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Driving Forces of Inflation Expectations*

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This paper addresses some important issues regarding the nature of inflation expectations. By utilizing measures of inflation expectations formed by consumers and professionals, a series of empirical applications are performed to identify main driving forces of variations in inflation expectations. Tests of forecast efficiency consistently indicate that survey expectations are not rational, and thus the expectations of real-world economic actors, not rational agents in a model, are found to be what matter for price setting. As a logical consequence of these findings, we explore potential factors agents rely on when forecasting inflation by looking more closely on price changes in consumption expenditure categories as well as some key macroeconomic aggregates. Empirical results suggest that agents think differently how aggregate inflation evolves mainly due to the fact that each type of agents employs a distinct set of information, which can be interpreted as a dominant source of disagreement among agents.

JEL Classification: C53, E31, E32
Keywords: Inflation, Survey Expectations, Disagreement, Forecast Error

I. Introduction

This paper addresses an important question of what the main driving forces of inflation expectations by households and professionals are to better understand how the expectations of real people, not a model's rational agents, are actually formed. Notwithstanding its importance, the nature of inflation expectations is not extensively discussed in the literature. This motivate us to assess how various macroeconomic aggregates including current inflation rate can help agents predict

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the rate of future inflation. In addition, by employing disaggregated Consumer Price Index (CPI) data, we place a special emphasis on the issue of which consumption expenditure categories consisting CPI market basket are helpful to account for the observed inflation expectations and potential sources of disagreement across agents.

Inflation expectations play an important role in most macroeconomic models analyzing monetary policy and business cycle, such as the New Keynesian Phillips curve, particularly because of the interdependence between expectations and actual economic outcome.[1] Inflation expectations influence the time paths of macroeconomic variables, and, concurrently, the time path of the economy affects expected inflation formed by agents. Expected future inflation, which is a key ingredient in the dynamic stochastic general equilibrium models, is typically modeled using rational expectations. Nonetheless, with a few exceptions, such as Del Negro and Eusepi (2011) and Nunes (2010), macroeconomic models under rational expectations have not been quite successful to explain some basic features of the data for inflation forecasts in the sense that observed inflation forecast errors measured by survey forecasts are predictable.[2] In addition, a number of studies directly assessing the efficiency of inflation forecasts have documented that there is little evidence that survey measures of inflation expectations are not compatible with what rational expectations suggest (Carroll, 2003; Capistrán and Timmermann, 2009; Mankiw, Reis, and Wolfers, 2004; Pfajfar and Santoro, 2010).[3] A series of empirical applications in those studies consistently indicate that information available at date of forecast is not fully exploited, and thus forecast rationality is strongly rejected. In addition, the amount of disagreement about inflation expectations among agents is found to be substantial (Branch, 2004; Mankiw, Reis, and Wolfers, 2004; Coibion and Gorodnichenko, 2012). Even for the same type of agent, there appear to be considerable intrapersonal variations in expected inflation, which is commonly called inflation uncertainty (Jang and Kim, 2015; Zarnowitz and Lambros, 1987). Clearly, these findings are not consistent with full-information rational expectations, while the nature of inflation expectations that real people actually form, which may be what matters for wage and price setting, has not been precisely discussed in the literature.[4]

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[1] Since inflation expectations greatly influence actual inflation, the extent to which inflation expectations are anchored has first-order implications for the ability of central bank to achieve the goal of price stability (Gürkaynak, Sack, and Swanson, 2005; Levin, Natalucci, and Piger, 2004).

[2] Skeptics of rational expectations argue that economic structure is consistently evolving in ways that are imperfectly understood by economic agents.

[3] For relevant studies using inflation expectations in Korea, see Jang and Kim (2015), Lee (2012), and Lee and Choi (2015), among other, who present cross-sectional and time-series properties of survey expectations.

[4] It is worth noting that survey measures of inflation expectations like many other macroeconomic variables are not free from measurement errors. Moreover, empirical results using survey inflation

To underscore the role of inflation expectations, a strand of research examines survey inflation forecasts in their ability to account for the observed inflation dynamics. For instance, Adam and Padula (2011) and Fuhrer (2012), among others, argue that survey expectations dominate inflation forecasts implied by a model's rational agents in their ability to improve the fit of a model in explaining variations in some key macroeconomic variables.[5] The logical consequence of these empirical findings is to study how the expectations of real-world economic actors are indeed formed. There exist basically two lines of research dealing with this issue. First, Mankiw, Reis, and Wolfers (2004) and Lee and Choi (2015), among others, employ a variety of macroeconomic aggregates, such as output gap, unemployment, and interest rate, to investigate how agents respond to these variables when predicting the rate of future inflation. Second, in the presence of apparent substantial interpersonal and intrapersonal variations in inflation forecasts across individuals, some studies, e.g., Blanchflower and MacCoille (2009), Carroll (2003), and Pfajfar and Santoro (2008), investigate the factors that potentially cause disagreement about inflation forecasts across demographic groups classified by age, gender, education, and region.[6] In this paper, we tackle this issue in an alternative way by utilizing disaggregated CPI data as well as macroeconomic aggregates. This is motivated by the observation that, undoubtedly, the current state of inflation greatly influences the rate of future inflation that economic agents expect, whereas the agents may not consider price changes for all items in CPI market basket when forecasting aggregate inflation. In particular, inflation forecasts made by households are likely to be more sensitive to items that they almost daily pay for, such as food and clothing, but not to items infrequently purchased or to those known to be extremely stable due to regulations. On the other hand, professionals may take other items more seriously, e.g., motor fuel, that are conventionally regarded as dominant source of inflation. Notwithstanding its importance, to the best of our knowledge, this attempt has never been done in the literature.

To draw attention to the importance of better understanding how survey forecasts are indeed made, we first present some salient features found in the data for survey inflation expectations in Korea. Since inflation forecasts differ substantially across agents, we consider both Consumer Survey and Consensus Survey. The former is a nationally representative survey of general public and the latter covers relatively

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expectations that are not consistent with rational expectations models do not necessarily imply the failure of rational expectations.

[5] Using the Survey of Professional Forecasters (SPF) data, Fuhrer (2012) shows that the coefficient on inflation forecast under rational expectations is not statistically significant, once the SPF forecast of inflation is introduced into the New Keynesian Phillips curve.

[6] Note that Carroll (2003) and Carroll (2006) propose the epidemiology of inflation expectations to answer an important issue of how a set of information that helps predict future inflation is spread out across agents, while its empirical evidence for the nexus between news coverage on inflation and household's inflation forecasts is not strong (Pfajfar and Santoro, 2013).

more sophisticated agents, such as central bankers and economists. Despite the fact that the survey measures of inflation expectations generally have a tendency to follow the long-term trend of aggregate inflation rate, they are much less volatile and display substantial persistence. Statistical tests routinely reject the null of forecast rationality, and suggest that inflation forecasts are better explained by alternative models in which agents predict the rate of inflation in an adaptive manner. In addition, a simple dynamic correlation analysis indicates that agents may not fully utilize recent price changes for all components of CPI market basket.

After having shown that survey inflation expectations are not rational, we take some steps to explore the determinants of inflation forecasts. First, we investigate which measure of current inflation rate is likely to be used by agents to predict future inflation. Since the most recent observation of inflation rate can be the first approximation of future inflation movements, a variety of inflation measures, such as headline inflation, core inflation, and inflation based on living necessaries, are evaluated in their relations with inflation forecasts. In addition, we examine whether agents revise their expectations towards what other agents think. Second, a number of macroeconomic aggregates, such as output gap, unemployment rate, and interest rate, that potentially help agents predict future inflation are considered as factors that influence inflation forecasts other than the recent inflation observation. Finally, using disaggregated CPI inflation data, we investigate which components of the CPI market basket are attributable to much of the observed inflation forecast pattern and potential sources in disagreement across agents. Two separate approaches depending on how consumption expenditure is disaggregated, consumption expenditure by major type of product and according to purpose are used.

Our empirical results suggest some important conclusions. Survey inflation expectations are apparently not rational in the sense that economic agents do not fully exploit all available information efficiently. Although the most recent observation of inflation plays a key role in accounting for inflation forecasts, we found some other factors driving inflation expectations that are closely related to current state of aggregate economic activities. Interestingly, information set used to predict inflation differ substantially across agents. For macroeconomic data, households strongly respond to the rate of Chonse price and leading index, while inflation forecasts made by professionals are quite sensitive to interest rates and future BSI.

Moreover, we found that agents interpret a change in macroeconomic condition differently how it influences future inflation. The analysis with disaggregated CPI inflation data additionally confirms that there appear to be substantial differences in the use of information between the types of agents when predicting future inflation. Changes in prices of "food and non-alcoholic beverages" and "restaurants and hotels" have an effect on inflation expectations of both households and professionals.

