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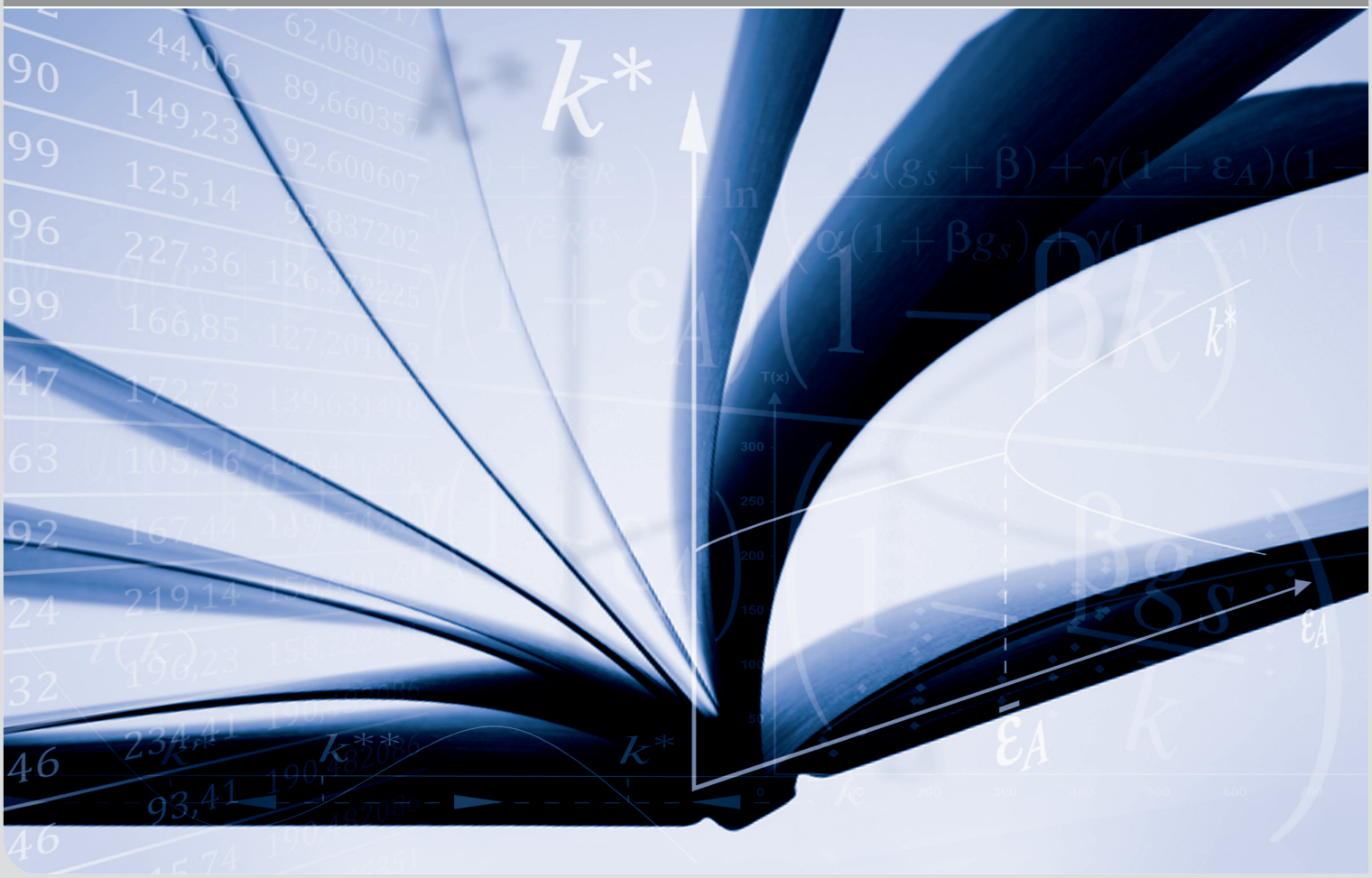

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Cognitive Abilities and Inflation Expectations

By Francesco D'Acunto, Daniel Hoang, Maritta Paloviita, and Michael Weber*

Over the last few years, interest has revived among economists in understanding how households form and update their expectations, as well as the determinants of the cross-sectional variation in economic expectations across households (for a discussion, see Gennaioli and Shleifer (2018); D'Acunto, Prokopczuk and Weber (2019); D'Acunto et al. (2018*c*)). Inflation expectations have been at the center stage of this strand of research, because of their relevance as a policy tool, especially when interest rates are low (Coibion et al. (2018)).

