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Multi-horizon inflation forecasts using disaggregated data☆

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ABSTRACT

In this paper we use multi-horizon evaluation techniques to produce monthly inflation forecasts for up to twelve months ahead. The forecasts are based on individual seasonal time series models that consider both, deterministic and stochastic seasonality, and on disaggregated Consumer Price Index (CPI) data. After selecting the best forecasting model for each index, we compare the individual forecasts to forecasts produced using two methods that aggregate hierarchical time series, the bottom-up method and an optimal combination approach. Applying these techniques to 16 indices of the Mexican CPI, we find that the best forecasts for headline inflation are able to compete with those taken from surveys of experts.

1. Introduction

With the purpose of finding models that can produce good forecasts of monthly inflation up to 12 months ahead, this document treats inflation as a seasonal series, and applies four time series models specifically designed to model and forecast them (Osborn, 2002). The models consider both, stochastic and deterministic seasonality, and are applied to 16 inflation series from the Mexican Consumer Price Index (CPI), including headline, and core inflation. The evaluation of each model is performed using out-of-sample forecasts, simultaneously taking into account all the forecast horizons.

Once the best model for each inflation series is determined, we face the problem of aggregating them in such a way that the resulting forecasts are consistent with the hierarchical order of the series (e.g., the headline price index has to equal a specific weighted average of the core and non-core price indices). To solve this problem, we compare two different methodologies, the commonly used bottom-up approach, and an optimal combination approach recently proposed by Hyndman et al. (2007), modified for the Mexican case. The forecasts produced with the latter not only satisfy the hierarchies, but in most cases have smaller mean squared forecast errors (MSFE) than both, the forecasts produced with the bottom-up approach, and the forecasts obtained with the best seasonal model for each series.

The document proceeds as follows. Section 2 presents the Mexican CPI data and documents the recent changes that the seasonal component of Mexican inflation has experienced. Section 3 presents the four seasonal models and their evaluation, using out-of-sample evaluation techniques to choose the best model for each of the 16 series. Section 4 introduces the discussion of whether to aggregate the forecasts of disaggregated variables or to forecast the aggregate variable of interest directly, and shows the evaluation of two alternative methods to aggregate the 16 resulting forecasts in a way that is consistent with the hierarchical order of the series. To put our results in context, Section 5 compares the best forecasts with forecasts from surveys of experts. Finally, Section 6 presents the conclusions.

2. Mexican inflation data

2.1. Data

Every month Banco de México compiles 170,000 prices of specific goods and services which are then grouped into 315 items ("genéricos", Banco de México, 2002b).[1] Each item has a certain weight

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[1] Banco de México is Mexico's central bank, with web page: http://www.banxico.org.mx.

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Table 1
Structure of the Mexican Consumer Price Index.
Source: Banco de México.

	Weight
Headline	100%
Core	75%
Merchandise	37%
Food	15%
Other merchandise	22%
Services	38%
Housing	18%
Education	5%
Other services	15%
Non-core	25%
Agricultural and livestock	8%
Fruits and vegetables	3%
Livestock	5%
Administered and regulated	17%
Administered	8%
Regulated	9%

Note: weight represents the percentage weight that each index has on headline.

inside the Mexican CPI, with the weights determined depending on the importance that each good and service has in the consumption basket that represents the average Mexican consumer.[2] The items are classified as part of groups, and then these groups are classified as elements of larger groups, leading to a hierarchical structure. In this paper we restrict our attention to the four higher levels of the hierarchy, which in the case of the Mexican CPI represents 16 series. This grouping is the most commonly used to monitor inflation in Mexico.

Table 1 presents the hierarchical structure of the Mexican CPI. The first disaggregation of the headline index is between core and non-core indices. The core index contains the less volatile items, and it is usually thought to respond to the aggregate economy and to monetary policy. For instance, prices in this index usually respond, with a lag, to domestic macroeconomic variables such as the interest rate, the exchange rate, and wages. The core index is disaggregated into merchandise and services indices, which are then disaggregated into food and other merchandise indices and into housing, education and other services indices, respectively. [3] In the case of the non-core index, it is formed by the very volatile agricultural and livestock group and by the group with administered and regulated prices such as those from gasoline, electricity, telephone, and local transport, among others (Banco de México, 2002b). The non-core index responds mostly to international prices and to domestic non-market forces. The former since most agricultural products and energy-related products are commodities, and the latter because an important part of administered and regulated prices are determined by the public sector. In particular, most energy prices under the administered group are determined by the federal government (e.g., gasoline), while a considerable part of the prices under the regulated group is regulated by sub-national governments (e.g., rights for water provision). [4]

The hierarchical structure of the time series that we analyze brings us to the discussion of whether to directly forecast an aggregate variable or to forecast disaggregate variables and then aggregate them. First, for the practical reason that the forecasts of the inflation of the 16 indices must be congruent with each other in the sense that they have to satisfy the hierarchies. Second, because of the possibility that certain aggregation methods may improve upon at least some of the individual forecasts (Espasa et al., 2002; Duarte and Rua, 2007).