However, households' inflation forecasts are relatively more sensitive to the changes in these categories because the coefficients are much greater than those for professionals. More importantly, households additionally take account of price changes of "clothing and footwear," "communication," and "recreation and culture," whereas professionals utilize "transport" added to the aforementioned categories. Therefore, these empirical findings strongly suggest that inflation expectations may differ across agents simply because they use a different set of information when assessing future inflation movements.

The remainder of this paper is structured as follows. The next section documents some salient features of survey inflation expectations data with a special emphasis on their relations with the use of disaggregated CPI data. Section 3 presents the role of macroeconomic aggregates including recent observations of inflation to account for variations in inflation forecasts. In addition, potential sources of disagreement about inflation expectations among economic agents are also discussed. In Section 4, we employ disaggregated CPI data to address issue regarding the main driving forces of inflation expectations made by households and professionals. Concluding remarks are included in Section 5.

II. Preliminary Analysis of Survey Inflation Expectations

In this section, we begin by presenting some important time-series properties of survey inflation expectations along with actual aggregate CPI inflation, with a special emphasis on their forecast rationality. The possibility of an alternative specification for inflation forecast is also discussed. By employing disaggregated CPI data, this section provides a preliminary examination of how price change in each individual item in the CPI market basket is systematically associated with the expected rate of inflation.

2.1. Time-series Properties of Survey Expectations

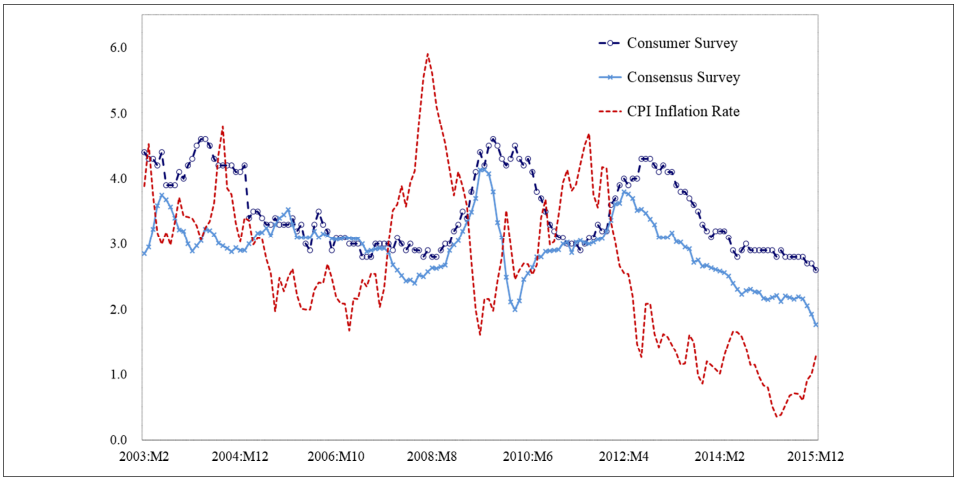
Following the previous studies documenting substantial discrepancies in inflation expectations among agent types (Coibion and Gorodnichenko, 2012; Mankiw, Reis, and Wolfers, 2004), two popular measures of survey expectations, Consumer Survey and Consensus Survey, for the sample of 2003:M2−2015:M12 are utilized in this paper.[7] The former represents inflation forecasts of households, the latter covers relatively more sophisticated agents such as central bankers and

[7] For a detailed description of those measures, see Jang and Kim (2015) and Lee (2012). Note that Survey of Professionals, which starts 2005:Q3, is not used because of an insufficient number of observations for the purpose of this study.

economists. As both the Consumer Survey and the Consensus Survey ask real world economic actors what they think about CPI inflation rate over the next 12 months, we consider 12-month-ahead forecast of inflation.[8]

Figure 1 presents these two sets of survey inflation expectations together with the corresponding 12-month aggregate inflation rate. As documented in earlier studies (Jang and Kim, 2015; Lee, 2012), survey expectations in Korea tell some common stories. While both inflation forecasts appear to exhibit the central tendency indicating that survey expectations seem to be consistent with trend inflation, each of survey inflation expectations is much smoother than the rate of headline inflation and displays substantial persistence. A closer look at the figure suggests that inflation expectations are somewhat lagging actual inflation, which implies that agents may form inflation forecasts in an adaptive manner. Thus, it is difficult to argue that the survey expectations are fully rational. Moreover, in line with numerous previous studies, such as Carroll (2003), Coibion and Gorodnichenko (2012), Jang and Kim (2015), and Mankiw, Reis, and Wolfers (2004), disagreement about inflation forecast across agent types is considerable and perpetual.

[Figure 1] Inflation Expectations from Consumer Survey and Consensus Survey



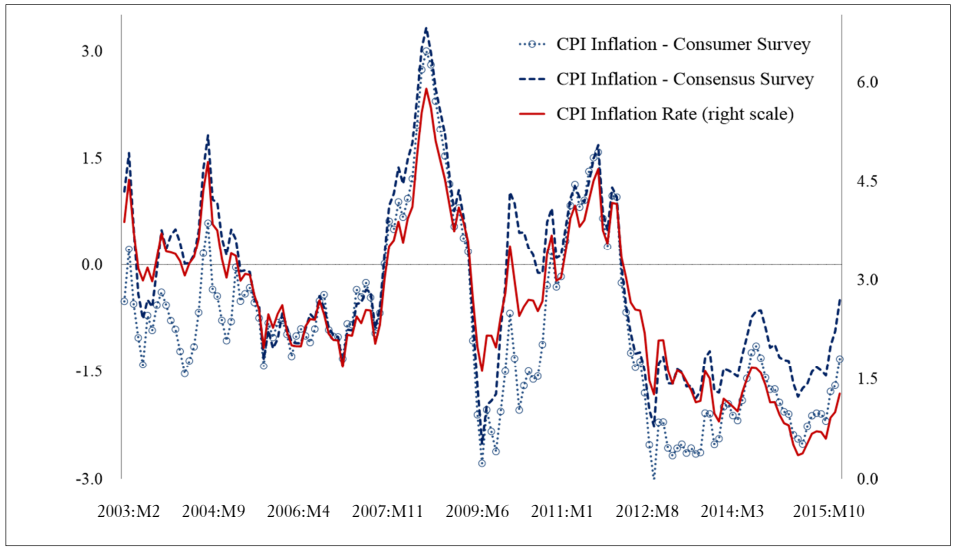
Note: This figure plots 12-month-ahead CPI forecasts from Consumer Survey and Consensus Survey along with all-item CPI inflation rate. The horizontal axis represents expectations at the endpoint of the corresponding forecast horizon to evaluate how each of the survey expectations has an ability to forecast future variations in actual inflation.

With regard to inflation forecast error defined as deviation of actual inflation from inflation expectations, $\pi_{t+12} - \mathbb{E}_t \pi_{t+12}$, some important features of the data

[8] Obviously, the study of long-term or trend inflation expectations is clearly of interest (Fuhrer, 2012; Mankiw, Reis, and Wolfers, 2004), but this paper focuses only on short-term inflation expectations due to a relatively small sample of the data.

directly emerge from Figure 2. First, for both survey measures, forecast errors are considerable through the entire sample and display large swings. For example, once agents begin to over-expect future inflation, they do not immediately revise their forecasts for some period of time. Next, the forecast errors have a systematic pattern with the level of inflation. When inflation is relatively high (low), forecast errors appear to be positive (negative).[9] These two empirical regularities are predominantly consistent with sticky information models (Carrillo, 2012; Mankiw and Reis, 2002). For instance, in a sticky information approach, since information about the arrival of shocks causing a rise in inflation is slowly disseminated across individuals, mean inflation forecast moves in a sluggish manner compared to the actual inflation. This apparently yields a downward bias in inflation forecast.[10]

[Figure 2] Inflation Forecast Errors



Note: This figure plots forecast errors $\pi_{t+12} - \mathbb{E}_t \pi_{t+12}$ (left scale) together with all-item CPI inflation rate π_{t+12} (right scale).

2.2. Tests of Forecast Rationality

Despite the fact that rational expectations are at the heart of most macroeconomic

[9] Note that disagreement across agent types tend to fall as inflation rises. This may be due to the fact that when inflation becomes a concern, agents are likely to put more efforts to correctly forecast inflation.

