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Searching for the Best Inflation Forecasters within a Consumer Perceptions Survey: Microdata Evidence from Chile [*]

Carlos Medel
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Abstract
The aim of this article is to evaluate quantitative inflation forecasts for the Chilean economy taking advantage of a specific survey of consumer perceptions at the individual microdata level which, at the same time, is linked to a survey of employment in Chile's capital city. Thus, it is possible to link, with no error, consumer perceptions and 12-month-ahead inflation forecasts with personal characteristics such as gender, age, educational level, county of living, and the economic sector in which they are currently working. By using a sample ranging from 2005.III to 2018.IV, the results suggest that women aged between 35 and 65 years old, with a college degree, living in the North-eastern part of Santiago, and working in Commonality and Public Services sector are the best forecasters. Men aged between 35 and 65 years old, with a college degree, in a tie living in the North-eastern and South-eastern zones but working in Government and Financial Services and Commerce Services sectors respectively, come in second place. Some econometric exercises reinforce and give more support to the winner inflation factor, and reveal that a factor different to the second-best in terms of forecast accuracy displays the characteristics required of a forecasting variable. Remarkably, this factor has the same specifications to the winner factor, with the only difference that it is composed by men instead of women, and thus, it looks promising for further consideration. These results are important because they help to identify the most accurate group when forecasting inflation and, thus, help to refine a routine read of the survey with this purpose.

Resumen
El objetivo de este artículo es evaluar las proyecciones cuantitativas de inflación para la economía chilena considerando una encuesta única de percepción de los consumidores disponible a nivel de microdatos individuales que, a su vez, se vinculada a una encuesta de empleo de la ciudad capital de Chile. Así, es posible vincular, sin errores, las percepciones de los consumidores y las proyecciones de inflación a 12 meses con características personales como género, edad, nivel educacional, comuna de residencia, y sector económico en el que se desempeñan actualmente. Utilizando una muestra entre 2005.III a 2018.IV, los resultados sugieren que las mujeres entre 35 y 65 años, con estudios universitarios, que viven en el noreste de Santiago y trabajan en el sector de Servicios Públicos y Comunales son las mejores pronosticadoras. Los hombres entre 35 y 65 años, con estudios universitarios, en un empate quienes viven en las zonas noreste y sureste, pero que trabajan en los sectores de Servicios Públicos y Financieros y Servicios Comerciales respectivamente, ocupan el segundo lugar. Algunos ejercicios econométricos refuerzan y apoyan al factor de inflación ganador, y revelan que un factor diferente al segundo mejor en términos de precisión predictiva cumple adecuadamente las características requeridas de una proyección. Sorprendentemente, este factor tiene

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las mismas especificaciones que el factor ganador, con la única diferencia que está compuesto por hombres en lugar de mujeres y, asimismo, parece prometedor para mayores consideraciones. Estos resultados son importantes porque ayudan a identificar el grupo más preciso al momento de pronosticar la inflación y, por lo tanto, ayudan a refinar una lectura rutinaria de la encuesta con este propósito.

1 Motivation, objective, and main results

Given the lag with which monetary policy typically operates on the economy, accurate forecasts of the future state of the economy as well as future inflation outcomes are key for the success of monetary policy in particular, and economic policy in general. Inflation expectations are, thus, one of the key pillars of the current understanding on monetary policy (Clarida, 2012; Mishkin, 2014, §13). Similarly, it is well documented that consumer perceptions surveys provide rich, timely, and useful information from a representative group of agents of the economy which, more than often, require some statistical refinement to disentangle its purely forward-looking content. On many occasions, consumer perceptions surveys, whose aim is to capture the consumers' mood or sentiment about the economy, also include quantitative indicators such as the prospective inflation rate of the Consumer Price Index (CPI). See, for instance, the *Business and Consumer Survey* by the European Commission, Eurobarometer, the *Survey of Consumers* by the University of Michigan, the New York Federal Reserve Bank's *Survey of Consumer Expectations*, the Canadian *Survey of Consumer Expectations*, the Swiss *Consumer Sentiment* survey by the State Secretariat for Economic Affairs, and the *Opinion Survey* by the Bank of Japan for advanced economies as well as the Brazilian IBRE/FGV *Consumer Confidence Survey* and the Indian *Inflation Expectations Survey of Households* (IESH) in emerging market economies.

The aim of this article is to evaluate quantitative inflation forecasts for the Chilean economy taking advantage of a specific survey of consumer perceptions at individual microdata level which, at the same time, is linked to a survey of employment/unemployment of Chile's capital city, Santiago. Thus, the key advantage of the database is that it is possible to link, with no error, consumer perceptions and 12-month-ahead inflation forecasts[1] with labour-market characteristics of the respondents which heavily relies on personal (yet anonymous) characteristics.[2] This is done by constructing sub-sets of inflation expectations factors with fully identifiable and mutually excluded characteristics. Mentioned characteristics are gender, age, education, county of living, and the economic sector of present work, representing the exploitable personal attributes of the database. There are some other interesting attributes available, but with a very small sample size, not suitable to conduct a reliable statistical inference.

The question on which group of consumers is better at inflation forecasting is not new.[3] However, there is scarce literature for emerging economies, particularly for the case of Chile. In this sense, this paper constitutes the first analysis of Chilean inflation forecasts considering personal, demographic, and geographic characteristics of the respondents in an out-of-sample evaluation.

By using a quarterly sample ranging from 2005.III to 2018.IV (55 observations), and different combinations of attributes leading to 648 different inflation forecasts (or "factors"), the results for total inflation suggest that women aged between 35 and 65 years old, with a college degree, living in the North-eastern part of the city (that with the highest living standards of the country), and working in *Commonality and Public Services* sector are the best forecasters of total inflation. Out of a total of 3,060 consumers surveyed each quarter, this group is composed by up to 26 consumers, *i.e.* the top 1% of forecasters. Men aged between 35 and 65 years old, with a college degree, in a tie living in the North-eastern and South-eastern part of the city, but working in *Government and Financial Services* and *Commerce Services* sectors respectively, are the second best at forecasting inflation. Finally, men aged between 35 and 65 years old, with a college degree, living in the North-western part of city, working on *Government and Financial Services* are in the fourth place. From the fifth to eight places, I found men aged between 35 and 65 years old as a common characteristic and concentrated in *Commonality and Public Services* and *Government and Financial*

[1] In particular, I use the results of Question 8: "*What will be the CPI inflation rate in 12 months?*" (numeric answer). Despite that the question is asked freely (and this is the way in which they are found in the original `Stata` files of the database), in the sense that respondents are not forced to frame their answers in a probability distribution of possible outcomes, this is how the results are presented in the IEE report in tranches of (-,2%), (2%,3%), (3%,4%), and (4%,+).

[2] Naturally, in Chile there are more surveys asking for inflation expectations at different horizons to different agents. See Appendix A for a comparison of the expectations analysed in this paper and others of common use.

[3] See, for instance, the linkages between demographic characteristics and inflation expectations in Bryan and Venkatu (2001a, 2001b), Souleles (2004), Pfajfar and Santoro (2008), Coibion and Gorodnichenko (2015), Madeira and Zafar (2015), Ehrman, Pfajfar, and Santoro (2017), Armantier *et al.* (2017), Axelrod, Lebow, and Peneva (2018), and Łyziak and Sheng (2018) for the case of the United States; Lindén (2005) and Drakos, Konstantinou, and Thoma (2020) for a group of European countries; Campelo *et al.* (2019) for the case of Brazil, Gosselin and Kahn (2015) for Canada, Sabrowski (2008) for Germany, Goyal and Parab (2019) for India, Malgarini (2009) and Easaw, Golinelli, and Malgarini (2013) for Italy, Ichiue and Nishiguchi (2015) and Diamond, Watanabe, and Watanabe (2020) for Japan, Rossow, Padayachee, and Bosch (2011) for South Africa, and Jonung (1981) and Palmqvist and Strömberg (2004) for Sweden.

Services, but with a different spatial distribution. Notice that all these results are compared to the naïve random walk (RW) forecast and the just mentioned eight out of 648 of total possible forecasts overperform the benchmark, with none of them coming out as statistically superior to the RW. For core inflation, none of the factors comes out as superior to the corresponding RW forecast; however, the best results are obtained with the same factor as those of total inflation.

Also, several econometric exercises are conducted to further discriminate between the inflation factors that come out as superior to the RW. These exercises—–(*i.e.* a brief comparison of key descriptive statistics, a regression-based biasedness analysis, forward- versus backward-lookingness estimates, a hybrid New Keynesian Phillips curve forecast comparison, and the U-Theil decomposition)—reinforce and give more support to the winner inflation factor. However, these exercises also reveal that a factor different to the second-best in terms of forecast accuracy, displays the characteristics required of a forecasting variable. Remarkably, this mentioned factor has the same specifications as the winner factor, with the only difference that it is composed by men instead of women. The results presented in this article are important because they help to identify the most accurate group when forecasting inflation and, thus, help to refine a routine read of the survey with this purpose.

In the rest of the article I describe the econometric setup, compounded by the dataset, the forecast evaluation framework plus some econometric estimations to characterise and emphasise the differences between inflation forecasts. In section 3, I present the results, whereas in section 4, I provide a discussion on three topics of interest in the light of results: (i) the extent to which the characteristics of the best forecasters are similar to that suggested by the international evidence, (ii) a discussion on why the mean is the chosen statistic instead of the median to represent individuals with the same characteristics, and (iii) an exploratory analysis on what type of price series the group with the worst results is targeting at. Finally, I conclude in section 5.

2 Econometric setup

2.1 Data

As mentioned above, I make use of the microdata freely available (after submitting an online registry) by the *Centro de Microdatos* of Universidad de Chile (`http://documentos.microdatos.cl/`). This database is the result of merging two surveys: the *Survey of Employment and Unemployment in Greater Santiago* (the EOD) and the *Survey of Perception and Expectations on the Economic Situation in Greater Santiago* (the IEE). A unique feature is that both databases are available (anonymously) at the individual level and are already merged as respondents are asked about both their labour situation as workers and their economic perceptions as consumers. The independence in answering both surveys, especially that of sentiment, is ensured by the wording of the questions. Thus, the sentiment is not conditioned to the labour situation by survey design.

