%*	42%	39%	**48%**	*43%*	42%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
3	20%	**53%**	21%	*32%*	13%	27%	*28%*	27%	27%	20%	*24%*	**53%**
6	19%	**53%**	21%	*31%*	47%	33%	*34%*	27%	27%	21%	*25%*	**60%**
9	20%	**53%**	21%	*32%*	20%	33%	*30%*	27%	27%	21%	*25%*	**67%**
12	20%	**53%**	21%	*32%*	40%	33%	*33%*	27%	27%	21%	*25%*	**40%**
	20%	**53%**	21%	*31%*	30%	32%	*31%*	27%	27%	21%	*25%*	**55%**

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
3	27%	**64%**	45%	*45%*	36%	45%	*44%*	18%	**45%**	36%	*33%*	**45%**
6	27%	**64%**	45%	*45%*	45%	**64%**	*48%*	18%	**45%**	36%	*33%*	27%
9	27%	64%	45%	*45%*	**73%**	64%	*53%*	18%	45%	36%	*33%*	**55%**
12	27%	**64%**	45%	*45%*	**64%**	**64%**	*52%*	18%	**45%**	36%	*33%*	9%
	27%	**64%**	45%	*45%*	55%	59%	*49%*	18%	**45%**	36%	*33%*	34%

Figure 5B: U.S. (1995.1–2008.12)

Qualitative Forecasting Performance: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
1	**81%**	78%	79%	*79%*	63%	69%	*66%*	**75%**	**67%**	70%	*71%*	**61%**
2	**67%**	58%	60%	*62%*	60%	65%	*62%*	53%	59%	55%	*56%*	**61%**
3	**75%**	58%	63%	*65%*	45%	57%	*51%*	49%	61%	**64%**	*58%*	55%
4	-	36%	38%	*37%*	**53%**	45%	*49%*	-	**61%**	**64%**	*63%*	51%
	74%	58%	60%	*61%*	55%	59%	*57%*	59%	62%	**63%**	*62%*	57%

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
1	76%	72%	75%	*74%*	**88%**	76%	*82%*	64%	**72%**	67%	*68%*	64%
2	**92%**	84%	88%	*88%*	80%	84%	*82%*	52%	67%	63%	*60%*	**68%**
3	**72%**	48%	71%	*64%*	60%	71%	*65%*	32%	**67%**	63%	*54%*	56%
4	-	20%	50%	*35%*	**56%**	52%	*54%*	-	**71%**	63%	*67%*	56%
	80%	56%	71%	*65%*	71%	71%	*71%*	49%	**69%**	64%	*62%*	61%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
3	69%	69%	**73%**	*70%*	63%	69%	*69%*	44%	44%	40%	*43%*	**56%**
6	56%	50%	**60%**	*55%*	56%	56%	*56%*	44%	50%	53%	*49%*	**56%**
9	69%	69%	73%	*70%*	69%	**75%**	*71%*	50%	63%	**67%**	*60%*	63%
12	-	56%	67%	*61%*	**75%**	63%	*64%*	-	63%	**73%**	*68%*	56%
	65%	61%	**68%**	*64%*	66%	66%	*65%*	46%	55%	**58%**	*55%*	**58%**

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	CPI							PCE				
Lag	MA12	MA18	MA24	*Average*	CPILFEN	Median	*Average*	MA12	MA18	MA24	*Average*	PCEPILFE
3	50%	**58%**	50%	*53%*	**58%**	50%	*53%*	58%	58%	50%	*56%*	**75%**
6	**50%**	**50%**	42%	*47%*	**50%**	42%	*47%*	42%	50%	50%	*47%*	**83%**
9	50%	58%	42%	*50%*	**75%**	50%	*54%*	25%	58%	58%	*47%*	**83%**
12	-	50%	**75%**	*63%*	67%	58%	*63%*	-	67%	**75%**	*71%*	67%
	50%	54%	52%	*53%*	**63%**	50%	*54%*	42%	58%	58%	*55%*	**77%**

Figure 6A: U.S. (1995.1–2008.12)