2.2. Importance of the seasonal component

Models to forecast inflation have traditionally focused on the trend of inflation, since this component would typically explain most of the variation of the series, in line with Granger's (1966) statement that most of the variation of economic time series is explained by the long-run trend. In particular, inflation's trend component has usually been modeled as stochastic, by means of models that contain a unit root (e.g., Stock and Watson, 2003). Nevertheless, under stable inflation, for example, that obtained under a credible inflation targeting regime, the trend loses importance as the dominant component (Stock and Watson, 2007). At present, this appears to be the case in Mexico. In particular, inflation in Mexico seems to have switched from a nonstationary to a stationary process around the end of 2000 or the beginning of 2001 (Chiquiar et al., 2007).

The component that seems to have replaced the trend as the dominant component in Mexico is the seasonal, as it now explains a larger amount of inflation's total variation. This can be seen by analyzing the evolution of the spectrum of the inflation series. The spectrum represents the contribution of cycles of different frequencies to the variance of the series. It takes higher values in those frequencies whose cycles have a larger contribution to the variance of the observed series. Thus, series that are dominated by long-run trends show a very particular form, with a larger portion of the density concentrated in lower frequencies, in what is known as the “typical spectral shape” of an economic variable, a name first used by Granger (1966). On the flip side, the spectrum of a monthly series with an important seasonal pattern will show jumps around the frequencies that correspond to 6, 5, 4, 3, 2, or 1 cycles per year, which correspond to cycles that are repeated every 2, 2.4, 3, 4, 6 and 12 months (Ghysels and Osborn, 2001). The estimated spectra for headline, core, and non-core inflation are presented in Fig. 1 for two different samples: from April 1995 to April 2001, and from May 2001 to May 2007 (72 observations for each sample).[5] Two changes are clear in the second sample: the drop of the peak at frequency zero, and the increase in the seasonal peaks.[6]

The changes in the spectra indicate that the seasonal could be the component that explains most of the total variation of inflation in recent times. [7] To calculate the proportion of such variation that is explained by the seasonal component, we estimate a series of regressions for monthly inflation and its components with each regression having as regressors 12 seasonal dummy variables. The first dummy variable takes the value of 1 each January and the value of 0 the rest of the months, the second variable takes the value of 1 each February and the value of 0 the rest of the months and so on. For the first regression, the sample consists of the first five years of each series. For the second one, the first observation is dropped and a new observation is added at the end of the sample, so that the sample always contains 5 years of data (i.e., rolling windows are used for the

[2] The information regarding the relative importance that each item has in the basket is obtained from a survey that the Instituto Nacional de Estadística y Geografía (INEGI) formulates to the Mexican households. This survey is known as the *Encuesta Nacional de Ingresos y Gastos de los Hogares* (ENIGH). For more information about the composition and the current weights of the Mexican CPI see Banco de México (2002a,b).

[3] The measure of core inflation that we use includes education. This is currently the definition of core inflation used by Banco de México (see Banco de México (2007)). However, before January 2008 Banco de México considered education part of non-core inflation. The historical series that we use is available at Banco de México's website.

[4] With the main exception of telephone tariffs, which are determined privately. However, they are considered in the regulated group because a large part is regulated through a concession contract.

[5] We choose to split the sample in April 2001 following the results in Chiquiar et al. (2007), who suggests that there may be a structural break in the persistence of inflation around that date. In addition, the same number of observations is incorporated in each sample for comparability.

[6] Another interesting observation is the decrease of total variance, measured as the area below the curve of the spectral density, in the most recent sample of headline and core inflation. This does not seem to happen with the total variance of non-core inflation, except perhaps at very low frequencies.

[7] Other components, such as volatility, could have also increased its share of inflation's total variation. Later on the paper it will be clear that this is the case for the inflation of fruits and vegetables.