[10] Capistrán and Timmermann (2009) also try to rationalize predictable forecast errors by considering forecasters who are subject to an asymmetric loss function. For example, during high inflation period, a constant bias component that captures the tendency of over-prediction is dominated by the asymmetric effects of under-predicting bias.

models, there is ample evidence that, at least in the context of inflation expectations, inflation forecasts implied by rational expectations models substantially differ from what real people think about future inflation (Adam and Padula, 2011; Further, 2012). Several reasons why inflation expectations are not completely rational have been suggested. Those include Reis (2006a), Reis (2006b), and Sims (2003) who argue that agents do not respond every instant to incoming news because of information acquisition and processing costs. Ball and Croushore (2003) also show that agents tend to under-react to information when forecasting inflation. In addition, a number of empirical studies have shown that economic agents' forecasts are not entirely rational in the sense that their forecast errors are predictable. For example, using median inflation expectations from a variety of surveys, Mankiw, Reis, and Wolfers (2004) ask several empirical questions regarding the efficiency of inflation expectations. They found that information including publicly available macroeconomic data in the forecast is not fully exploited.[11]

Let us revisit this issue for the case of Korea by illustrating the relationship between survey inflation expectations, $\mathbb{E}_t\pi_{t+12}$, and actual inflation rate, π_{t+12}. As presented in Panel (a) of Figure 3, there is no clear pattern between those variables. Surprisingly, the figure even suggests the possibility of anomalous feature of the data as they appear to be negatively related each other (Jang and Kim, 2015). On the other hand, there is almost one-for-one relationship between inflation forecasts, $\mathbb{E}_t\pi_{t+12}$, and the rate of inflation at date of forecast, π_t, as in Panel (b) of Figure 3. These findings point out empirical failure of full-information rational expectations models, and thus it is imperative to consider an alternative framework for subjective inflation expectations. We scrutinize whether inflation forecasts can be better explained by alternative expectations in which agents predict the rate of future inflation in an adaptive fashion. In line with Ball (2000) and Mankiw, Reis, and Wolfers (2004), we consider a simple empirical model, which regress mean inflation forecasts against a finite number of past inflation observations as well as some key macroeconomic variables that might help predict inflation forecasts,

$$\mathbb{E}_t\pi_{t+12} = \alpha + \beta(L)\pi_t + \gamma U_t + \kappa U_{t-3} + \delta i_t + \phi i_{t-3}, \tag{1}$$

where $\mathbb{E}_t\pi_{t+12}$ is subjective inflation expectations of time $t+12$ formed in period t and $\mathbb{E}_t[\cdot]$ is either survey forecasts from Consumer Survey or those from Consensus Survey. For macroeconomic aggregates, unemployment rate, U, and interest rate, i, in both date of forecast and three months prior are used.[12]

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[11] For inflation expectations data in Korea, Jang and Kim (2015) also demonstrate that survey forecast series can consistently reject the null of rationality. In particular, their percentile regression analysis results suggest that a dominant part of households does not efficiently use available information.

[12] For interest rate, two measures, 91-day CD rate and 10-year Treasury bond yield are used.

[Figure 3] Inflation Forecasts and Actual Inflation

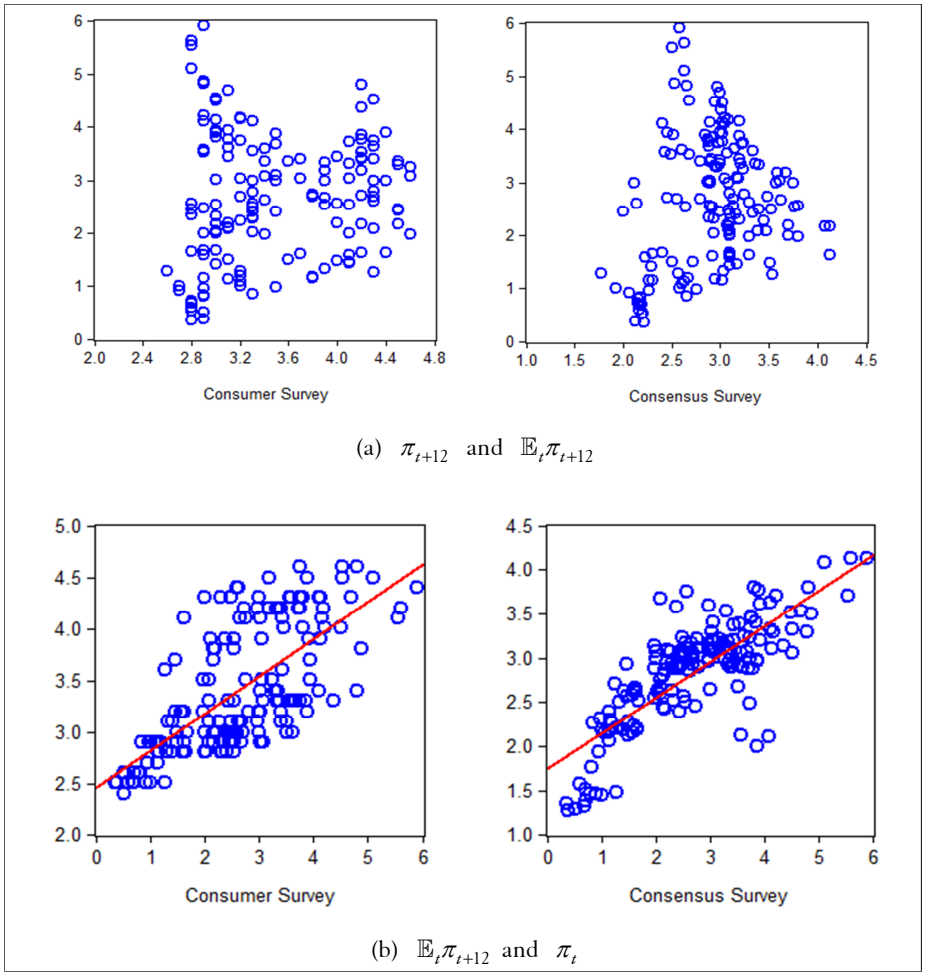

Table 1 presents test results of the adaptive expectations model. That estimates of lagged inflation observations, $\hat{\beta}$, are significantly different from zero at the 1% level indicates that both types of agents may use backward-looking rule when predicting future inflation.[13] As the estimates are consistently positive, agents facing rising inflation tend to expect a higher inflation in the following year. Next, macroeconomic aggregates have some ability to explain inflation forecasts. In particular, the choice of macroeconomic variables when forecasting inflation differs between two types of agents. Consumers barely consider macroeconomic aggregates, except that their inflation forecasts appear to fall further than adaptive expectations

[13] It is worth noting that there is the possibility that economic agents exploit only some components of CPI market basket, such as core inflation, rather than using aggregate CPI inflation. This issue will be extensively discussed in the following sections.

implies, when the unemployment rate rises. Any measure of interest rate is unlikely to help predict inflation expectations for consumers, but relatively more sophisticated agents, Consensus Survey, heavily utilize this piece of information when assessing short-run variations in inflation. Finally, we examine whether survey expectations can be represented by a distributed lag of inflation rates by testing the null of $\gamma = \kappa = \delta = \phi = 0$, and find somewhat mixed results. The null hypothesis is mostly rejected for Consensus Survey, while consumers' forecasting pattern is quite consistent with adaptive expectations.[14] This finding does not come to a surprise as professionals may have a larger set of information than consumers do, and thus one of driving forces of disagreement about inflation expectations can be the differences in information set across individuals.

[Table 1] Test Results of Adaptive Expectations

	Consumer Survey			Consensus Survey		
Constant: $\hat{\alpha}$	3.17**	2.96**	3.38**	1.76**	1.65**	1.90**
	(5.93)	(6.88)	(6.15)	(5.19)	(4.07)	(5.91)
CPI Inflation						
$\hat{\beta}$: Sum of 8 coeffis	0.51**	0.48**	0.50**	0.36**	0.27**	0.35**
	(9.91)	(8.69)	(8.96)	(6.98)	(3.50)	(7.47)
Unemployment						
$\hat{\gamma}$: U_t	-0.14	-0.12	-0.17	-0.10	-0.14	-0.12
	(-1.56)	(-1.39)	(-1.69)	(-1.43)	(-1.45)	(-1.73)
$\hat{\kappa}$: U_{t-3}	-0.20*	-0.22*	-0.28**	0.12	0.14	0.05
	(-2.16)	(-2.26)	(-2.79)	(1.97)	(1.63)	(0.80)
CD rate						
$\hat{\delta}$: i_t	0.01		0.00	0.46**		0.47**
	(0.15)		(-0.05)	(6.35)		(5.98)
$\hat{\phi}$: i_{t-3}	-0.01		-0.09	-0.43**		-0.52**
	(-0.14)		(-1.04)	(-7.36)		(-7.70)
Treasury bond yield						
$\hat{\delta}$: i_t		-0.10	-0.08		0.10	-0.12
		(-0.79)	(-0.65)		(0.90)	(-1.25)
$\hat{\phi}$: i_{t-3}		0.17	0.21		0.01	0.23*
		(1.24)	(1.56)		(0.09)	(2.20)
Reject AE?						
($\gamma = \kappa = \delta = \phi = 0$)	No	No	No	Yes	No	Yes
Adj. R^2	0.611	0.630	0.635	0.700	0.573	0.738

Note: ** and * denote statistical significance at the 1% and 5% levels, respectively. The numbers in parentheses are t statistics based on the Newey-West robust standard errors.