Combination of Qualitative Forecasts: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
1	**43%**	**43%**	15%	33%	(45%)	6%	**28%**	**28%**	11%	20%	(53%)
2	**43%**	43%	15%	33%	(45%)	16%	**28%**	**28%**	11%	20%	(53%)
3	**43%**	**43%**	15%	33%	(45%)	10%	**28%**	**28%**	11%	20%	(53%)
4	**43%**	**43%**	15%	33%	(45%)	34%	**28%**	**28%**	11%	20%	(53%)
	43%	**43%**	15%	33%	(45%)	16%	**28%**	**28%**	11%	20%	(53%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
1	**26%**	**26%**	9%	15%	(57%)	33%	**43%**	**43%**	22%	38%	(57%)
2	**26%**	**26%**	9%	15%	(57%)	8%	**43%**	**43%**	22%	38%	(57%)
3	**26%**	**26%**	9%	15%	(57%)	4%	**43%**	**43%**	22%	38%	(57%)
4	26%	26%	9%	15%	(57%)	**50%**	**43%**	**43%**	22%	38%	(57%)
	26%	**26%**	9%	15%	(57%)	24%	**43%**	**43%**	22%	38%	(57%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
3	**36%**	**36%**	7%	13%	(53%)	7%	**21%**	**21%**	7%	13%	(57%)
6	**36%**	**36%**	7%	13%	(53%)	13%	**21%**	**21%**	7%	13%	(57%)
9	**36%**	**36%**	7%	13%	(53%)	13%	**21%**	**21%**	7%	13%	(57%)
12	**36%**	**36%**	7%	13%	(53%)	33%	**21%**	**21%**	7%	13%	(57%)
	36%	**36%**	7%	13%	(53%)	17%	**21%**	**21%**	7%	13%	(57%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
3	**45%**	**45%**	27%	43%	(64%)	27%	**36%**	**36%**	18%	25%	(67%)
6	**45%**	**45%**	27%	43%	(64%)	**45%**	**36%**	**36%**	18%	25%	(67%)
9	45%	45%	27%	43%	(64%)	**64%**	**36%**	**36%**	18%	25%	(67%)
12	45%	45%	27%	43%	(64%)	**64%**	**36%**	**36%**	18%	25%	(67%)
	45%	**45%**	27%	43%	(64%)	**50%**	**36%**	**36%**	18%	25%	(67%)

(1) Forecasts are made only when there is unanimity.

Figure 6B: U.S. (1995.1–2008.12)

Combination of Qualitative Forecasts: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
1	79%	79%	75%	**82%**	(92%)	54%	72%	72%	62%	**74%**	(81%)
2	63%	63%	56%	**66%**	(85%)	49%	55%	55%	45%	**57%**	(77%)
3	63%	63%	50%	**75%**	(67%)	45%	**62%**	**62%**	40%	61%	(65%)
4	**38%**	38%	8%	22%	(38%)	39%	64%	64%	28%	**68%**	(40%)
	60%	60%	47%	**61%**	(70%)	47%	63%	63%	44%	**65%**	(66%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
1	**79%**	**79%**	71%	77%	(92%)	68%	67%	67%	58%	**70%**	(83%)
2	88%	88%	83%	**91%**	(92%)	76%	**67%**	**67%**	50%	60%	(83%)
3	67%	67%	42%	**71%**	(58%)	52%	**63%**	**63%**	29%	50%	(58%)
4	**33%**	**33%**	8%	25%	(33%)	48%	**71%**	**71%**	25%	60%	(42%)
	67%	67%	51%	66%	(69%)	61%	**67%**	**67%**	41%	60%	(67%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
3	**73%**	**73%**	**73%**	13%	(100%)	56%	**40%**	**40%**	**40%**	**40%**	(100%)
6	53%	**53%**	47%	31%	(87%)	50%	47%	47%	47%	**54%**	(87%)
9	**73%**	**73%**	60%	33%	(80%)	69%	**67%**	**67%**	53%	62%	(87%)
12	**73%**	**73%**	27%	33%	(40%)	56%	**67%**	**67%**	33%	**71%**	(47%)
	68%	**68%**	52%	28%	(77%)	58%	55%	55%	43%	**57%**	(80%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