Naturally, the universe of the IEE is the same of that of EOD:[4] inhabitants over 14 years old living in the Santiago Metropolitan Region and in Puente Alto and San Bernardo counties. These adds up to about 40% of the Chilean population in 2017. The sample is made up of 3,060 individuals per quarter, consisting in a stratified random sampling with a panel data component–a rotating panel. This is a method where part of the whole panel is kept permanently, and another part is an entirely new cross-section sample. The sample of 3,060 individuals in each quarter is divided into four subsamples of 765 individuals, where each subsample is independent and represents the Greater Santiago. The rotation design is of the 2-2-2 type, where two selected individuals are interviewed twice in a row, then they are not contacted in the following two rounds, and then they are interviewed again in the following two rounds, covering a period of 18 months in total. The collection technique is face-to-face interviews and the reported answer rate reaches 77.4% (informed on March 2014). The representativeness with respect to the universe could be considered adequate, but this is not the case when the whole country is considered, as it focuses in Santiago only.[5] The IEE is released quarterly and fully available since March 2001 (75 observations available until September 2019).

[4]Specific details can be found in Centro de Microdatos (2016).

[5]Santiago is Chile's capital city with 7.037 million inhabitants of a country total of 18.730 million in 2017, thus representing 37.57% of the total population.

The merged database is compounded of a total of 142 variables. Out of this total, 18 are associated with the IEE, and 46 with the EOD. Remaining variables are answers on the household's income and debt related issues and working variables for internal use. However, financial variables are available in a shorter sample span, making difficult to use it for the purposes of this article. Moreover, not all series of the EOD are possible to use for this same reason or for a very low answer rate. This is the case of income and the time of the respondent working in the same job. Particularly, these two questions would be useful to discriminate between groups (income as so, and the second as a proxy experience) and thus, other variables must fulfil this task.

The actual total and core inflation measures are presented in Figure 1, panel A. Notice that given that inflation rates are presented in monthly frequency, two versions of the quarterly series are analysed: the end-of-period rate (comparing the annual variation of the last month of each quarter with the same month of the previous year), and the average rate (comparing the annual variation of the 3-month average of the quarter with the same average of the previous year). For completeness, I also analyse whether factors predict core inflation[6] in its two versions (end-of-period and average). The variables used to classify and compound the inflation factors are gender, age, education, county of living, and economic sector of current work. Notice that all these attributes are mutually exclusive. I consider all individuals that respond "*Working*" to the "*Employment Situation*" question because it leads to a more meaningful result from where it is possible to draw some economics-based conclusions.[7] However, given the extensive answer classification in some of these questions, some factors deliver empty entries in quarters where no individuals fulfil the classification. To avoid this problem, I re-code some variables according to the key of Table 1.

Table 1. Re-coding key of considered attributes (*)

1. Gender
Original: Female, Male.
Re-coding: No re-coding.
2. Age
Original: 1=[0,14], 2=[15,24], 3=[25,34], 4=[35,44], 5=[45,54], 6=[55,65], 7=[65+].
Re-coding: 1=[0,34], 2=[35,65], 3=[65+].
3. Education
Original: 0=No education, 1=Elementary (incomplete), 2=Elementary (completed), 3=Secondary, 4=Technical, 5=College, 6=Other, 7=Non specified.
Re-coding: 1=[No education, Elementary, Secondary], 2=[Technical], 3=[College].
4. County of living
Original: 1=[Ñuñoa, La Reina, Macul, Peñalolén], 2=[San Miguel, La Cisterna, San Joaquín, La Granja, San Ramón, Pedro Aguirre Cerda, Lo Espejo], 3=[El Bosque, La Pintana, San Bernardo], 4=[Maipú, Cerrillos, Pudahuel, Lo Prado, Cerro Navia], 5=[Recoleta, Independencia, Conchalí, Renca, Quilicura, Huechuraba], 6=[Providencia, Vitacura, Las Condes, Lo Barnechea], 7=[Santiago, Estación Central, Quinta Normal], 8=[La Florida, Puente Alto].
Re-coding: 1=[San Miguel, La Cisterna, San Joaquín, La Granja, San Ramón, Pedro Aguirre Cerda, Lo Espejo, El Bosque, La Pintana, San Bernardo, Santiago, Estación Central, Quinta Normal], 2=[Ñuñoa, La Reina, Macul, Peñalolén, La Florida, Puente Alto], 3=[Providencia, Vitacura, Las Condes, Lo Barnechea], 4=[Maipú, Cerrillos, Pudahuel, Lo Prado, Cerro Navia, Recoleta, Independencia, Conchalí, Renca, Quilicura, Huechuraba].
5. Economic sector
Original: 1=Agriculture, 2=Mining, 3=Industry, 4=Construction, 5=Commerce, 6=Government and Financial Services, 7=Personal and Household Services, 8=Commonality and Personal Services, 9=Transportation and Storage.
Re-coding: No re-coding.

(*) Source: Author's calculations.

As mentioned above, I consider all "*Working*" answers to the "*Employment situation*" question, corresponding to 59.1% of total answers in average, 2005-18 (see Figure 1, panel B). The second and third place in terms of number of answers are "*Housework*" and "*Others*", from which are more difficult to delve further into their characteristics

[6]Core inflation is defined as the inflation rate of the CPI minus food and energy components.

[7]This could be possible if, for instance, the economic sector in which consumers are currently working was more or less exposed to the business cycle, and thus, an "exposure" mechanism to more relevant economic information could lead to more accurate forecasts (see Faure and Medel, 2020).

leading to more accurate forecasts as, for instance, considering the economic sector in which they worked (if applicable).

In terms of gender and age, Figure 1, panel C, suggests that the (34,55) years old (re-coded) tranche is the biggest for both male and female, whereas the survey is biased towards female in all the original tranches. This fact could be potentially problematic, but all other attributes could partially correct this bias by refining the groups with a sample closer to the population.

Regarding the education, Figure 1, panel D, display the distribution of the three tranches of education, re-coded to strengthen inflation factors with a more aggregate definition of "education". Notice that they are displayed using the original eight zones in which the IEE is compiled, showing a greater concentration of college degree level in the North-eastern part of Santiago, and lower levels of education living in the Western part of the city. Aiming to strengthen factors with a greater number of observations, the eight zones of Santiago defined and surveyed by the IEE are re-coded following a cardinal representation of them: South-western, South-eastern, North-eastern, and North-western. According to Figure 1, panel 5, cardinal zones are balanced in terms of total answers, except for the North-eastern zone. However, the correct representation is ensured through the different attributes shaping inflation factors, and then all of them evaluated in the same manner. Finally, the distribution of the sample across the economic sectors is presented in Figure 1, panel F. There is no re-coding for this variable and so, *Commerce* (2005-18 average: 21.1%), *Social Services* (18.9%), *Commonality and Public Services* (18.5%), *Industry* (13.8%), and *Personal Services* (10.1%) are the biggest sectors with double-digit weight in the total sample of the IEE.

Despite the re-coding of some variables to strengthen the factors, it is still possible to have some of them with no entry for some quarters. So, I use a criterion of each of the 648 factors disposing of at least 95% of the total possible observations (50 of out 55 observations). This criterion leaves out 55 of the 648 total factors which are listed in Figure 2. Also, given the reduced number of factors, it is possible to proceed with a brute-force exercise testing all factors instead of an algorithm-based search for the attributes leading to the best out-of-sample results.

2.2 Complementary econometric analyses

After finding the most promising factors, *i.e.* those exhibiting a better forecasting performance than the RW, I conduct some econometric exercises aiming to further discriminate between them. The first exercise is the simplest one and consists in a comparison of practical-use descriptive statistics. The second exercise compares the biases of the forecasting series. Expectations are unbiased–*i.e.* they show no room for improvement–if they are on average equal to actual inflation. This translates into the regression:

$$\pi_{\tau+4|\tau-4} = \alpha + \beta\pi_{\tau|\tau} + \varepsilon_{\tau}, \tag{1}$$

where $\pi_{\tau+4|\tau-4}$ is the 12-month-ahead forecast (but transformed to quarters), lagged in four quarters to be comparable to actual inflation $\pi_{\tau|\tau}$, α and β are parameters to be estimated, and ε_{τ} is a white noise. The frequency transformation implies replacing the t+12 subscript for τ+4. So, the condition of lack of bias means simultaneously that α=0 and β=1, that is tested through a Wald-type F-test. If the null hypothesis NH: α=0, β=1 is rejected, then the forecast is biased and there is room for improvements; otherwise, the prediction is said to be *efficient* in terms of using the information available up to the release of the latest observation.

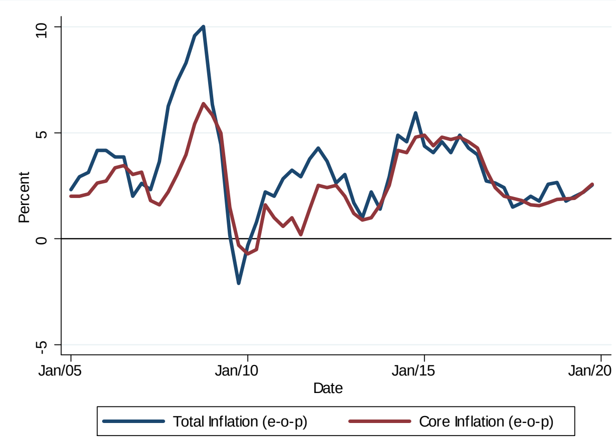
The third exercise, which encompasses the results of bias when present, consists in asking the degree to which forecast variables are forward- versus backward-looking. A static version of this test is represented with the regression:

$$\pi_{\tau+4|\tau} = \lambda + \gamma\pi_{\tau+4} + (1-\gamma)\pi_{\tau-1} + \upsilon_{\tau}, \tag{2}$$

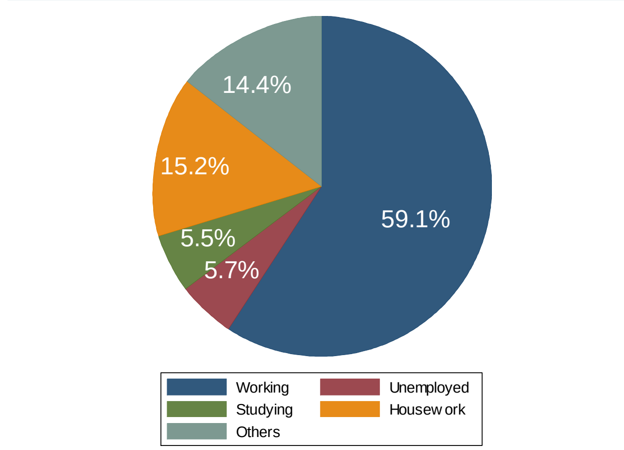
where λ and γ are parameters to be estimated, and υ_{τ} is a white noise. Thus, as the γ-parameters are constrained to add to unity, a relatively greater γ parameter reflects a higher degree of forward-lookingness of the factor, which is desirable for a forecasting variable. As Łyziak (2013) posits, a γ=1 parameter suggest that inflation forecasts are fully forward-looking and meet the requirement that the rational expectations hypothesis be unbiased. In contrast, if γ is not statistically different from zero, inflation forecasts are fully backward-looking, being very easy to outperform and, thus, providing very little informational content.