[14] Note that this test result does not necessarily implies that more sophisticated individuals' forecast patterns are consistent with rational expectations. We will revisit this issue in the following section.

2.3. Disaggregate CPI Inflation

To answer the important question of how inflation expectations are actually formed, we now turn to look more closely disaggregate CPI components. This is motivated by the findings that, while most individuals tend to place greater weights on recent inflation observations than other macroeconomic variables, different types of agents utilize different sets of information when forecasting inflation. Therefore, it is reasonable to ask which components of CPI market basket that different types of agents reckon with are more important to forecast inflation.[15]

[Table 2] Descriptive Statistics of Disaggregate CPI Inflation Rates

	Weights	Mean	Median	Std. Dev.	ρ
All items	1000.0	2.65	2.55	1.20	0.947
Panel I: Major type of product					
Commodities	448.1	2.95	2.93	2.11	0.920
1. Agricultural and marine products	77.9	3.79	3.15	5.13	0.843
2. Industrial products	325.8	2.70	2.19	2.20	0.933
3. Electricity, water, and gas	44.4	2.16	3.87	5.11	0.937
Services	551.9	2.46	2.58	0.78	0.973
1. Rentals for housing	93.2	2.43	2.34	1.55	0.977
2. Public services	145.1	1.56	1.65	1.54	0.950
3. Personal services	313.6	2.94	3.00	1.18	0.974
Panel II: Consumption purpose					
1. Food and non-alcoholic beverages	137.7	4.07	3.18	3.53	0.885
2. Alcoholic beverages and tobacco	15.5	5.76	1.10	13.44	0.911
3. Clothing and footwear	61.4	2.85	2.72	1.60	0.898
4. Housing, water, electricity, gas and other fuels	170.2	2.86	3.00	1.60	0.943
5. Furnishings, household equipment and routine maintenance	41.7	2.08	2.04	1.82	0.949
6. Health	68.7	1.57	1.76	0.71	0.922
7. Transport	111.0	2.40	3.13	5.05	0.938
8. Communication	54.8	-1.42	-1.01	1.44	0.914
9. Recreation and culture	57.2	0.28	0.31	1.51	0.928
10. Education	97.0	3.39	2.33	1.91	0.976
11. Restaurants and hotels	129.4	2.72	2.35	1.33	0.969
12. Miscellaneous goods and services	55.4	3.21	3.00	3.11	0.925

Note: The relative importance of each category is as of January 2016. ρ represents the coefficient estimate of a first-order autoregressive process.

[15] A relevant strand of research, such as Blanchflower and MacCoille (2009), Carroll (2003), McGranahan and Paulson (2005), and Pfajfar and Santoro (2010), focuses on how different types of agents in terms of demographics have disagreement about inflation expectations. This approach should prove useful to account for inflation dynamics, but it is not feasible for inflation expectations in Korea as demographic information of survey respondents is not publicly available.

Before formally investigating main driving forces of inflation expectations, we begin with a very preliminary and coarse examination of disaggregate inflation rates with a special emphasis on their relations with the expected headline inflation. There exist two separate approaches depending on how consumption expenditure is disaggregated, "consumption expenditure by major type of product" and "consumption expenditure according to purpose." Since there has not been any discussion about which one is more reasonable for studying inflation expectations, both consumption expenditure classifications are utilized. First, consumption expenditure by major type of product is divided into two broad categories, "commodities" and "services."[16] Next, we also consider 12 major components of CPI market basket classified according to the purpose of consumption expenditure. One-year inflation rate data for each category are obtained from the Statistics Korea.

Table 2 presents some basic descriptive statistics of the disaggregate CPI inflation rates together with the rate of headline inflation. Some interesting aspects of the data immediately appear from the table. Overall, variations in prices differ substantially across expenditure categories in terms of time-series mean (median) and standard deviation.[17] Next, Panel I suggests prices for commodities appear to be more volatile than those for services. For example, "agricultural and marine products" is the main force that drives a rise in aggregate inflation, while variations in price of "public services" are relatively low. For consumption, according to purpose presented in Panel II, variations in aggregate price level are mainly driven by "food and non-alcoholic beverages," "housing, water, electricity, gas and other fuels," and "miscellaneous goods and services," whereas prices for "health," "communication," and "recreation and culture" are less fluctuating. In addition, inflation rates for "education" and "restaurants and hotels" are markedly more persistent than other categories.

To examine how inflation expectations are sensitive to each of price changes in these categories, we calculate cross-correlations between survey expectations, $E_t\pi_{t+12}$ for Consumer Survey and $F_t\pi_{t+12}$ for Consensus Survey, and recent inflation observations of item j, $\pi_{j,t-k}$, for $j=1,2,\cdots,J$ and $k\geq 0$, where J is the number of categories. Table 3 reports the correlation coefficients for $k=0,1$, and 2. Agents tend to update their forecast sporadically as dynamic correlations do not significantly change across the lags. More importantly, not all price variations in consumption expenditure categories are statistically associated with inflation

[16] For a more detailed classification, commodities include "agricultural and marine products," "industrial products," and "electricity, water, and gas," and services consist of "rentals for housing," "public services," and "personal services." Note that, due to data availability, "electricity, water, and gas" is not used for statistical analysis.

[17] For consumption purpose, inflation rate of "alcoholic beverages and tobacco" exhibit the highest mean and standard deviation, while median value is among the lower ones. However, this must be interpreted with caution because of a substantial increase in tobacco tax in January 2015.

[Table 3] Survey Inflation Expectations and Disaggregate Inflation Rates

	Consumer Survey			Consensus Survey		
	$k=0$	$k=1$	$k=2$	$k=0$	$k=1$	$k=2$
Panel I: Major type of product						
Commodities	0.613	0.653	0.668	0.766	0.779	0.770
1. Agricultural and marine products	0.363	0.394	0.404	0.323	0.379	0.433
2. Industrial products	0.480	0.513	0.527	0.676	0.661	0.620
3. Electricity, water, and gas	0.620	0.585	0.553	0.716	0.675	0.638
Services	0.558	0.592	0.617	0.502	0.489	0.465
1. Rentals for housing	0.531	0.545	0.554	0.116	0.111	0.104
2. Public services	-0.250	-0.249	-0.233	-0.012	0.003	0.016
3. Personal services	0.589	0.618	0.636	0.580	0.560	0.530
Panel II: Consumption purpose						
1. Food and non-alcoholic beverages	0.553	0.575	0.573	0.416	0.441	0.465
2. Alcoholic beverages and tobacco	-0.367	-0.354	-0.336	-0.581	-0.548	-0.506
3. Clothing and footwear	0.313	0.273	0.213	-0.026	-0.056	-0.086
4. Housing, water, electricity, gas and other fuels	0.521	0.537	0.547	0.610	0.568	0.509
5. Furnishings, household equipment and routine maintenance	0.463	0.472	0.467	-0.011	-0.029	-0.047
6. Health	0.115	0.095	0.133	0.156	0.133	0.115
7. Transport	0.312	0.345	0.364	0.793	0.800	0.775
8. Communication	-0.601	-0.568	-0.541	-0.433	-0.411	-0.388
9. Recreation and culture	0.494	0.502	0.510	0.200	0.174	0.147
10. Education	0.292	0.310	0.326	0.431	0.429	0.426
11. Restaurants and hotels	0.701	0.717	0.715	0.483	0.459	0.424
12. Miscellaneous goods and services	0.161	0.202	0.236	0.131	0.134	0.140

Note: The numbers indicate cross-correlation coefficients, $Corr(E_t\pi_{t+12}, \pi_{j,t-k})$ for Consumer Survey and $Corr(F_t\pi_{t+12}, \pi_{j,t-k})$ for Consensus Survey, where j denotes the j-th consumption expenditure category.

forecasts. This suggests that agents consider prices of only some components that are known to be volatile or they regularly purchase, when predicting future aggregate inflation. Moreover, expenditure categories showing relatively high correlations with inflation forecast greatly differ between Consumer Survey and Consensus Survey. Since consumption categories by major type of product are too broad, it is not quite clear that dynamic correlation patterns differ substantially, except that consumers' inflation expectations react considerably to a change in price for "rentals for housing," while it is essentially uncorrelated with inflation forecasts made by professionals. On the other hand, disparities in dynamic correlation across categories are much evident in Panel II. Consumers greatly respond to price changes in "food and non-alcoholic beverages," and "restaurants and hotels," whereas variations in inflation expectations formed by professionals are mainly due to price changes in "housing, water, electricity, gas and other fuels" and "transport."