	MOVING AVERAGES (CPI)					Cores	MOVING AVERAGES (PCE)				
Lag	Major	Signal 1	Signal 2	Unam[1]		Unam	Major	Signal 1	Signal 2	Unam	
3	50%	50%	50%	**55%**	(92%)	42%	50%	50%	50%	**60%**	(77%)
6	42%	42%	42%	**50%**	(83%)	33%	**50%**	**50%**	42%	45%	(85%)
9	42%	42%	42%	**56%**	(75%)	42%	**50%**	**50%**	25%	43%	(54%)
12	**75%**	**75%**	8%	50%	(17%)	58%	67%	67%	25%	**75%**	(31%)
	52%	52%	35%	**53%**	(67%)	44%	54%	54%	35%	**56%**	(62%)

(1) Forecasts are made only when there is unanimity.

Figure 7: Canada (1995.1–2008.12)

Qualitative Forecast Performance: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
1	31%	27%	28%	29%	**45%**
2	32%	27%	28%	29%	**44%**
3	32%	27%	28%	29%	**42%**
4	**32%**	27%	28%	29%	30%
	32%	27%	28%	29%	**40%**

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
1	**42%**	0%	32%	24%	17%
2	**42%**	0%	32%	24%	17%
3	**42%**	0%	32%	24%	33%
4	42%	0%	32%	24%	**46%**
	42%	0%	32%	24%	28%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
3	27%	29%	14%	23%	**53%**
6	27%	29%	14%	23%	**60%**
9	27%	29%	14%	23%	**40%**
12	27%	**29%**	14%	23%	20%
	27%	29%	14%	23%	**43%**

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
3	27%	**45%**	36%	36%	36%
6	27%	**45%**	30%	34%	36%
9	27%	**45%**	30%	34%	36%
12	27%	**45%**	30%	34%	**45%**
	27%	**45%**	32%	35%	39%

Qualitative Forecast Performance: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
1	**80%**	78%	77%	78%	75%
2	75%	71%	**77%**	74%	71%
3	61%	51%	**62%**	58%	57%
4	-	45%	**64%**	54%	55%
	72%	61%	70%	66%	64%

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
1	**88%**	79%	87%	85%	64%
2	**100%**	79%	96%	92%	80%
3	**88%**	54%	78%	73%	68%
4	-	13%	**52%**	32%	**52%**
	92%	56%	78%	71%	66%

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
3	**75%**	67%	73%	72%	69%
6	63%	60%	67%	63%	**75%**
9	44%	47%	53%	48%	**69%**
12	-	60%	67%	63%	**69%**
	60%	58%	65%	61%	**70%**

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MA12	MA18	MA24	Average	Core CPI
3	**58%**	**58%**	55%	57%	**58%**
6	50%	58%	**64%**	57%	58%
9	50%	75%	55%	60%	**83%**
12	-	75%	73%	74%	**92%**
	53%	67%	61%	62%	**73%**

Figure 8: Canada (1995.1–2008.12)

Combination of Qualitative Forecasts: Level Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
1	**20%**	**20%**	**9%**	**17%**	(49%)
2	**20%**	**20%**	**9%**	**17%**	(49%)
3	20%	20%	9%	**17%**	(49%)
4	20%	20%	9%	**17%**	(49%)
	20%	20%	9%	**17%**	(49%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
1	**14%**	**14%**	0%	0%	(43%)
2	**14%**	**14%**	0%	0%	(43%)
3	**14%**	**14%**	0%	0%	(43%)
4	**14%**	**14%**	0%	0%	(43%)
	14%	**14%**	0%	0%	(43%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
3	**21%**	**21%**	**14%**	**18%**	(79%)
6	21%	21%	14%	**18%**	(79%)
9	21%	21%	14%	**18%**	(79%)
12	21%	21%	14%	**18%**	(79%)
	21%	21%	14%	**18%**	(79%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
3	**40%**	**40%**	**10%**	**20%**	(42%)
6	40%	40%	10%	**20%**	(42%)
9	40%	40%	**10%**	**20%**	(42%)
12	40%	40%	10%	**20%**	(42%)
	40%	40%	10%	**20%**	(42%)