Figure 1. Actual inflation time series and considered attributes of the IEE (*)

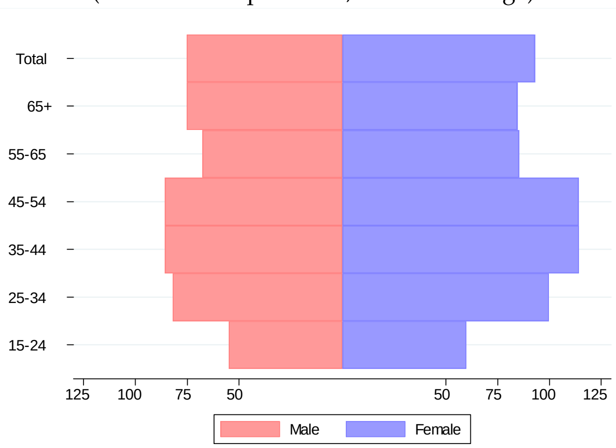
A. Total and core inflation
(annual variation)



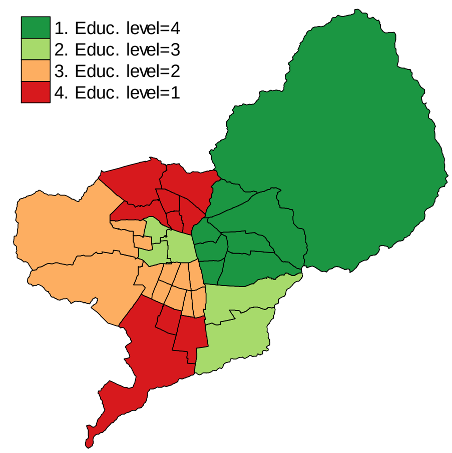
B. Employment situation
(percentage of total answers, 2005-18)



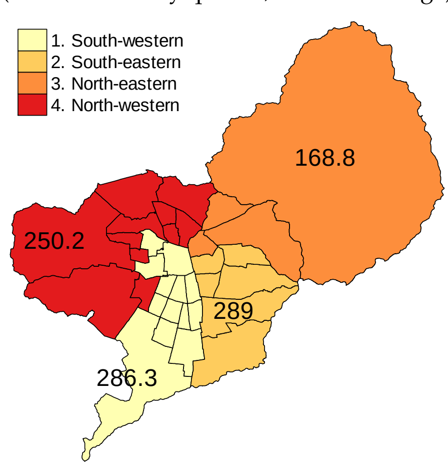
C. (Original) age groups by gender
(number of respondents, 2005-18 average)



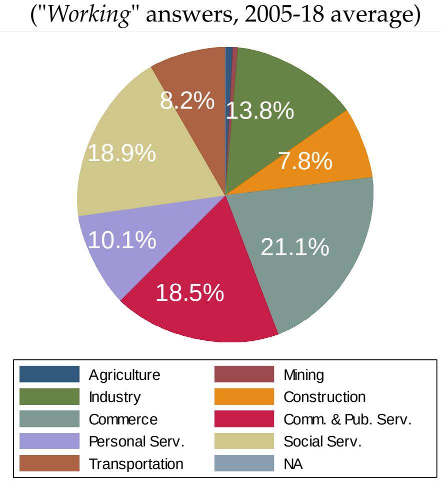
D. Education by (original) zones (8 zones)
(re-coded education, 2005-18 average)



E. Cardinal regions of Greater Santiago
(total answers by quarter, 2005-18 average)

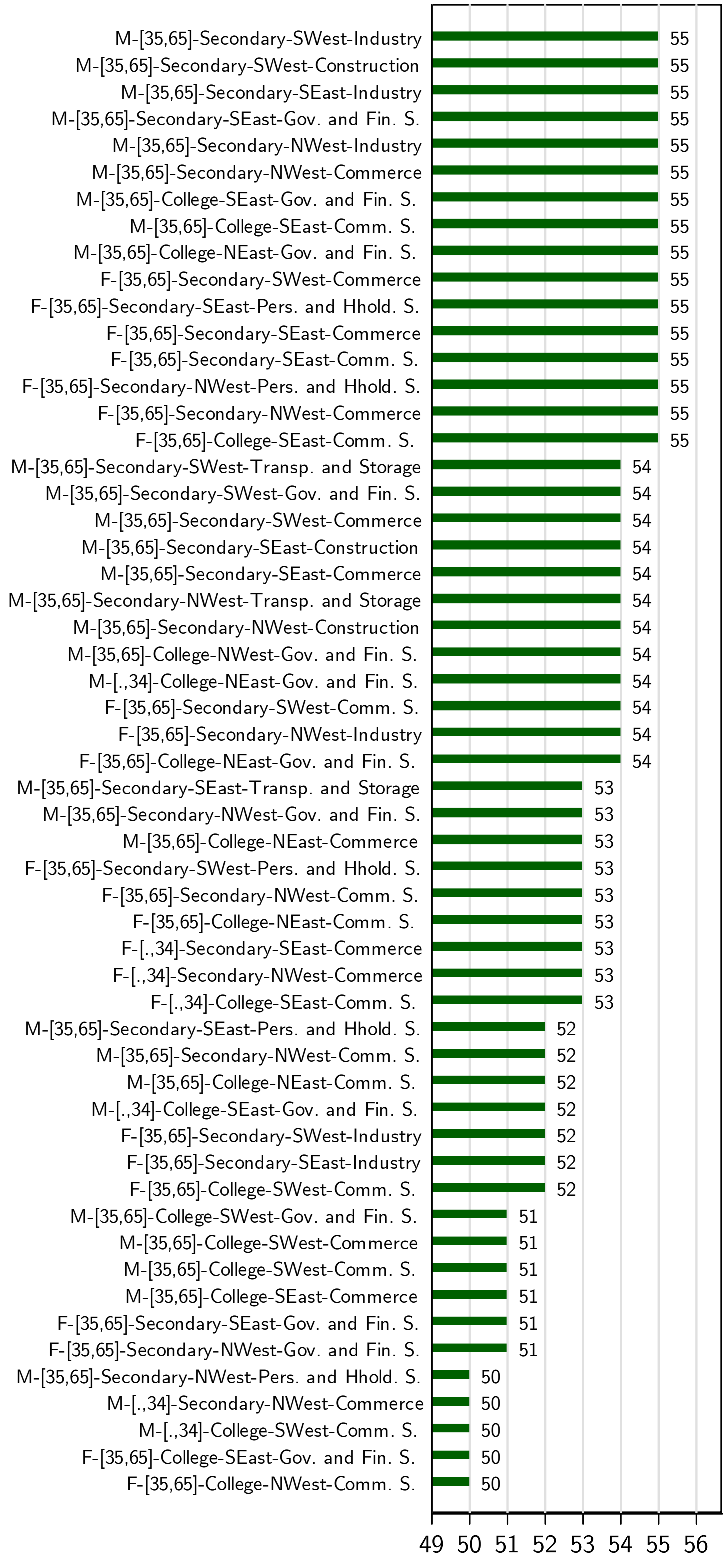


F. Economic sectors
("*Working*" answers, 2005-18 average)



(*) Author's calculations based on *Centro de Microdatos* database.

Figure 2. Considered factors for evaluation (*)



(*) Bars show the number of quarters with data considered in the analysis (those factors with at least 95% of total time sample with non-missing data)—*i.e.* 55 out of 648 of total factors. Total sample: 2005.II-2018.IV (55 observations). Source: Author's calculations based on *Centro de Microdatos* database.

Regarding the fourth exercise, a lot of empirical research has been conducted on the Phillips curve. Particularly after the proposal of Galí and Gertler (1999) of the hybrid New Keynesian Phillips curve including direct measures of inflation expectations, many authors have fit this type of Phillips curve for forecasting purposes.[8] The success of this version of the Phillips curve relies on the mixture of two features of price dynamics, namely, its persistence, captured with lagged inflation, and the prospective price formation by firms captured by direct measures of expectations. This is added to a cost push measure such as the output gap, reflecting inflationary pressures from the real economy.

Thus, if inflation expectations act as so, they must be statistically significant in this setup as argued in Łyziak (2013). Thus, the fourth exercise consists in using each promising inflation factor in a hybrid New Keynesian Phillips curve described as:

$$\pi_\tau = \overline{\pi} + \rho\pi_{\tau-1} + (1-\rho)\pi_{\tau+4|\tau} + \phi\widetilde{y}_\tau + \psi_\tau \tag{3}$$

where $\widetilde{y}_\tau$ is the output gap[9], $\overline{\pi}$, ρ, and ϕ are parameters to be estimated, and ψ_τ is a white noise. The criteria to determine in this case which inflation factor is preferable is based on both the statistical significance of the associated coefficient, and the improvements in the goodness-of-fit of the model. A third criterion is based on the 4-quarter-ahead forecast obtained with each estimated version of equation (3), and evaluated according to a symmetric cost function (the root mean squared forecast error). The estimation sample considers the first 30 observations for estimation (2005.III-2012.IV, 30 observations), leaving the remaining part of the sample (2013.I-2018.IV, 24 observations) for forecast evaluation.