Therefore, these results imply an additional source of disagreement about inflation expectations, differences in items used across individuals when forecasting inflation.

III. Macroeconomic Aggregates as Determinants of Inflation Expectations

After having shown that survey inflation expectations are not rational in the sense that forecast errors are predictable and display substantial persistence, we now study how best explain the survey forecasts by employing a variety of macroeconomic variables. Despite the fact that agents tend to forecast future inflation in an adaptive fashion to some extent, evidence for adaptive expectations is not quite strong. Based on the preliminary results, we address the following empirical questions regarding macroeconomic aggregates including current inflation as determinants of inflation forecasts. First, which measure of current inflation is most useful in forecasting inflation? Next, do agents use different sets of macroeconomic variables to form inflation expectations? Third, what is the role of forecast errors when forecasting inflation? Finally, what are the main driving forces of variations in inflation expectations? We study these issues in turn as follows.

3.1. Inflation Measures, Forecast Errors, and Inflation Expectations

A number of studies assume that economic agents form inflation expectations based on inflation data that they recently observed as the first set of information (Adam and Padula, 2011; Andolfatto, Hendry, and Moran, 2008; Branch, 2004; Capistrán and Timmermann, 2009; Carroll, 2003; Coibion and Gorodnichenko, 2012, 2015; Fuhrer, 2012; Jang and Kim, 2015; Mankiw, Reis, and Wolfers, 2004; Pfajfar and Santoro, 2008, 2010). For instance, as a benchmark case, rational expectations hypothesis must imply that economic agents optimally use all available information at time t including currently observed inflation rate, π_t, to correctly forecast the rate of inflation. On the other hand, under adaptive expectations hypothesis, inflation forecast is given by a distributed lag of inflation observations with exponentially declining weights and other macroeconomic aggregates should not be useful.

Economist disagree about which measure of inflation is the most useful to efficiently predict future headline inflation rate. Equivalently, inflation data economic agents are assumed to use as a basis for the forecast of inflation differs across studies. Thus, we begin with studying how each of inflation measures is associate with survey inflation expectations. Of course, the headline inflation at the date of forecast, π_t, is the most reasonable one and is popularly used in the literature. Yet, in practice, current inflation observation, π_t, is often not publicly

available when forecasting inflation, and hence Mankiw, Reis, and Wolfers (2004) argue that it is more plausible to use the most recent inflation data, π_{t-1}, that survey respondents can utilize. Since some individuals attempt to overlook temporary variations in particular prices to distinguish inflation signal from transitory noise, we also consider a sum of recent CPI inflation observation, $\sum_{k=0}^{K} \pi_{t-k}$, where K is the optimal lag length.[18]

In addition to all-item inflation, some studies suggest that alternative measures of inflation should prove useful to account for the behavior of inflation forecasts as economic agents do not respond to variations in prices of all CPI component. First, to capture a clearer trend of the underlying inflationary pressures, agents may want to use a measure of inflation that excludes the rate of increase of prices for certain volatile components in price indices, such as food and energy prices, which is commonly referred to core inflation, π_t^{core}. Many studies routinely argue that changes in core measures are much less likely to be influenced by noises, and thus core inflation is a better guide to where headline inflation itself is heading. A serious shortcoming that this type of core inflation measures possess is that agents are assumed to restrict themselves and do not use all available information when forecasting inflation (Bullard, 2011). Moreover, a typical consumer indeed cares about prices of the excluded items in core measures as she pays for energy and food items on a daily basis.[19] Therefore, following Lee and Choi (2015) and Lee (2012), we also employ an alternative inflation measure based on the CPI for living necessaries, π_t^{living}, that represents variations in prices of items that consumers frequently purchase in everyday life.

Table 4 reports how the current inflation plays a role in predicting future headline inflation by regressing survey expectations, $\mathbb{E}_t \pi_{t+12}$, against each of the inflation measures. Here $\mathbb{E}_t \pi_{t+12}$ differs across agents: $E_t \pi_{t+12}$ for Consumer Survey and $F_t \pi_{t+12}$ for Consensus Survey. Not surprisingly, all inflation measures have predictable power as the slope coefficient estimates are different from zero at 1% significance level. Since the estimates are consistently positive, agents expect the rate of inflation will be higher next year, when they experience a rise in inflation, which is consistent with Panel (b) of Figure 3. It is worth noting that each regression yields an impressive value of R^2 indicating recent variations in prices themselves contain a great deal of information about future inflation development. Since there is little difference in conclusion across inflation measures and survey expectations, we will proceed with π_t for the rest of empirical applications.[20]

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[18] For a relevant study, Cogley (2002) suggests an adaptive measure of core inflation designed to track unanticipated and persistent variations in inflation due to changes in monetary policy regimes.

[19] Note that Bryan and Cecchetti (1994), Smith (2004), and Kim and Kim (2015), among others, also point out that a limited influence estimator that potentially includes prices of food and energy items outperforms excluded-item measures in terms of forecastability.

[20] An explanation of why core inflation explains the Consumer survey better than the Consensus

Finally, this simple test can be used as a test of forecast efficiency by examining whether inflation expectations are centered on the right value. Since we strongly reject the null of a constant that is zero for all cases, the deviation is statistically significant and the magnitude of the bias appears to be not negligible.

[Table 4] Inflation Measures and Inflation Expectations

	Consumer Survey: $E_t\pi_{t+12}$					Consensus Survey: $F_t\pi_{t+12}$				
Constant	2.55***	2.46***	2.31***	2.34***	3.11***	2.05***	2.04***	1.99***	2.40***	2.29***
	(18.06)	(18.77)	(19.53)	(14.24)	(19.00)	(17.07)	(16.07)	(15.43)	(9.77)	(21.38)
π_t	0.33***					0.31***				
	(6.91)					(7.62)				
π_{t-1}		0.37***					0.32***			
		(8.15)					(6.97)			
$\sum\pi_{t-k}$			0.41***					0.33***		
			(10.06)					(7.15)		
π_t^{core}				0.44***					0.20**	
				(7.63)					(2.04)	
π_t^{living}					0.12***					0.21***
					(2.69)					(7.34)
Adj. R^2	0.377	0.442	0.514	0.506	0.106	0.516	0.514	0.533	0.162	0.501

Note: *** and ** denote statistical significance at the 1% and 5% levels, respectively. The numbers in parentheses are t statistics based on the Newey-West robust standard errors.

[Table 5] Inflation Expectations and Forecast Errors

Consumer Survey: $E_t\pi_{t+12}$				Consensus Survey: $F_t\pi_{t+12}$			
Constant	1.63***	3.60***	2.21***	Constant	1.43***	2.95***	1.84***
	(3.72)	(38.59)	(4.46)		(5.25)	(53.01)	(5.38)
π_t	0.35***		0.28***	π_t	0.33***		0.28***
	(7.12)		(2.63)		(8.68)		(6.48)
$E_{t-12}\pi_t$	0.24*			$F_{t-12}\pi_t$	0.18**		
	(1.94)				(2.31)		
$\pi_t - E_{t-12}\pi_t$		0.22***		$\pi_t - F_{t-12}\pi_t$		0.26***	
		(4.42)				(6.04)	
$F_t\pi_{t+12}$			0.17	$E_t\pi_{t+12}$			0.08
			(0.66)				(0.71)
Adj. R^2	0.482	0.233	0.382	Adj. R^2	0.611	0.437	0.519

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are t statistics based on the Newey-West robust standard errors.

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survey is that the consumers less actively respond to changes in oil prices than the professionals do.