Combination of Qualitative Forecasts: Gap Model

Non-Overlapping Forecasts: **One-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
1	79%	79%	**72%**	79%	(90%)
2	74%	74%	64%	**79%**	(79%)
3	57%	57%	43%	**65%**	(65%)
4	51%	51%	21%	**50%**	(42%)
	65%	65%	50%	**68%**	(69%)

Non-Overlapping Forecasts: **Two-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
1	**91%**	**91%**	78%	90%	(83%)
2	96%	96%	83%	**100%**	(79%)
3	70%	70%	57%	**93%**	(58%)
4	22%	22%	13%	**38%**	(33%)
	70%	70%	58%	**80%**	(64%)

Non-Overlapping Forecasts: **Three-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
3	**73%**	**73%**	**67%**	71%	(93%)
6	60%	60%	60%	**64%**	(93%)
9	47%	47%	**33%**	45%	(73%)
12	73%	73%	27%	**57%**	(47%)
	63%	63%	**47%**	**60%**	(77%)

Non-Overlapping Forecasts: **Four-Quarter Ahead**

Lag	MOVING AVERAGES				
	Major	Signal 1	Signal 2	Unam	
3	**55%**	**55%**	**55%**	**55%**	(85%)
6	64%	64%	45%	**56%**	(69%)
9	55%	**55%**	45%	71%	(54%)
12	73%	**73%**	27%	100%	(23%)
	61%	**61%**	43%	**70%**	(58%)

(1) Forecasts are made only when there is unanimity.

Banco Central do Brasil

Trabalhos para Discussão

Os Trabalhos para Discussão do Banco Central do Brasil estão disponíveis para download no website
http://www.bcb.gov.br/?TRABDISCLISTA

Working Paper Series

The Working Paper Series of the Central Bank of Brazil are available for download at
http://www.bcb.gov.br/?WORKINGPAPERS

231	**Capital Requirements and Business Cycles with Credit Market Imperfections** *P. R. Agénor, K. Alper and L. Pereira da Silva*	Jan/2011
232	**Modeling Default Probabilities: the case of Brazil** *Benjamin M. Tabak, Daniel O. Cajueiro and A. Luduvice*	Jan/2011
233	**Emerging Floaters: pass-throughs and (some) new commodity currencies** *Emanuel Kohlscheen*	Jan/2011
234	**Cyclical Effects of Bank Capital Requirements with Imperfect Credit Markets** *Pierre-Richard Agénor and Luiz A. Pereira da Silva*	Jan/2011
235	**Revisiting bank pricing policies in Brazil: Evidence from loan and deposit markets** *Leonardo S. Alencar*	Mar/2011
236	**Optimal costs of sovereign default** *Leonardo Pio Perez*	Apr/2011
237	**Capital Regulation, Monetary Policy and Financial Stability** *P.R. Agénor, K. Alper, and L. Pereira da Silva*	Apr/2011
238	**Choques não Antecipados de Política Monetária e a Estrutura a Termo das Taxas de Juros no Brasil** *Fernando N. de Oliveira e Leonardo Ramos*	Abr/2011
239	**SAMBA: Stochastic Analytical Model with a Bayesian Approach** *Marcos R. de Castro, Solange N. Gouvea, André Minella, Rafael C. Santos and Nelson F. Souza-Sobrinho*	Apr/2011
240	**Fiscal Policy in Brazil through the Lens of an Estimated DSGE Model** *Fabia A. de Carvalho and Marcos Valli*	Apr/2011
241	**Macro Stress Testing of Credit Risk Focused on the Tails** *Ricardo Schechtman and Wagner Piazza Gaglianone*	May/2011
242	**Determinantes do *Spread* Bancário *Ex-Post* no Mercado Brasileiro** *José Alves Dantas, Otávio Ribeiro de Medeiros e Lúcio Rodrigues Capelletto*	Maio/2011