Finally, the fifth exercise consists in the so-called U-Theil decomposition of forecast errors in bias, regression, and disturbance proportions. The objective of this decomposition is to disentangle and provide a taxonomy of forecast errors aiming to determine the sources of them. Consequently, depending on the source, an improvement strategy could be deployed. As Ahlburg (1984) states, following Theil (1971), the decomposition of the mean squared forecast error (MSFE) is:

$$MSFE = \frac{1}{P}\sum_{\tau=1}^{P}\left(\pi_{\tau+4|\tau} - \pi_{\tau+4}\right)^2 = \underbrace{\left(\overline{\pi}_{\tau+4|\tau} - \overline{\pi}_{\tau+4}\right)^2}_{\textit{Bias proportion}} + \underbrace{\left(\sigma_{\pi_{\tau+4|\tau}} - \rho\sigma_{\pi_{\tau+4}}\right)^2}_{\textit{Regression proportion}} + \underbrace{\left(1-\rho^2\right)\sigma^2_{\pi_{\tau+4}}}_{\textit{Disturbance proportion}}, \tag{4}$$

where $\overline{\pi}_{\tau+4|\tau}$ and $\overline{\pi}_{\tau+4}$ are the means of the predicted and actual values of inflation series, respectively, whereas $\sigma_{\pi_{\tau+4|\tau}}$ and $\sigma_{\pi_{\tau+4}}$ are their standard deviations, and ρ is the correlation coefficient between the predicted and actual values of the series. The bias proportion arises from the systematic under- or over-estimation of the mean of the target variable, whereas the regression proportion is due to the slope coefficient obtained of the relationship between the actual value of the series and its forecast value. These two sources of forecasting errors are systematic and could be reduced to improve accuracy. In contrast, the disturbance proportion is the non-systematic error, not allowing a role for the forecaster. To ease a comparison between these three components, they are re-scaled to the MSFE, so that they are now comparable across inflation factors. A factor with the highest disturbance proportions is, thus, a signal that forecasters are more efficient in the use of information. Notice that this evaluation is made with inflation factors obtained as so, without any kind of correction or combination. This is relevant as some factors that exhibit a worse performance than the RW in the first step, in an eventual second step of correction may outperform some factors with an initial promising accuracy. This kind of analysis–a data mining with forecasting purposes–, while useful certainly goes beyond the scope of this article. Also, a combination or accuracy enhancing technique will blur the true contribution of a specific group to forecast accuracy, being difficult to identify.

[8] See, for instance, Paloviita and Mayes (2005) for 11 European countries, Nason and Smith (2008) for the US, Henzel and Wollmershauser (2008) for Italy, Paloviita (2009) for the Eurozone, Jean-Baptiste (2012) for the UK, and Medel (2015, 2017) and Marcel, Medel, and Mena (2017) for the case of Chile.

[9] The approximation used here for the output gap is obtained as the difference between the logarithmic level of actual GDP and potential GDP. The latter is defined as the logarithmic level of the seasonally-adjusted and filtered version of the GDP including up to five years of forecast observations coming from an *ad-hoc* ARIMA model. This last step is performed to avoid the "end-of-sample" identification problem when using the Hodrick-Prescott (λ=1,600) method to filter the series. The seasonal adjustment program used is the X-13ARIMA-SEATS, whereas the ARIMA forecasting model is the so-called *airline model* (Box and Jenkins, 1970; Ghysels, Osborn, and Rodrigues, 2006).

2.3 Forecast evaluation framework

The forecast evaluation statistic used is the root mean squared forecast error (RMSFE) defined as:

$$RMSFE = \left[\frac{1}{P}\sum_{t=1}^{T=55}\left(\pi_{\tau+4} - \pi_{\tau+4|\tau}\right)^2\right]^{\frac{1}{2}}, \tag{5}$$

where $\pi_{\tau+4|\tau}$ represents the transformed 4-quarter-ahead forecast of $\pi_{\tau+4}$ made with information known up until time t. I dispose of a total of P=55 forecasts, ranging from 2005.II to 2018.IV in quarterly frequency. For simplicity, the results are reported using a relative measure of the RMSFE, easing a comparison across the alternative forecasts:

$$\text{RMSFE ratio=RMSFE}^{\text{Factor}}/\text{RMSFE}^{\text{RW}}, \tag{6}$$

where "Factor" stands for each of the 55 available factors. Thus, values below one imply a better performance in favour of the consumer-based factor.

To investigate to what extent the predictive gains are statistically significant, I make use of the unconditional one-sided t-type Giacomini and White (2006; GW) test providing the advantage of comparing forecasting methods instead of forecasting models. As the null hypothesis (NH) is defined as *the competing forecast has a superior predictive ability compared to the* RW, a one-sided t-type GW statistic is used accordingly.

Formally, I test the NH: $\mathbb{E}_\tau(d_\tau) \leq 0$, against the alternative AH: $\mathbb{E}_\tau(d_\tau) > 0$, where

$$\widehat{d_\tau} = \left(\pi_{\tau+4} - \pi^{RW}_{\tau+4|\tau}\right)^2 - \left(\pi_{\tau+4} - \pi^{Factor}_{\tau+4|\tau}\right)^2, \tag{7}$$

using the Newey and West (1987) heteroskedasticity and autocorrelation corrected estimator of the standard deviation of $\widehat{d_\tau}$. The NH is rejected if the subsequent t-statistic is greater that $t_{\alpha\%}$, corresponding to the tabulated value of a normal distribution with probability α%.

3 Results

3.1 RMSFE results

The RMSFE ratio results are presented in Table 2 for both headline and core inflation using the end-of-period as well as the average high-to-low frequency transformation. As mentioned above, figures below one are in favour of the consumer-based inflation factor. Factors are coded with the mask "`[Gender]`-`[Age tranche]`-`[Education]`-`[Cardinal region]`-`[Economic sector]`" and shown in lexicographic order. Also, those coming out better than the RW are labelled as *Fj*, where *j* is the ranking according to the RMSFE results. A further visual comparison can be found in Appendix B.

A remarkable result is that none of the factors outperforms the RW when forecasting core inflation neither the end-of-period nor the average version; and, thus, no further analysis with these target variables is performed. When analysing total inflation, however, eight factors outperform the RW with both end-of-period and average versions, even in a similar (but not equal) ranking. In both cases, the winner factor is that composed by women aged between 35 and 65 years old, with a college degree, living in the North-eastern part of the city, and working in *Commonality and Public Services* sector. This group is composed by up to 26 consumers, *i.e.* the top 1% of forecasters. In the second place, and still for the end-of-sample transformation, comes the factor composed by men aged between 35 and 65 years old, with a college degree, in a tie living in the North-eastern and South-eastern part of the city, but working in *Government and Financial Services* and *Commerce Services* sectors respectively. Then, in the fourth place are men aged between 35 and 65 years old, with a college degree, living in the North-western part of city, working on *Government and Financial Services*. From the fifth to eight places, I found men aged between 35 and 65 years old as a common characteristic, and concentrated in *Commonality and Public Services* and *Government and Financial Services*, but with an uneven spatial distribution. No other that the mentioned eight factors come out as superior to the RW. For the average transformation, the same ranking is observed except for a swap between the sixth and the seventh place.

Table 2. RMSFE ratio and Giacomini-White test (†)

Factor	*Headline inflation*		*Core inflation*	
	End-of-period	Average	End-of-period	Average
M-[.,34]-Secondary-NWest-Commerce	3.307**	3.404**	5.049**	5.196**
M-[.,34]-College-SEast-Gov. and Fin. S.	1.880	1.967	2.668	2.769
M-[.,34]-College-NEast-Gov. and Fin. S.	1.054	1.058	1.401	1.429
M-[35,65]-Secondary-SWest-Industry	1.654	1.691	2.435*	2.546*
M-[35,65]-Secondary-SWest-Construction	1.303	1.333	1.982**	2.052**
M-[35,65]-Secondary-SWest-Commerce	2.062**	2.115**	3.209**	3.318**
M-[35,65]-Secondary-SWest-Gov. and Fin. S.	2.424**	2.490**	3.601***	3.719***
M-[35,65]-Secondary-SWest-Transp. and Storage	2.387	2.479	3.638	3.759
M-[35,65]-Secondary-SEast-Industry	1.105	1.131	1.660	1.703
M-[35,65]-Secondary-SEast-Construction	1.587*	1.641*	2.368**	2.450**
M-[35,65]-Secondary-SEast-Commerce	1.383	1.387	2.156	2.200
M-[35,65]-Secondary-SEast-Gov. and Fin. S.	1.262	1.311	1.767*	1.849*
M-[35,65]-Secondary-SEast-Pers. and Hhold. S.	2.717	2.752	4.221	4.336
M-[35,65]-Secondary-SEast-Transp. and Storage	1.927*	1.964*	2.817**	2.934**
M-[35,65]-Secondary-NWest-Industry	1.335	1.365	2.079**	2.139**
M-[35,65]-Secondary-NWest-Construction	1.998	2.008	3.145*	3.228*
M-[35,65]-Secondary-NWest-Commerce	1.482	1.509	2.175*	2.250*
M-[35,65]-Secondary-NWest-Gov. and Fin. S.	2.342	2.375	3.497	3.589
M-[35,65]-Secondary-NWest-Comm. S.	1.268	1.289	1.815*	1.892**
M-[35,65]-Secondary-NWest-Transp. and Storage	1.410	1.421	2.094	2.165
M-[35,65]-College-SWest-Commerce	1.121	1.162	1.640*	1.684*
M-[35,65]-College-SWest-Gov. and Fin. S.	0.912	0.914	1.397	1.395*
M-[35,65]-College-SWest-Comm. S.	0.956	0.966	1.402	1.452
M-[35,65]-College-SEast-Commerce	1.829	1.885	2.628	2.732
M-[35,65]-College-SEast-Gov. and Fin. S.	0.913	0.910	1.366	1.389
M-[35,65]-College-SEast-Comm. S.	0.862	0.865	1.317	1.339
M-[35,65]-College-NEast-Commerce	2.071	2.096	3.132	3.205
M-[35,65]-College-NEast-Gov. and Fin. S.	0.862	0.856	1.085	1.097
M-[35,65]-College-NEast-Comm. S.	0.902	0.895	1.090	1.108
M-[35,65]-College-NWest-Gov. and Fin. S.	0.898	0.885	1.303	1.338
F-[.,34]-Secondary-SEast-Commerce	2.189**	2.267***	3.475***	3.568***
F-[.,34]-Secondary-NWest-Commerce	1.479**	1.517*	2.239***	2.313***
F-[.,34]-College-SEast-Comm. S.	2.137	2.183	3.066*	3.205*
F-[35,65]-Secondary-SWest-Industry	2.253***	2.327***	3.438***	3.564***
F-[35,65]-Secondary-SWest-Commerce	1.974*	2.015*	3.019**	3.118**
F-[35,65]-Secondary-SWest-Pers. and Hhold. S.	2.586***	2.666***	4.044***	4.170***
F-[35,65]-Secondary-SWest-Comm. S.	1.642*	1.674*	2.406***	2.476***
F-[35,65]-Secondary-SEast-Industry	2.556	2.608	3.901	4.021
F-[35,65]-Secondary-SEast-Commerce	2.257**	2.303**	3.379**	3.481**
F-[35,65]-Secondary-SEast-Gov. and Fin. S.	1.976	2.016	2.788	2.890*
F-[35,65]-Secondary-SEast-Pers. and Hhold. S.	2.246*	2.264*	3.584**	3.669**
F-[35,65]-Secondary-SEast-Comm. S.	2.369	2.409	3.720*	3.816*
F-[35,65]-Secondary-NWest-Industry	2.110**	2.143**	3.159***	3.265***
F-[35,65]-Secondary-NWest-Commerce	2.027*	2.081*	3.072**	3.206**
F-[35,65]-Secondary-NWest-Gov. and Fin. S.	1.525	1.546	2.288**	2.359**
F-[35,65]-Secondary-NWest-Pers. and Hhold. S.	1.437	1.453	2.163***	2.238***
F-[35,65]-Secondary-NWest-Comm. S.	2.573	2.651	3.790*	3.930*
F-[35,65]-College-SWest-Comm. S.	1.535	1.553	2.524*	2.564*
F-[35,65]-College-SEast-Comm. S.	1.769	1.801	2.665*	2.735*
F-[35,65]-College-NEast-Gov. and Fin. S.	1.031	1.018	1.467	1.485
F-[35,65]-College-NEast-Comm. S.	0.811	0.826	1.095	1.120