To investigate what makes agents revise their inflation forecasts other than current inflation rate, π_t, we study how expected inflation is influenced by agents' forecast behavior. As a first step, Table 5 considers forecast errors and forecasts by other types of agents, reporting regressions of one-year-ahead inflation forecasts for each of survey expectations, $\mathbb{E}_t\pi_{t+12}$, against those variables separately. At date of forecast, agents are assumed to use current inflation, π_t, and their past inflation forecast, $\mathbb{E}_{t-12}\pi_t$. Estimates for both π_t and $\mathbb{E}_{t-12}\pi_t$ are significantly different from zero, suggesting that information in the rate of current inflation and their past inflation forecasts are extensively exploited when forecasting future inflation. In particular, the coefficient on $\mathbb{E}_{t-12}\pi_t$ is positive for both types of agents, which implies that inflation forecasts are quite persistent. Next, rather than using π_t and $\mathbb{E}_{t-12}\pi_t$ separately, agents are now assumed to revise inflation expectations based on forecast error that they can observe when forecasting inflation, $\pi_t - \mathbb{E}_{t-12}\pi_t$. We regress inflation expectations on forecast errors that agents recognize when forecasts are made at time t to capture the extent to which they under or over respond to information. The positive coefficient on forecast error reported in the table indicates that agents tend to revise their inflation expectations upward when they have under-reacted to the recent news about inflation. Third, we ask whether agents take what other agents think about future inflation into account. This is motivated by epidemiology framework by Carroll (2003) arguing that households tend to update their inflation expectations from the news on professional forecasters' views on upcoming inflation movements. After controlling for current inflation rate, π_t, the regressions yield a qualitatively similar conclusion for both survey expectations. Neither consumers nor professionals do not statistically respond to the other type of inflation forecasts. For example, in the case of Consumer Survey, the coefficient on inflation expectations by professionals, $F_t\pi_{t+12}$, is not different from zero even at the 10% significance level. This is in line with a recent finding by Pfajfar and Santoro (2013) that most households do not revise their inflation forecasts toward the rate of inflation that professional forecasters predict. Therefore, our empirical finding suggests weak support to the epidemiological expectations, and disconnection among agents can be an important source of disagreement about inflation expectations.

3.2. Inflation Expectations and Macroeconomic Fundamentals

We now turn to analyzing whether macroeconomic aggregates other than recent episode of inflation help understand inflation expectations formed by economic agents. This is motivated by the empirical findings presented in the previous section that the efficiency of inflation forecast is strongly rejected, while there is the possibility that inflation forecasts can be better explained by adaptive expectations as shown in Table 1. However, there exist some potential drawbacks to the

preliminary analysis. First, the test of adaptive expectations considers only some key macroeconomic aggregates that are popularly used in the existing literature. Thus, in this section, we employ a variety of additional macroeconomic variables that possibly help predict future inflation. It is worth noting that there is a potentially important econometric issue in this type of empirical specification. This econometric representation used by a vast majority of previous studies implicitly assumes that $\mathbb{E}_t\pi_{t+12}$ is stationary simply because of the difficulty in convincingly judging whether inflation forecasts are indeed stationary.[21] Second, the adaptive expectations test results do not suggest a reason why inflation expectations are not rational. Thus, by investigating predictable components of inflation forecast errors, we study how the forecast errors are systematically associated with macroeconomic variables.

Table 6 presents empirical results by regressing survey inflation expectations, $\mathbb{E}_t\pi_{t+12}$, on recent macroeconomic data including the most recent inflation rate. At the outset, we employ some key macroeconomic aggregates widely accepted in the previous studies, such as output gap, unemployment rate, and short- and long-term interest rates, along with π_t and $\mathbb{E}_{t-12}\pi_t$ used in Table 5.[22] As shown in Model (i) in the table, except for output gap, none of those key macroeconomic variables has little predictive power to account for inflation expectations. Interestingly, the direction how output gap predicts price changes differ between the two groups. For example, according to the sign of the estimate on output gap, when output gap rises, consumers tend to expect inflation rate to fall, while professionals think the rate of inflation will increase next year. A possible explanation of this somewhat inexplicable empirical result can be a situation in which different agents interpret changes in economic environment differently: when the economy is now booming, consumers may expect inflation to fall due to increases in production, whereas professionals think a rise in inflation is associated with an increase in aggregate demand.[23]

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[21] If $\mathbb{E}_t\pi_{t+12}$ follows an I(1) process, this type of empirical specification may not be statistically plausible. Thus, we test the (non)stationarity of $\mathbb{E}_t\pi_{t+12}$ by utilizing several unit-root tests that are popularly employed in the literature and found that the series of statistical tests can only offer somewhat mixed evidence for the (non)stationarity of inflation expectations measures. Therefore, it is hard to strongly conclude that $\mathbb{E}_t\pi_{t+12}$ follows a non-stationary process. Note also that the introduction of a linear time trend does not change the main conclusion of the empirical results in this paper.

[22] The output gap is measured as the Hodrick-Prescott filtered Industrial Production Index.

[23] For a relevant study, Souleles (2004) documents that heterogeneous forecast errors can be due to demographic characteristics. For example, during the same period of economic expansion, high-income households receive relatively good shocks, but low-income households suffer from negative shocks.

[Table 6] Inflation Expectations and Macroeconomic Variables

	Consumer Survey: $E_t\pi_{t+12}$			Consensus Survey: $F_t\pi_{t+12}$		
	(i)	(ii)	(iii)	(i)	(ii)	(iii)
Constant	2.20***	102.60***	98.00***	1.36***	76.99***	49.43***
	(3.58)	(4.12)	(6.55)	(5.02)	(3.61)	(2.78)
π_t	0.37***	0.26***	0.33***	0.38***	0.28***	0.36***
	(4.82)	(5.94)	(12.02)	(9.48)	(9.14)	(9.26)
$\mathbb{E}_{t-12}\pi_t$	0.23*	0.37***	0.43***	0.32***	0.14	0.22***
	(1.92)	(5.75)	(7.28)	(3.24)	(1.51)	(4.41)
$F_t\pi_{t+12}$	0.02	0.14				
	(0.11)	(1.28)				
$E_t\pi_{t+12}$				-0.12	0.07	
				(-1.22)	(0.74)	
Output gap	-0.08***			0.06**		
	(-3.47)			(2.15)		
Unemployment	-0.11			0.03		
	(-1.05)			(0.47)		
CD rate	0.01			0.02		0.17**
	(0.07)			(0.30)		(2.44)
Treasury bond yield	-0.07			-0.06		-0.18***
	(-0.58)			(-0.87)		(-2.87)
Δ Business income		-6.04***	-6.62***		2.57**	3.17***
		(-5.37)	(-6.47)		(2.03)	(3.18)
Δ Property income		-0.38**			0.21	
		(-2.31)			(1.09)	
Δ Chonse price		6.10***	6.01***		-0.99	
		(7.26)	(6.43)		(-0.89)	
Leading index		-10.18*	-9.29*		-8.57	
		(-1.76)	(-1.77)		(-1.24)	
Coincident index		-11.41*	-11.84**		-8.71	-11.73***
		(-1.83)	(-2.35)		(-1.46)	(-2.98)
Future BSI		-0.13			2.08***	1.38***
		(-0.32)			(5.18)	(3.49)
ESI		-0.41			-1.10**	
		(-1.10)			(-2.20)	
Adj. R^2	0.541	0.799	0.799	0.656	0.715	0.761

Note: ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are t statistics based on the Newey-West robust standard errors.

Next, we utilize other macroeconomic variables that have not been extensively used in the literature, but probably have some information regarding how aggregate inflation evolves over time. These include major income categories, such as business income and property income, Chonse price index, and some important economic

indicators measuring current state of aggregate economic activity, "coincident index," and showing a pattern or trend that the economy starts to follow, "leading index." We also introduce a variety of sentiment indexes. For instance, "Economic Sentiment Indicator (ESI)," which is a composite indicator made up of mainly consumer and business confidence indicators, and "Future Business Sentiment Indicator (BSI)" based on enterprises' expectations for the future regarding their production.[24] Model specification (ii) of Table 6 reports regression results suggesting some additional macroeconomic factors measuring current and future economic conditions, such as business income growth rate and coincident index. The introduction of those variables greatly improves the fit of model as adjusted R^2 substantially rises to an impressive value.

As inflation expectations are better explained by including the additional variables found in this paper, we consider those variables as well as the conventional macroeconomic aggregates used in the literature, and the empirical results are summarized in Model (iii), which only covers explanatory variables that are significant. Several important implications are as follows. Most importantly, recent inflation rate observed at the date of forecast to be a greatly robust predictor of inflation forecast. Controlling for past inflation forecasts and macroeconomic variable only slightly undermines the effect of current inflation on inflation forecasts, because the coefficient on π_t does not vary across model specifications. Second, there exist some macroeconomic variables other than π_t found to be useful in explaining inflation forecasts. This suggests, when predicting inflation, both types of agents utilize a more sophisticated model than a simple adaptive expectations model assumes. Third, agents employ a considerably different set of macroeconomic data resulting in disagreement about inflation expectations, although both types of agents react to changes in business income growth and coincident index.[25] In addition to those variables, consumers strongly respond to the rate of Chonse price and leading index, while inflation forecasts made by professionals are quite sensitive to the interest rates and future BSI. In particular, this finding supports the view that the relationship between inflation expectations and monetary policy stance can be the core issue to account for the observed expected inflation dynamics. Since only professionals are found to actively respond to the short-term interest rate, they take into account the role of monetary policy in forecasting future inflation more

[24] The data for all macroeconomic variables used in this paper are obtained from the Statistics Korea. Note that there exist many other macroeconomic variables that are not listed in this paper, e.g., hosing price index, Korea Composite Stock Price Index (KOSPI), and government budget balance, but we find that those variables are not statistically significant or highly correlated with other variables. For a detailed discussion about those variables, see an earlier version of this paper.