243	**Economic Activity and Financial Institutional Risk: an empirical analysis for the Brazilian banking industry** *Helder Ferreira de Mendonça, Délio José Cordeiro Galvão and Renato Falci Villela Loures*	May/2011
244	**Profit, Cost and Scale Eficiency for Latin American Banks: concentration-performance relationship** *Benjamin M. Tabak, Dimas M. Fazio and Daniel O. Cajueiro*	May/2011
245	**Pesquisa Trimestral de Condições de Crédito no Brasil** *Clodoaldo Aparecido Annibal e Sérgio Mikio Koyama*	Jun/2011
246	**Impacto do Sistema Cooperativo de Crédito na Eficiência do Sistema Financeiro Nacional** *Michel Alexandre da Silva*	Ago/2011
247	**Forecasting the Yield Curve for the Euro Region** *Benjamim M. Tabak, Daniel O. Cajueiro and Alexandre B. Sollaci*	Aug/2011
248	**Financial regulation and transparency of information: first steps on new land** *Helder Ferreira de Mendonça, Délio José Cordeiro Galvão and Renato Falci Villela Loures*	Aug/2011
249	**Directed clustering coefficient as a measure of systemic risk in complex banking networks** *B. M. Tabak, M. Takami, J. M. C. Rocha and D. O. Cajueiro*	Aug/2011
250	**Recolhimentos Compulsórios e o Crédito Bancário Brasileiro** *Paulo Evandro Dawid e Tony Takeda*	Ago/2011
251	**Um Exame sobre como os Bancos Ajustam seu Índice de Basileia no Brasil** *Leonardo S. Alencar*	Ago/2011
252	**Comparação da Eficiência de Custo para BRICs e América Latina** *Lycia M. G. Araujo, Guilherme M. R. Gomes, Solange M. Guerra e Benjamin M. Tabak*	Set/2011
253	**Bank Efficiency and Default in Brazil: causality tests** *Benjamin M. Tabak, Giovana L. Craveiro and Daniel O. Cajueiro*	Oct/2011
254	**Macroprudential Regulation and the Monetary Transmission Mechanism** *Pierre-Richard Agénor and Luiz A. Pereira da Silva*	Nov/2011
255	**An Empirical Analysis of the External Finance Premium of Public Non-Financial Corporations in Brazil** *Fernando N. de Oliveira and Alberto Ronchi Neto*	Nov/2011
256	**The Self-insurance Role of International Reserves and the 2008-2010 Crisis** *Antonio Francisco A. Silva Jr*	Nov/2011
257	**Cooperativas de Crédito: taxas de juros praticadas e fatores de viabilidade** *Clodoaldo Aparecido Annibal e Sérgio Mikio Koyama*	Nov/2011

258	**Bancos Oficiais e Crédito Direcionado – O que diferencia o mercado de crédito brasileiro?** *Eduardo Luis Lundberg*	Nov/2011
259	**The impact of monetary policy on the exchange rate: puzzling evidence from three emerging economies** *Emanuel Kohlscheen*	Nov/2011
260	**Credit Default and Business Cycles: an empirical investigation of Brazilian retail loans** *Arnildo da Silva Correa, Jaqueline Terra Moura Marins, Myrian Beatriz Eiras das Neves and Antonio Carlos Magalhães da Silva*	Nov/2011
261	**The relationship between banking market competition and risk-taking: do size and capitalization matter?** *Benjamin M. Tabak, Dimas M. Fazio and Daniel O. Cajueiro*	Nov/2011
262	**The Accuracy of Perturbation Methods to Solve Small Open Economy Models** *Angelo M. Fasolo*	Nov/2011
263	**The Adverse Selection Cost Component of the Spread of Brazilian Stocks** *Gustavo Silva Araújo, Claudio Henrique da Silveira Barbedo and José Valentim Machado Vicente*	Nov/2011
264	**Uma Breve Análise de Medidas Alternativas à Mediana na Pesquisa de Expectativas de Inflação do Banco Central do Brasil** *Fabia A. de Carvalho*	Jan/2012
265	**O Impacto da Comunicação do Banco Central do Brasil sobre o Mercado Financeiro** *Marcio Janot e Daniel El-Jaick de Souza Mota*	Jan/2012