(†) Factor key: `[Gender]-[Age tranche]-[Education]-[Cardinal region]-[Economic sector]`. Shaded cells=RMSFE ratio<1. Giacomini and White (2006) test's p-value: (***) p<1%, (**) p<5%, (*) p<1%. Source: Author's calculations.

A major drawback of these results is that none of the mentioned eight factors comes out as statistically superior to the RW according to the Giacomini-White test. Notice that among the common characteristics of the eight best factors is that all of them are composed by consumers aged [35,65] and with a college degree. They are also composed by men, except for the winner factor. Regarding the economic sectors, despite being the option with more alternatives available, the best results are concentrated in just two sectors: *Government and Financial Sector* and *Commonality and Public Sector*. Finally, there is no clear pattern regarding the spatial location.

3.2 Complementary econometric results

As mentioned above, complementary econometric exercises aim at further discriminating between the eight best factors. The results are presented in Table 3. The first panel displays some descriptive statistics of both actual series and factors. Factors closest to the total end-of-period mean are *F3*, *F5*, and *F6* (see Table 2 for notation) whereas for the median are *F5*, *F3*, and *F1*. When comparing the standard deviations, *F3* and *F5* again come out with satisfactory results, a result replicated to the percentage of times within the (2,4) interval. In this sense, *F3* and *F5* display similar in-sample diagnostic as total end-of-period inflation, but it is relevant to delve into their predictive features with the remaining exercises.

The second panel suggests that the null hypothesis of unbiasedness is rejected for all factors and thus, there is room for improvement in all of them. However, the results of factors *F1* and *F2* suggest that they are more efficient in the use of information because the only statistically significant coefficient is that unrelated to actual inflation. Thus, for instance, a less-invasive intercept-correction method could deliver better results that the remaining factors, which requires more information to achieve efficiency. This is the case of the *F3* and *F5* factors, in which β result as statistically significant—0.258 and 0.149, respectively—and thus, they are not considering information of actual inflation when estimated. Notice, however, that this evaluation of factors is made to identify the characteristics of the group that better forecasts inflation, and not entirely of forecast accuracy, in the sense that digging more with these factors—particularly with these with a good behaviour—could deliver the best results after a number of statistical treatments and factor combinations; a task left for further research.

The third panel relates to the predictive characteristic of factors. In particular, to the degree of forward- versus backward-lookingness. As so, a significant and bigger γ coefficient is desirable. In this sense, *F1* and *F5* factors come out as the best options showing a share close to 50% of forward-lookingness. Remarkably, neither of the estimated coefficients comes out significant for *F7* and *F8* factors. This result is unexpected given their satisfactory results in the rest of the exercises. It is argued that, so far, *F1* (and recalling that it is the best factor according to the RMSFE ratio) and *F5* are the factors with the desirable features of a forecasting variable, and that the only difference in their composition is that while *F1* is compounded by women, *F5* is compounded by men.

The fourth panel is regarding the hybrid New Keynesian Phillips curve. It is observed that all factors display statistically significant results and, thus, the discriminatory power seems low. However, when making predictions with these estimates (actual end-of-period inflation four quarters ahead) the differences are more noticeable. In particular, *F2* and *F7* factors display the lowest RMSFE, followed by the *F3* and *F5* factors, and then *F4* and *F1* factors. Thus, the hybrid New Keynesian Phillips curves based on neither *F1* nor *F5* are on the top three of inflation forecasts, with the caveat that no statistical inference is carried out between them. These results could be explained by a slightly greater output gap coefficient allowed by the factors leading to the best forecasting results, and also to the difficulty to estimate regression coefficients with covariates more correlated between them.

Finally, the fifth panel concerns the U-Theil decomposition. As mentioned above, a greater share of the disturbance proportion is desirable from the point of view of this evaluation, as it aims to reveal how efficient the respondents are in the use of information and expectation formation, without any *ex post* statistical intervention. Consequently, the *F1* factor comes out as the best alternative because it shows the largest share of disturbance and, by construction, the smallest share of bias and noise due to the regression. In these terms, the *F5* factor is the one with the best options to be corrected as displaying the highest regression proportion.

An in-depth analysis of *F1* and *F5* factors consists in hand-picking observations in which they both perform poorly and transform it to missing observation. On the one hand, for the *F1* factor, an observation with a greater deviation is found in 2009.IV (showing 6.0% when the actual inflation was -2.1%). Dropping this observation reduces the RMSFE ratio from 0.811 to 0.807. On the other hand, for the *F5* factor, two major deviations are noticed; one in 2009.IV (6.0% versus -2.1% actual) and another in 2010.IV (7.5% versus 2.0% actual). Dropping these observations implies dropping the RMSFE ratio from 0.902 to 0.878–thus, a fall in the RMSFE ratio is not enough to overperform the *F1* factor. Therefore, the *F1* factor still stands as the best factor. Also, a remarkable fact is that during the 2008-09 *Global Financial Crisis*, the *F1* factor recorded an inflation forecast of 10.1% while the effective rate was 9.9%. At the same time, the *F5* factor registered a wider difference by recording a rate of 4.8%.[10]

In sum, according to the analysis of complementary econometric exercises, the *F1* factor (*F*-[35,65]-*College*-*NEast*-*Comm. S.*) is consistently the best in terms of accuracy and desired features expected from a forecasting variable. However, the *F5* factor (*M*-[35,65]-*College*-*NEast*-*Comm. S.*), despite not being the second best in terms of accuracy measured through the RMSFE ratio, comes out as a valid option fulfilling the behaviour of a forecasting variable.

Table 3. Complementary econometric results (*)

	Total	Total					°			
	E-o-p	Average	*F1*	*F2*	*F3*	*F4*	*F5*	*F6*	*F7*	*F8*
RMSFE ratio	-	-	0.811	0.862	0.862	0.898	0.902	0.912	0.913	0.956
Mean	3.335	3.428	3.754	4.025	3.490	3.798	3.322	3.729	3.962	3.953
Median	2.932	3.176	3.268	3.481	3.268	3.667	3.091	3.310	3.586	3.500
Std. deviation	2.122	2.150	1.467	1.808	1.282	1.771	1.235	2.297	2.263	2.430
% within (2,4)	65.9%	49.1%	59.2%	62.3%	66.0%	43.1%	74.5%	46.7%	58.5%	42.2%
Equation 1: $\pi_{\tau+4\mid\tau}=\alpha+\beta\pi_{\tau\mid\tau}+\varepsilon_\tau$, $\varepsilon_\tau \sim$ white noise										
α	-	-	**3.515**	**3.222**	**2.600**	**2.951**	**2.811**	**2.526**	**2.469**	**2.996**
p-value	-	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.007)
β	-	-	0.067	0.232	**0.258**	**0.243**	**0.149**	**0.339**	0.432	0.280
p-value	-	-	(0.653)	(0.150)	(0.000)	(0.070)	(0.036)	(0.000)	(0.113)	(0.371)
F-test (α=0,β=1)	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.017
p-value	-	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.011)
Adj. R-sq.	-	-	0.000	0.062	0.181	0.075	0.056	0.079	0.161	0.033
Equation 2: $\pi_{\tau+4\mid\tau}=\lambda+\gamma\pi_{\tau+4}+(1-\gamma)\pi_{\tau-1}+\upsilon_\tau$, $\upsilon_\tau \sim$ white noise										
γ	-	-	**0.450**	**0.319**	**0.383**	**0.298**	**0.454**	**0.248**	0.155	0.186
p-value	-	-	(0.003)	(0.008)	(0.000)	(0.005)	(0.000)	(0.006)	(0.312)	(0.366)
$1-\gamma$	-	-	**0.550**	**0.681**	**0.617**	**0.702**	**0.546**	**0.752**	0.845	0.814
p-value	-	-	(0.003)	(0.008)	(0.000)	(0.005)	(0.000)	(0.006)	(0.312)	(0.366)
Adj. R-sq.	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Phillips curve: $\pi_\tau=\overline{\pi}+\rho\pi_{\tau-1}+(1-\rho)\pi_{\tau+4\mid\tau}+\phi\widetilde{y}_\tau+\psi_\tau$, $\psi_\tau \sim$ white noise										
ρ	-	-	**0.884**	**0.836**	**0.772**	**0.866**	**0.794**	**0.810**	**0.790**	**0.894**
p-value	-	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$1-\rho$	-	-	**0.116**	**0.164**	**0.228**	**0.134**	**0.206**	**0.190**	**0.210**	**0.106**
p-value	-	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ϕ	-	-	**0.304**	**0.316**	**0.254**	**0.281**	**0.285**	**0.241**	**0.336**	**0.407**
p-value	-	-	(0.034)	(0.032)	(0.050)	(0.047)	(0.000)	(0.088)	(0.011)	(0.028)
Adj. R-sq.	-	-	0.705	0.721	0.740	0.718	0.737	0.732	0.745	0.683
RMSFE (*h*=4)	-	-	1.768	1.404	1.501	1.725	1.509	1.791	1.440	2.085
U-Theil decomposition: Squared errors = Bias + Regression + Disturbance										
Bias	-	-	2.4%	8.1%	0.1%	2.0%	0.1%	2.0%	22.3%	13.5%
Regression	-	-	17.3%	17.4%	67.7%	50.6%	87.4%	43.9%	10.5%	21.8%
Disturbance	-	-	80.3%	74.6%	32.1%	47.3%	12.5%	54.1%	67.2%	64.6%