[25] Note that the sign of coefficient on the growth rate of business income differs between Consumer Survey and Consensus Survey. This is probably due to the fact that, like output gap, agents interpret the effect of changes in business income on inflation differently.

[Table 7] Rationality of Survey Inflation Expectations

	Consumer Survey	Consensus Survey
Constant	-496.29***	-240.46***
	(-4.15)	(-2.73)
$\mathbb{E}_{t-12}\pi_t$	-0.33	-0.23
	(-1.14)	(-0.77)
π_t	0.00	-0.47**
	(-0.03)	(-2.49)
CD rate		-0.57**
		(-2.39)
Treasury bond yield		1.30***
		(6.71)
Δ Business income	-4.52	-11.36***
	(-1.02)	(-2.78)
Δ Chonse price	-7.77**	
	(-2.42)	
Leading index	89.19***	
	(4.59)	
Coincident index	18.68	51.80***
	(0.92)	(2.65)
Future BSI		-0.10
		(-0.06)
Reject efficiency?	Yes	Yes
(*p*-value)	(0.000)	(0.023)
Adj. R^2	0.428	0.445

Note: ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are t statistics based on the Newey-West robust standard errors.

intensely than households do.

To scrutinize whether our empirical findings of what the dominant factors driving inflation expectations are robust to an alternative econometric specification, we regress survey forecast errors, $\pi_{t+12} - \mathbb{E}_t\pi_{t+12}$, on the macroeconomic variables that are found to be statistically significant in Model (iii) of Table 6. As shown in Table 7, this analysis indicates that the main conclusion from our empirical results does not differ across econometric models, although this statistical representation is associated with what factors are not in agents' information set rather than what factors are in it. This empirical excercise yields some additional important implications on inflation expectations as follows. First, since we have found that agents tend to employ a larger set of information than a simple adaptive expectations model uses, the empirical evidence for adaptive expectations model presented in Table 1 weakens as additional control variables are included. However, this does not necessarily imply that survey inflation expectations are rational, and

thus we investigate whether survey inflation expectations take sufficient account of publicly available information. The empirical results presented in Table 7 indicate that the forecast errors involve predictable components and macroeconomic data are not fully exploited. That is, *F*-test of the joint significance of the macroeconomic variables is strongly rejected at the 1% significance level. As a consequence, neither rational expectations nor adaptive expectations is compatible with survey inflation expectations.[26] Next, this specification also helps account for the extent to which agents under- or over-respond to information on macroeconomic data. In Table 7, the coefficient on an explanatory variable that is negative indicates that inflation expectations appear to underrespond to the variable. For example, a rise in short-term interest rate leads professionals to forecast future inflation too high or negative forecast errors. In addition, a negative coefficient on Chonse price growth rate implies consumers tend to over-predict inflation or under-react to information on a greater rate of Chonse price. These findings are in line with the previous studies showing agents tend to under-respond to news in macroeconomic aggregates when predicting future inflation (Ball and Croushore, 2003).

IV. Inflation Expectations and Disaggregate CPI Inflation Rates

We have shown that survey inflation expectations are not rational and there exists substantial disagreement about inflation expectations across individuals. Each type of agents utilizes a different set of macroeconomic information that help predict future inflation. Even if agents employ the same macroeconomic variable, there is the possibility that agents think differently how inflation evolves due to a change in the state of economic activity. In this section, we explore main driving forces of inflation expectations from a different perspective. Specifically, by considering disaggregate CPI inflation rates, we investigate which components of the CPI market basket are attributable to much of the observed inflation forecast pattern. This analysis is motivated by the fact that agents are unlikely to consider prices of all items they purchase when forming their expectations of aggregate inflation. None of previous studies has attempted to directly examine how changes in macroeconomic environment are systematically related to individual prices that agents care about.[27]

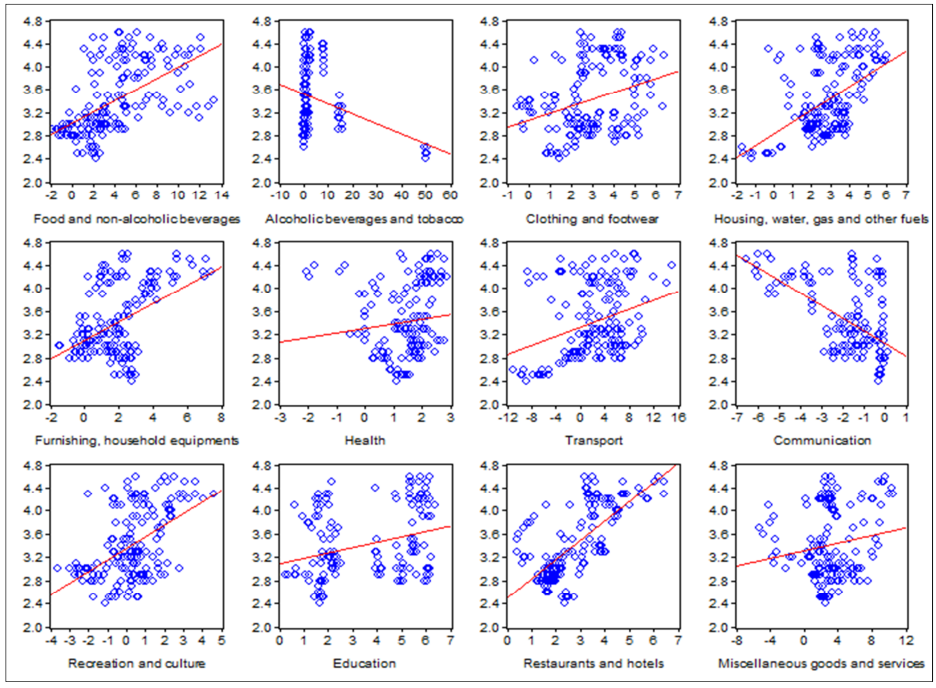
To underscore the role of the disaggregation in explaining inflation forecast

[26] As Woodford (2013) points out, this conclusion suggests that further empirical studies must be undertaken to identify the specifications of subjective expectations best describing observed behavior, although it is not entirely reasonable to assume that there exists a single model of expectations.

[27] Note that some recent papers, such as Hendry and Hubrich (2011) and Ibarra (2012), also employ disaggregated CPI data, but the main goal of those studies is to improve the accuracy of inflation forecasts.

behavior, we begin by illustrating how the forecasts of aggregate inflation are associated with each of the disaggregate CPI inflation data. Figure 4 plots the relationship between the expectations of one-year-ahead inflation formed by consumers at time t, $E_t\pi_{t+12}$, and the most recent observation of price changes for consumption expenditure categories according to purpose, $\pi_{j,t}$, where $j=1,2,\cdots,12$, at the date of forecast. Evidently, not all expenditure categories display a systematic relation with the expected rate of headline inflation.[28] This implies that consumers take only a part of price changes seriously to predict future inflation. They expect inflation to increase next year, particularly when they are experiencing a rise in prices of "food and non-alcoholic beverages" and "restaurants and hotels." On the other hand, their inflation forecasts are essentially uncorrelated with price changes of "health," "transport," and "education." This is probably because prices of items that are subject to government regulations conventionally do not fluctuate significantly in the short run. Even if agents observe price changes in those

[Figure 4] Inflation Expectations and Disaggregate Inflation Rates



Note: The vertical axis represents inflation expectations from Consumer Survey, $E_t\pi_{t+12}$ and the horizontal axis represents the rate of price changes for consumption expenditure category j, $\pi_{j,t}$.

[28] To conserve on space, the results for Consensus Survey and consumption expenditure by major type of product are not reported (available from the author upon request) as those cases essentially yield qualitatively the same conclusion.

consumption categories, they may not expect additional price changes in the following year. It is worth mentioning that there are differences in the disaggregate CPI data exploited to predict future inflation across agent types. For example, professionals are likely to take changes in price of fuels for personal transportation equipment as one of dominant factors driving inflation movements since current price changes in "transport" is strongly associated with their inflation forecasts.