(*) *F1*-...-*F8* are the eight factors highlighted in Table 2 sorted according to its RMSFE ratio. Bold estimates in panels 2 to 4 show statistically significant coefficients at 10% level of confidence. *p*-value shown in parentheses. "Adj. R-sq." stands for adjusted

[10] A final exploratory check is regarding forecast combinations. An exercise carried out combining both *F1* and *F5* factors with linear weights adding to unity suggest that pairwise combinations does not improve the accuracy of the *F1* factor. In particular, using the 9-ordered-pair grid ranging from 0.1 to 0.9 as weight for *F1* (and, consequently, of 0.9 to 0.1 for *F5*) deliver RMSFE ratios of 0.890, 0.874, 0.860, 0.849, 0.839, 0.831, 0.826, 0.823, and 0.823 which are all below the 0.811 RMSFE ratio exhibited by the *F1* factor alone.

goodness-of-fit coefficient. In panel 2, "F-test (α=0,β=1)" stands for the F-statistic of the null hypothesis α=0 and β=1. In panel 4, all estimates are performed with the Ordinary Least Squares method, and the Newey and West (1987) heteroskedasticity and autocorrelation corrected estimator for the standard deviation. For forecasting purposes, the sample 2005.III-2012.IV (30 observations) is used for estimation, whereas the sample 2013.I-2018.IV (24 observations) is used for evaluation. In panel 5, each column adds to unity. Sample: 2005.II-2018.IV (55 observations). Source: Author's calculations.

4 Discussion

In this section, I analyse three issues of interest in the light of results: (i) the extent to which they have common features with the international evidence, (ii) an explanation on why I use of the mean instead of the median as the statistic that built inflation factors, and (iii) an exploratory analysis on the results of the less accurate factor (*M-[.,34]-Secondary-NWest-Commerce*, see Table 2), questioning which granular prices respondents may be targeting at when they are surveyed.

The first issue of this section is to analyse to what extent the characteristics of the best forecasters found in this paper relates to the international evidence. Three facts are worth mentioning: (i) the results of this paper could be easily summarised as higher-income (due to its county of living) women aged between 35-65 years old with a college degree are the best forecasters within the survey (when using the whole sample), (ii) it is very common to find that higher-income households, males, more educated, and older respondents are the best forecasters when analysing international surveys, and (iii) it is very uncommon to find women as the best forecasters.

The evidence collected from the *Survey of Consumers* of the University of Michigan for the United States gives a good benchmark as it reports personal characteristics of the respondents, such as gender, age, marital status, education, race, and income level. The findings generally suggest that white males with more than high-school educational level, within the 55-65 years-old range provide more accurate inflation forecast 12-month-ahead (Bryan and Venkatu, 2001a, 2001b; Souleles, 2004; Pfajfar and Santoro, 2008; Meyer and Venkatu, 2011; Madeira and Zafar, 2015). The "race" variable is included in Bryan and Venkatu (2001a), Meyer and Venkatu (2011), Madeira and Zafar (2015), Axelrod, Lebow, and Peneva (2018) when using the *Survey of Consumers*, and Rossow, Padayachee, and Bosch (2011) analysing the South African case, playing a role in forecast accuracy, but it is not captured by the IEE survey as Chile's Metropolitan Area has a relatively low race diversity at the time survey's sampling was set. Nowadays, however, as Central Bank of Chile (2018) points out, an immigration shock was experienced during 2015-2017 in Chile which was of a substantial number of people (achieving 8.8% of the labour force according to the 2017 Census) and concentrated in the Metropolitan Area. Also, origin countries and race of this immigration wave are more diverse and showing a significant participation in the labour market (a rate of 77% registered in the March-May 2017 moving quarter). Thus, future sample updating of the IEE could include the race variable.

Also, Palmqvist and Strömberg (2004) using a survey conducted by *Statistiska Centralbyrån* (Statistics Sweden) and *Growth from Knowledge* (GfK) for Sweden, Armantier *et al*. (2017), using the New York Fed's *Survey of Consumer Expectation* for the United States, Campelo *et al*. (2019) using the Brazilian IBRE/FGV *Consumer Confidence Survey*, among others cited above using the *Survey of Consumers* of the University of Michigan, includes geographic zones which are determinant of inflation expectations differences among demographic groups but, by nature, they are incomparable across surveys.

Interestingly, Sabrowsky (2008) makes use of the *Business and Consumer Survey* conducted by the European Commission for Germany being able to find a statistically significant role of labour status (working/unemployed) when finding the best forecasting demographic group; an issue also treated in Malgarini (2008) for the Italian case. Similarly, Ehrman, Pfajfar, and Santoro (2017) are able to analyse the role of financial situation of respondents using the *Survey of Consumers*, finding that more credit-constrained respondents tends to overestimate inflation rates. Goyal and Parab (2019) include the assessment of the economic outlook of respondents when analysing consumers' inflation expectations for the case of India, whereas Ichiue and Nishiguchi (2015) are able to analyse the role of asset holdings and financial literacy for the case of Japan, and Diamond, Watanabe, and Watanabe (2020) add the type of contract of the respondent as determinant of inflation expectations, also for Japan.

The overwhelming majority of survey-based results on inflation expectations by demographic groups suggest males as the best forecasters when controlling for all mentioned variables. This is the main difference of the results of this paper with the international evidence. In general, females tend to overestimate inflation because they put an additional attention to prices with a higher volatility, overreacting when forming their inflation expectations. This hypothesis was firstly analysed in Jonung (1981) for the case of Sweden and proposed in Pfajfar and Santoro (2008) using the *Survey of Consumers*. However, in the case of Chile, this fact seems to play in favour of females when forming their inflation expectations. This advantage could be obtained by three reasons: females spending more time screening a major portion of CPI-basket item prices or the Chilean total inflation is specifically driven by those items in which females put more attention than males, *i.e.* food stuff, as suggested by Jonung (1981), or a combination of both reasons.

Regarding the first reason, there is some supporting evidence in the Chilean *National Survey on Time Use* (ENUT) conducted by the National Statistics Institute (2015), pointing out that within the group of employed, men dedicate an average of 2.85 hours a day to "unpaid work" (category that includes purchases of home stuff), while women allocate an average of 5.85 hours a day to these tasks (difference women minus men: +3 hours). This difference grows within the unemployed, in which men spend an average of 3.49 hours a day, while women 7.11 hours (difference: +3.62 hours), and a slightly larger difference (+3.69 hours) in inactive people, with men allocating 2.54 hours, while women 6.23 hours, which is almost equal to an office-based working time of 8 hours per working day.

This explanation is also in line with the claim of Reis (2006a, 2006b), suggesting that different agents of the economy have different incentives to "rational in-attend" changes in prices. This could explain the difference across income levels and, added to the results regarding time use, it also could explain the difference between males and females.

The second issue of this section relates to the use of the mean instead of the median of each group of respondents as the statistic used to build factors. Meyer and Venkatu (2011) suggest that the appropriate statistic to be used to represent and compare demographic groups in inflation expectations, should be the median instead of the mean. However, a first important difference of this paper with respect to Meyer and Venkatu (2011) is the sampling method, sample span, and the frequency in which the survey is conducted. As Meyer and Venkatu (2011) make use of the *Survey of Consumers* elaborated by the University of Michigan, they dispose of a minimum of 500 answers per month with samples designed to be representative of all American households, excluding those in Alaska and Hawaii, which is very different to the Chilean case analysed in this paper, referring just to the Greater Metropolitan Area (and the CPI still being elaborated country wide). Also, the question about inflation expectations[11] has been asked since the early 1980s, thus, covering a time span of 30 years at the time of that study (2011). Instead, the Chilean data of *Centro de Microdatos* covers a time span of 13 years in a quarterly basis. All these differences pose a titanic challenge to ensure the right representation of each characteristic that together compound an inflation factor.

Nevertheless, and even more relevant for the exercise carried out in this paper, it is key that when more respondents fulfil the characteristics that defines the factor, they can re-shape the distribution function and change the group's outcome: this occurs when using the mean instead of the median. This makes that any respondent that fulfil characteristics counts and, as lack of more information, any of them do that with the same weight $1/N$ (assuming randomness with N being the number of respondents of the factor). In contrast, when using the median, respondents could be *irrelevant* despite that they fulfil with the criteria to be part of the factor, contradicting the setup of this exercise. For instance, a factor could be compounded of $N-2$ respondents, and two new respondents must be added to the factor. By using the $N-2$ sample, the factor displays a median of $\overline{M}_{N-2}$. If the new entries are $(\overline{M}_{N-2}+\varepsilon_1)$ and $(\overline{M}_{N-2}-\varepsilon_2)$, where $0<(\varepsilon_1,\varepsilon_2)<\gamma$ with $\gamma \leq \min\{\left|x^{\max}-\overline{M}_{N-2}\right|,\left|\overline{M}_{N-2}-x^{\min}\right|\}$, where $x^{\max}$ and $x^{\min}$ are the maximum and the minimum value of inflation expectation reported, then $\overline{M}_{N-2}=\overline{M}_N$, and the two new observations become irrelevant when considering the median—despite that the respondents fulfil the characteristics of the factor and thus, must be included. However, when using the mean, the case $\overline{M}_{N-2}=\overline{M}_N$ only happens if $\varepsilon_1=\varepsilon_2$ and all respondents are included in any case. Also, if $\varepsilon_1>\varepsilon_2$ then $\overline{M}_{N-2}<\overline{M}_N$, and if $\varepsilon_1<\varepsilon_2$ then $\overline{M}_{N-2}>\overline{M}_N$, making every respondent to have an impact on the overall score of the factor. As the

[11] *"During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?"*.

exercise carried out in this paper makes every respondent count (in a large extent because of the sampling method of the database), I opt to use the mean as the chosen point of the distribution.

In any case, the Table 1C in Appendix C display the results mimicking Table 2 but using the median instead of the mean. The results are sensitive to this change, and now a total of 14 (instead of 8) factors display a RMSFE ratio below unity, explained because the insensitivity of the median to outliers. Yet, none of the factors comes out as statistically significant according to the Giacomini-White test. All of the eight factors that show a better performance than the RW using the mean are still better than the RW when using the median, except the *M-[35,65]-College-SWest-Comm. S.* factor that is no longer better than the RW. This result makes the point that excluding some respondents not *always* lead to better results and choosing the point of the distribution function with the best forecasting results for a factor could be a more sophisticated task than calculate an automated statistic.

The third issue of this section consists of analysing the factor showing the worst performance (according to the RMFSE loss function) when forecasting the end-of-period headline inflation. This is the *M-[.,34]-Secondary-NWest-Commerce* factor (see Table 2), showing a RMSFE ratio of 3.307. So, the question is if the respondents with mentioned characteristics aimed at forecasting a specific price item or a reduced subset of the CPI basket. To that end, I make use of the 2018 CPI basket data prices at granular level constructed in Alvarado and Medel (2020) to calculate the correlation coefficient between mentioned factor and 303 items compounding the current CPI basket. An important feature is that the correlation is estimated contemporarily, this is, without considering the time horizon in which the respondents give their answers and the horizon in which they are asked. This is so—and, thus, the used statistic is the correlation coefficient and not the RMSFE—because the respondents could easily think in "12-months ahead" as a vague future date, without necessarily perfectly matching the months in which the questions is posed. This distinction is highly sensitive for the RMSFE calculation over the 303 items of the CPI basket, and so, the results are firstly of an exploratory nature using the contemporary correlation coefficient.

The results are shown in Table 4. These consist of all items with a correlation coefficient greater than |40%| with the most inaccurate factor (first column), obtaining five out of 303 items fulfilling this criterion;[12] almost all of them classified as necessities: potatoes, canned vegetables, milk flavour, homeopathic medicines and food supplements, and furniture repair service. Also, the correlation between the *M-[.,34]-Secondary-NWest-Commerce* factor and total inflation is -0.11% for the 2005.II-2018.IV (55 observations) sample, being almost unrelated between them in contemporaneous terms. To further delve into the target of the analysed factor, the items could be grouped in three sets: food stuff, medicines, and home maintenance—which could be associated to a spending composition of lower-income households.

According to CLAPES-UC (2020), an estimation of the 2018-based CPI basket for the poorest-income quantile comes out with a greater weight for "*Food and non-alcoholic beverages*" of 26.34%, representing 7.04 basis points greater than the weight of the whole CPI basket. In contrast, "*Health*" represents 6.77% of the poorest-income quantile basket, -1 basis point less than that of the whole CPI basket, and "*Home equipment and maintenance*" comes out with 4.46% of the poorest-income quantile basket, corresponding to -2.07 basis points less than the weight in the whole basket. Note that a greater weight of food items is generally associated to poorer-income household spending. Also, as public health in Chile is free or provided with a subsidized low end-price for the poorer households, the CPI captures better private health prices that obeys more to a market-oriented logic. Thus, it is not surprising that the poorest-income quantile is less represented by this category in the CPI; also, considering that the identified item corresponds to what is considered alternative medicine in Chile (homeopathic) rather than the conventional Western medicine, suggest the use of cheaper treatment alternatives. Finally, it is undistinguishable from the label "*Home equipment and maintenance*" which share is associated to "*maintenance*", but the spending in "*Furniture repair service*" certainly suggest the use of a second-best alternative to new home furniture. In sum, there is some evidence suggesting that the *M-[.,34]-Secondary-NWest-Commerce* factor is inaccurate when forecasting total inflation because its respondents are targeting a subset of the whole CPI, but they could be very accurate when forecasting a CPI basket more oriented to lower-income households. Also, this result does not rule out that respondents compounding this factor follow a similar price-expectation formation process than those respondents of the most accurate factor but with different targets, which deserve a more in-depth research.

[12] Notice that a higher threshold, *e.g.* |50%|, leads to just two items (*Potatoes and Canned vegetables*) fulfilling the criterion, whereas lower thresholds, namely |30%|, |20%|, and |10%| lead to 19, 45, and 78 items, respectively, being more difficult to find a common characteristic across them. So, a |40%| threshold led to a plausible number of items to be analysed.

Table 4. CPI basket items with higher correlation (|40%|) with the most inaccarute factor (*)

No.	Item	Correlation of the item with the most inaccurate factor	Correlation of the item with the total CPI inflation	2018 CPI basket weight of the item
1	*Potatoes*	0.561	0.328	0.3362
2	*Canned vegetables*	0.505	0.294	0.0437
3	*Milk flavour*	0.441	0.282	0.0502
4	*Homeopathic medicines and food suppl.*	0.431	0.143	0.0855
5	*Furniture repair service*	0.400	0.147	0.0266

(*) The most inaccurate factor is *M-[.,34]-Secondary-NWest-Commerce*. Items' time-series at granular level are obtained from Alvarado and Medel (2020). Sample: 2010.I-2018.IV (36 observations). Source: Author's calculations.

5 Concluding remarks

The aim of this article is to evaluate quantitative inflation forecasts for the Chilean economy taking advantage of a specific survey of consumer perceptions at the individual microdata level which, at the same time, is linked to a survey of employment/unemployment of Chile's capital city, Santiago. Thus, the key advantage of the database is that it is possible to link, with no error, consumer perceptions and 12-month-ahead inflation forecasts with labour-market characteristics of the respondents which heavily rely on personal (yet anonymous) characteristics. This is done by constructing sub-sets of inflation expectations factors with fully identifiable and mutually excluded characteristics such as gender, age, education, county of living, and the economic sector of present work.

By using a quarterly sample ranging from 2005.III to 2018.IV, the results for total inflation suggest that women aged between 35 and 65 years old, with a college degree, living in the North-eastern part of the city (that with the highest living standards of the country), and working in *Commonality and Public Services* sector are the best forecasters. Men aged between 35 and 65 years old, with a college degree, in a tie living in the North-eastern and South-eastern part of the city, but working in *Government and Financial Services* and *Commerce Services* sectors respectively, are the second best at forecasting inflation. Finally, men aged between 35 and 65 years old, with a college degree, living in the North-western part of city, working on *Government and Financial Services* are in fourth place. From the fifth to eight places, I found men aged between 35 and 65 years old as a common characteristic and concentrated in *Commonality and Public Services* and *Government and Financial Services*, but with a different spatial distribution. All these results are obtained by comparing mentioned inflation expectations factors to the naïve RW forecast. Only these eight out of 648 total possible factors outperform the RW, and none of them coming out as statistically superior. For core inflation, none of the factors comes out as superior to the corresponding RW forecast.

A number of econometric exercises are also conducted to further discriminate between the best inflation factors, revealing that a factor different to the second-best in terms of forecast accuracy, displays the characteristics required of a forecasting variable. Remarkably, this factor has the same specifications as the winner factor, with the only difference that it is composed by men instead of women. Thus, potentially, there is space to delve into more intricate schemes to take full advantage of the predictive information of the overall survey–a task left for further research.

The results of this paper are different to the general conclusions found in the international evidence, in the sense that women are better forecasters than men. All other comparable characteristics (higher income, higher educational level, and age range) are in line with the common findings. This led to think that in Chile either women pay more attention to a wider range of CPI-basket price items, or the Chilean total inflation is driven specifically by those items in which women form their expectations much better than men. Finally, the most inaccurate factor owes its result to the fact that it targets a subset of the CPI basket and focused on a lower-income household spending. This does not necessarily suggest that they form their expectations in the wrong way or different from that of the winning factor.

It is important to remark that all this evaluation is made to reveal how efficient certain groups of respondents are in the use of information and inflation expectation formation, with neither any *ex post* statistical intervention nor factor combinations.[13] The results presented in this article are important because they help to identify the most accurate group when forecasting inflation and, thus, help to refine a routine read of the survey with this purpose.

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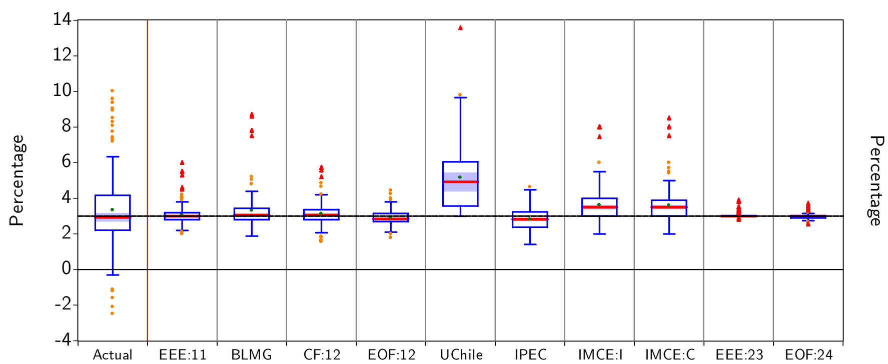
A Surveys of inflation expectations in Chile

In this appendix, I compare the Universidad de Chile's *Centro de Microdatos* inflation expectations average ("UChile") with seven surveys asking at the same horizon plus two at 24-months ahead, *i.e.* the official monetary policy horizon, and including the actual total inflation series.

The comparison is made through the boxplots of Figure 1A.[14] Note that "UChile" is the survey with the worse performance when using all raw data in terms of point and dispersion—with the distinctive feature that is the only survey considered in this figure that is conducted in a quarterly basis, whereas remaining ones are conducted in a monthly or daily basis. Other consumer expectations are "IPEC" ("*Índice de Percepción de la Economía*" elaborated by *Adimark*) whereas the remaining ones are answered by either experts or professional analysts. The best results at 12-month horizon are obtained with "EEE:11" ("*Encuesta de Expectativas Económicas*," elaborated by the Central Bank of Chile), "BLMG" (*Bloomberg* survey), "CF:12" (*Consensus Economics* survey, applying a weighting scheme to transform it from a moving horizon to a 12-month fixed horizon), and "EOF:12" ("*Encuesta de Operadores Financieros*" conducted by the Central Bank of Chile before each Monetary Policy Meeting). The last two boxplots display the EEE and EOF inflation expectations at 24-month ahead, with a little or virtually no variation from the inflation target of 3% within the sample.