To account for the observed dynamic behavior of survey inflation expectations, we now employ a formal statistical methodology to identify the main driving forces of inflation forecasts among individual CPI components. First, we consider consumption expenditure categories classified by major type of product, and the regression results are presented in Table 8. Not surprisingly, the first column for each survey expectations indicates that the coefficients on price changes in "commodities" and "services" are all significantly different from zero. Empirical analysis using more detailed categories shown in Column 2 for each survey suggests that agents react to both "agricultural and marine products" and "industrial products."[29] For services category, both type of agents tend to take account of "personal services," but not "public services." Interestingly, only consumers respond to price changes of "rentals for housing." These findings are quite robust to the introduction of macroeconomic variables and their past inflation forecasts into the empirical specification.[30] However, using such a relatively broad classification does not yield any additional important implication on the driving forces of inflation expectations beyond the empirical specification with macroeconomic aggregates examined in Section 3. Of course, an analysis with a set of more detailed product types may prove useful. However, instead of increasing the complexity of empirical specification, we take an alternative route, disaggregated CPI data classified according consumption purpose, which may lead us to find the main reasons particularly when agents revise their inflation expectations. Table 9 presents empirical results by regressing one-year-ahead inflation forecast on the most recent observations of disaggregate CPI inflation rates by consumption expenditure purpose along with some additional variables that may help predict inflation. Overall, the estimated model fits the survey inflation expectations data quite well as adjusted R^2s are around 0.9 for Consumer Survey and 0.8 for Consensus Survey. It is worth noting that, instead of utilizing macroeconomic variables including headline inflation, only recent price changes in some main expenditure categories explains more than 85% of variations in inflation forecasts made by consumers.

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[29] Due to the availability of data for our sample period, "electricity, water, and gas" is not used in our analysis.

[30] Note that, according to the sign of estimated coefficient, the model implications how the macroeconomic variables that are significant affect inflation expectations are typically identical to the results in Section 3.

[Table 8] Inflation Expectations and Disaggregated CPI Data by Major Type of Product

	Consumer Survey			Consensus Survey		
Constant	2.44***	2.06***	85.22***	2.11***	2.16***	-4.26**
	(12.02)	(10.74)	(5.59)	(16.88)	(13.81)	(-2.32)
$\mathbb{E}_{t-12}\pi_t$			0.32***			0.36***
			(3.92)			(4.93)
Commodities	0.11***			0.14***		
	(3.08)			(6.25)		
Agricultural and marine products		0.02**	0.01*		0.02***	0.01**
		(2.09)	(1.78)		(2.67)	(2.13)
Industrial products		0.06***	0.10***		0.10***	0.13***
		(2.88)	(6.36)		(5.82)	(8.70)
Services	0.28***			0.15***		
	(2.72)			(3.46)		
Rentals for housing		0.24***	0.15***		0.02	
		(4.96)	(3.75)		(0.48)	
Public services		0.05			-0.02	
		(1.20)			(-0.49)	
Personal services		0.17***	0.17***		0.12***	0.20***
		(4.26)	(5.14)		(2.84)	(3.35)
Treasury bond yield						-0.15*
						(-1.96)
Δ Business income			-5.02***			2.13*
			(-3.81)			(1.82)
Δ Chonse price			2.98**			
			(2.00)			
Coincident index			-18.29***			
			(-5.53)			
Future BSI						1.31***
						(2.99)
Adj. R^2	0.382	0.678	0.833	0.510	0.561	0.766

Note: ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are t statistics based on Newey-West robust standard errors.

Some further important implications are as follows. First, as we discussed in Section 2, there appear to be substantial differences in the use of information on individual price data between the types of agents when predicting future inflation. The first column of each survey forecast reports estimated coefficients on the expenditure categories that are different form zero at least the 5% significance level.[31] Changes in prices of "food and non-alcoholic beverages" and "restaurants

[31] Other expenditure categories, "alcoholic beverages and tobacco," "housing, water, electricity, gas, and other fuels," "furnishings, household equipment, and routine maintenance," "health," "education," and "miscellaneous goods and services," do not play a role in explaining the behavior of survey inflation expectations.

[Table 9] Inflation Expectations and Disaggregated CPI Data by Consumption Purpose

	Consumer Survey		Consensus Survey	
Constant	2.09***	37.55***	2.28***	1.35***
	(24.00)	(2.79)	(29.35)	(10.44)
$\mathbb{E}_{t-12}\pi_t$		0.16***		0.30***
		(2.81)		(7.83)
Food and non-alcoholic beverages	0.04***	0.03***	0.02**	0.02*
	(3.93)	(3.81)	(2.01)	(1.81)
Clothing and footwear	0.12***	0.09***		
	(6.95)	(5.62)		
Transport			0.07***	0.08***
			(6.03)	(12.30)
Communication	-0.15***	-0.12***		
	(-7.90)	(-6.01)		
Recreation and culture	0.05**	0.04***		
	(2.12)	(3.14)		
Restaurants and hotels	0.21***	0.21***	0.12***	0.12***
	(6.23)	(8.12)	(3.77)	(4.17)
Δ Business income		-2.22**		1.45*
		(-2.39)		(1.82)
Δ Chonse price		1.46*		
		(1.91)		
Leading index		-7.80***		
		(-2.68)		
Adj. R^2	0.859	0.906	0.658	0.816

Note: ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The numbers in parentheses are t statistics based on Newey-West robust standard errors.

and hotels" have an effect on inflation expectations of both households and professionals. However, according to the size of coefficient estimate, households' inflation forecasts are relatively more sensitive to the changes in these categories because the coefficients are much greater than those for professionals. More importantly, households additionally take account of price changes of "clothing and footwear," "communication," and "recreation and culture," whereas professionals also utilize only "transport." Controlling for macroeconomic variables and past inflation forecasts yields the same conclusion as shown in the second column for each survey. Therefore, these empirical results suggest that survey inflation expectations are not rational because agents do not take all consumption expenditure categories into consideration to predict future inflation. Moreover, the dominant source of disagreement about inflation expectations may be that agents think differently how aggregate inflation rate evolves because each type of agents utilizes a distinct set of information. Next, to better account for the behavior of

inflation expectations, agents tend to exploit some additional information from macroeconomic aggregates. For Consumer Survey, households consider leading indicator that measures how the economic activity evolves near future and recent changes in business income and Chonse prices. Similar to the results in the previous section, the coefficients on the growth rate of business income and leading index are highly significant and consistently negative. This may indicate that consumers think inflation rate will be lower when aggregate economic activity increases. On the other hand, other than price changes in some expenditure categories, professionals assess future inflation by additionally considering the growth rate of business income.[32] Thus this confirms our conjecture that inflation expectations differ since agents employ a different set of information to evaluate inflation movements. Finally, inflation expectations formed by agents last year are positively associated with their inflation forecasts since the coefficient on $\mathbb{E}_{t-12}\pi_t$ is significantly greater than zero, which implies that survey expectations display substantial persistence. Although it is not reported in this paper, we also find that agents do not revise their inflation forecasts conforming to what other types of agents think about the rate of future inflation, which is in line with Pfajfar and Santoro (2013).

V. Concluding Remarks

In this paper, we address some important issues regarding the nature of inflation forecasts. By utilizing survey measures of inflation expectations made by consumers and professionals, a series of empirical applications are performed to identify main driving forces of variations in inflation expectations. Overall, statistical analysis results are in line with the majority of the previous studies that argue survey expectations are not rational since agents do not use all available information efficiently. Thus, the logical consequence of these findings is to explore main factors economic agents rely on when forecasting inflation. We take some steps in this direction by looking more closely on price changes in consumption expenditure categories as well as some key macroeconomic aggregates. Empirical applications with the disaggregated CPI data indicate that agents think differently how aggregate inflation evolves due to the fact that each type of agents utilizes a distinct set of information, which may be interpreted as a dominant source of disagreement among economic agents.

For a deeper understanding of inflation expectations, further research is clearly needed. For instance, it is imperative to suggest a model of subjective inflation

[32] Note that coefficient on business income growth rate is found to be positive, which is contrary to Consumer Survey, suggesting that professionals expect a rising inflation when the economy is expanding.

expectations best describe observed agents' forecast behavior. Moreover, the use of disaggregated CPI data allows us to better understand the dynamics of inflation and forecast errors. Finally, in the presence of evident disagreement due to different sets of information when predicting inflation, it must be useful to study how a model's implications change to a shock that affects only a part of agents' inflation expectations.

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