The "IMCE:I" and "IMCE:C" corresponds to the "*Indicador Mensual de Confianza Empresarial*" (entrepreneurs) elaborated by *Instituto Chileno de Administración Racional de Empresas* (ICARE) and *Universidad Adolfo Ibáñez* (UAI), where "I" stands for "Industry" (manufacturing) and "C" for "Commerce" (retail). These two surveys are not as accurate as those responded by experts and professional analysts, but certainly are much better than those of "UChile". So, Figure 1A puts into perspective the challenge to be addressed and the sense in search for the best forecasters within the "UChile" consumer perception survey.

Figure 1A. Boxplots of Chilean inflation expectations surveys (*)



(*) All data are transformed to annual variation in order to be compared to the 3% annual variation official inflation target. "Actual" stands for annual variation of total CPI inflation in monthly frequency. Sample: Jan-00/Jul-20 (247 observations). Source: National Statistics Institute. "EEE:11" and "EEE:23" plus "EOF:12" and "EOF:24" stands por "*Encuesta de Expectativas Económicas*" at 11- and 23-month horizon, and "*Encuesta de Operadores Financieros*" (prior to each Monetary Policy Meeting) at 12- and 24-month ahead; respectively. Sample: EEE: Sep-01/Jul-20 (227 observations); EOF: Dec-09/Jun-20 (127 observations). Source: Central Bank of Chile. "BLMG" stands for *Bloomberg* daily median inflation forecast, considering the last day of each month. Sample: Jan-08/Jul-20 (151 observations). Source: Bloomberg. "CF:12" corresponds to a 24-term weighted average between the "current year" and the "next year" horizons of the *Consensus Forecast* report to reflect a unique 12-month comparable horizon. Sample: Jan-00/Jul-20 (247 observations). Source: *Consensus Economics*. "UChile" stands for the Universidad de Chile's *Centro de Microdatos Survey of Perception and Expectations on the Economic Situation in Greater Santiago* quarterly data. Sample: 2005.II/2018.IV (55 observations). Source: *Centro de Microdatos*. "IPEC" stands for "*Índice de Percepción de la Economía*"

[14]Note that Figure 1A depicts survey-based inflation expectations only. However, it could be easily extended by making use of the information obtained from financial assets which are possible to extract the breakeven inflation rate. However, those expectations are of a different nature. The complete graph, however, including those expectations coming from financial assets, is available here.

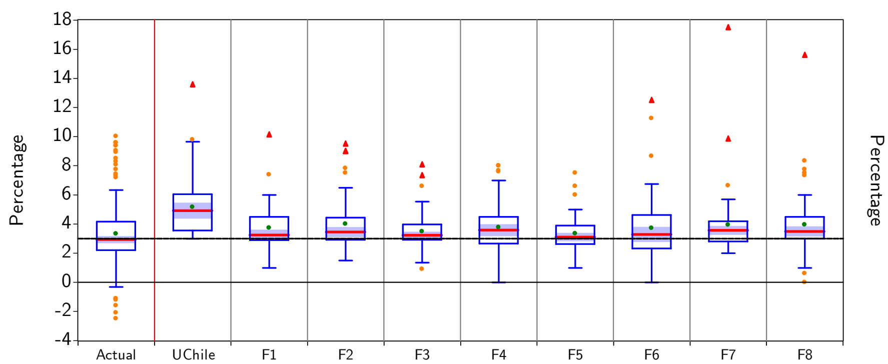
(consumers) and the original index with 50 as a neutral value is extrapolated as 3% inflation rate. Sample: Mar-02/Jun-20 (220 observations). Source: *Adimark*. "IMCE" stands for "*Indicador Mensual de Confianza Empresarial*" (entrepreneurs) where "I" stands for "Industry" (manufacturing) and "C" for "Commerce" (retail). Sample: May-05/Jun-20 (182 observations). Source: *Instituto Chileno de Administración Racional de Empresas* (ICARE) and *Universidad Adolfo Ibáñez* (UAI).

B A visual comparison between the best factors

In this appendix, I analyse the boxplots of the eight factors that outperform the RW, compared to the aggregate "UChile" factor and the actual total inflation series. The boxplots are shown in Figure 1B.

The first fact to note is that all factors display an enhanced forecast accuracy compared to the aggregate in terms of the mean point, whereas some of them (*e.g.* *F6*, *F7*, and *F8*) are worst in terms of dispersion, *i.e.* a major number of outliers. Remarkably, *F1* display just a few outliers, similarly to *F4* and *F5*, but *F4* with a greater interquartile range. Also, the median of *F1*, *F3*, and *F5* are the closest to the 3% target, but *F3* and *F5* display more outliers than *F1*, because they have a tighter interquartile range. Thus, *F1*, *F3*, and *F5* factors comes out as the most promising factors within the survey, and deserving more analyses delving into its differences.

Figure 1B. Boxplots of actual inflation and consumer-perceptions based inflation factors (*)



(*) All data show the CPI inflation annual variation. "Actual" stands for annual variation of total inflation in monthly frequency. Sample: Jan-00/Jul-20 (247 observations). "UChile" stands for the Universidad de Chile's *Centro de Microdatos Survey of Perception and Expectations on the Economic Situation in Greater Santiago* quarterly data. Sample: 2005.II-2018.IV (55 observations). "F1" to "F8" stands for the inflation factors that outperform the RW—see Table 2. Source: Author's calculations based on National Statistics Institute and Universidad de Chile's *Centro de Microdatos* database.

C RMSFE ratio results using the median factor

Table 1C. RMSFE ratio and Giacomini-White test (†)

Factor	*Headline inflation*		*Core inflation*	
	End-of-period	Average	End-of-period	Average
M-[.,34]-NWest-Commerce	3.801*	3.913*	5.750*	5.925*
M-[.,34]-SEast-Gov. and Fin. S.	2.745	2.859	3.944	4.093
M-[.,34]-NEast-Gov. and Fin. S.	1.081	1.090	1.422	1.456
M-[35,65]-SWest-Industry	0.910	0.913	1.202	1.244
M-[35,65]-SWest-Construction	0.975	1.023	1.410**	1.476*
M-[35,65]-SWest-Commerce	1.992	2.002	3.106	3.187
M-[35,65]-SWest-Gov. and Fin. S.	1.959	1.996	2.836	2.925
M-[35,65]-SWest-Transp. and Storage	2.164	2.261	3.145	3.266
M-[35,65]-SEast-Industry	0.852	0.872	1.156	1.189
M-[35,65]-SEast-Construction	1.072	1.107	1.631*	1.666**
M-[35,65]-SEast-Commerce	1.570	1.567	2.372	2.416
M-[35,65]-SEast-Gov. and Fin. S.	1.129	1.186	1.430	1.516
M-[35,65]-SEast-Pers. and Hhold. S.	2.736	2.770	4.238	4.353
M-[35,65]-SEast-Transp. and Storage	1.810	1.854	2.544*	2.666*
M-[35,65]-NWest-Industry	0.930	0.934	1.275	1.311
M-[35,65]-NWest-Construction	1.573	1.593	2.398	2.479
M-[35,65]-NWest-Commerce	0.998	1.017	1.298*	1.350*
M-[35,65]-NWest-Gov. and Fin. S.	2.162	2.198	3.157	3.238
M-[35,65]-NWest-Comm. S.	1.112	1.123	1.546	1.614
M-[35,65]-NWest-Transp. and Storage	0.857	0.838	1.156	1.158
M-[35,65]-SWest-Commerce	1.154	1.193	1.650	1.703*
M-[35,65]-SWest-Gov. and Fin. S.	0.978	0.982	1.481*	1.484*
M-[35,65]-SWest-Comm. S.	1.087	1.091	1.626	1.669
M-[35,65]-SEast-Commerce	0.914	0.916	1.265	1.302
M-[35,65]-SEast-Gov. and Fin. S.	0.822	0.833	0.999	1.037
M-[35,65]-SEast-Comm. S.	0.920	0.935	1.227	1.266
M-[35,65]-NEast-Commerce	1.958	1.984	2.952	3.021
M-[35,65]-NEast-Gov. and Fin. S.	0.866	0.862	1.075	1.089
M-[35,65]-NEast-Comm. S.	0.921	0.910	1.149	1.168
M-[35,65]-NWest-Gov. and Fin. S.	0.898	0.890	1.250	1.286
F-[.,34]-SEast-Commerce	1.978***	2.055***	3.170***	3.244***
F-[.,34]-NWest-Commerce	1.304	1.319	1.953**	2.002**
F-[.,34]-SEast-Comm. S.	2.037	2.063	2.911*	3.031*
F-[35,65]-SWest-Industry	1.872*	1.921*	2.876*	2.985**
F-[35,65]-SWest-Commerce	1.339	1.360	2.000	2.060
F-[35,65]-SWest-Pers. and Hhold. S.	2.324**	2.397**	3.567***	3.674***
F-[35,65]-SWest-Comm. S.	1.064	1.073	1.455*	1.492*
F-[35,65]-SEast-Industry	2.442	2.485	3.728	3.834
F-[35,65]-SEast-Commerce	1.594	1.629	2.386*	2.456*
F-[35,65]-SEast-Gov. and Fin. S.	2.367	2.425	3.300	3.421
F-[35,65]-SEast-Pers. and Hhold. S.	1.854	1.861	2.873	2.938
F-[35,65]-SEast-Comm. S.	2.200	2.238	3.475	3.554
F-[35,65]-NWest-Industry	1.918	1.957	2.809**	2.917**
F-[35,65]-NWest-Commerce	1.490	1.518	2.252	2.339
F-[35,65]-NWest-Gov. and Fin. S.	1.312	1.317	1.996*	2.039*
F-[35,65]-NWest-Pers. and Hhold. S.	1.110	1.111	1.610**	1.665**
F-[35,65]-NWest-Comm. S.	0.939	0.957	1.402	1.458

(†) See notes to Table 2. Source: Author's calculations.

Table 1C (cont.). RMSFE ratio and Giacomini-White test (†)

Factor	*Headline inflation*		*Core inflation*	
	End-of-period	Average	End-of-period	Average
F-[35,65]-SWest-Comm. S.	1.441	1.475	2.187	2.230
F-[35,65]-SEast-Comm. S.	1.733	1.768	2.535	2.605
F-[35,65]-NEast-Gov. and Fin. S.	1.005	0.992	1.347	1.358
F-[35,65]-NEast-Comm. S.	0.924	0.922	1.160	1.195

(†) See notes to Table 2. Source: Author's calculations.

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