Forming and updating expectations about future macroeconomic variables such as inflation requires the use of cognitive resources at several stages, ranging from collecting information about the prevailing inflation rates to forecasting future potential states of the world and their likelihood. Cognitive abilities thus appear as a natural potential determinant of the cross-sectional variation in inflation expectations.

Indeed, D'Acunto et al. (2018*b*) document in a representative population that the variation in cognitive abilities across individuals is an important determinant of the variation in their macroeconomic expectations. Individuals with mid-to-low IQ levels have absolute forecast errors for 12-month-ahead inflation rates 2.5 times as large as individuals with high IQ levels, and about 4 times as large as the average realized inflation rate throughout the sample period. D'Acunto et al. (2018*b*) further document mid-to-low IQ individuals are about 4 times more likely to provide round numbers when asked about their inflation forecasts – which might reflect higher uncertainty in the forecasts – and are twice as likely to report implausible values for their average forecast.

In a related paper, D'Acunto et al. (2018*a*) further show cognitive abilities are an important friction to the effectiveness of economic policies that aim to affect the overall economy through managing households' expectations (D'Acunto, Hoang and Weber (2016) discuss unconventional fiscal policy as one example). The facts that a substantial part of a representative population of economic agents (i) barely form plausible inflation expectations and (ii) do not react to changes in their inflation expectations when making plans about consumption and saving choices drive this result.

A direct consequence of policies that aim to stimulate consumption expenditure via managing inflation expectations is that the policy measure might be less effective than a representative-agent model implies. An indirect, unintended consequence of policies that aim to affect behavior via managing expectations is, instead, that such policies might imply a redistribution of resources from the mid-to-low parts of the distribution by cognitive ability to the higher end of the distribution.

I. IQ: Subcomponents

The research described so far has treated cognitive abilities as a catch-all concept.

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Cognition though is a complex human characteristic and includes several facets that are not necessarily highly correlated. For instance, individuals who have strong quantitative cognitive skills need not have also strong verbal or visuospatial skills.

At the same time, one might expect that all these three facets of cognition are important in the determination of expectations regarding future economic variables. Quantitative skills are crucial for individuals to map changes in price levels into inflation rates. Visuospatial skills are important because they allow individuals to abstract from their personal situation and form plausible scenarios about future general inflation and other macroeconomic variables as well as attach plausible probabilities to these future states of the world. Verbal skills might matter because individuals need to obtain information about current, past, and potentially future states of the world through sources such as newspaper articles, television, or family and friends.

Understanding which *types* of cognitive abilities might matter to explain the observed differences in expectations is still a widely open question. Answering this question is important to assess the viability of potential interventions that aim to increase the effectiveness of economic policies.

Because short-term interventions are unlikely to affect the cognitive abilities of economic agents, policymakers need to understand the specific skills agents lack, in order to design policies that could effectively substitute for such skills. For instance, if agents cannot process the information about economic variables from newspaper articles or official central-bank statements, policymakers might invest in communication strategies that aim to make such concepts easy to grasp for the broader population (Coibion, Gorodnichenko and Weber (2019)). Alternatively, information might be provided to economic agents in a vivid fashion that does not require high cognition or knowledge about basic economic concepts but relies on agents' comparison of their conditions with those of their peers (D'Acunto, Rossi and Weber (2019)). If, instead, information treatments were ineffective or required substantial investment in financial education, cheap advice mechanisms such as robo-advising tools individuals could easily access through their phones might improve the quality of low-IQ households' expectations and choice (D'Acunto, Prabhala and Rossi (forthcoming) and D'Acunto et al. (2019)).

II. Data and Results

In this paper, we propose a first step to understand which types of cognitive abilities might matter more or less to explain the heterogeneity in inflation expectations across individuals.

We build on the empirical setting of D'Acunto et al. (2018*b*) and D'Acunto et al. (2018*a*), who merge administrative data on cognitive ability test scores from the Finnish Armed Forces (FAF) for a representative sample of men with unique information on their inflation expectations from Statistics Finland.[1] Grinblatt, Keloharju and Linnainmaa (2011) and Grinblatt et al. (2015) use the data on cognitive abilities in finance research and discuss in detail the incentives test takers have to put effect into answering the questions.

For this paper, we exploit the fact that the 120 questions from the FAF test cognitive abilities across three types, namely, quantitative, verbal, and visuospatial abilities. FAF aggregate the scores within each category and standardizes them within cohorts of test takers so that the IQ rankings follow a stanine distribution. Stanine (STAndard NINE) is a method of scaling test scores on a nine-point standard scale with a mean of five and a standard deviation of two. The respondents with the lowest 4% of test scores are at least 1.75 standard deviations from the mean and are assigned a standardized IQ score of 1, and the 4% with the highest test scores are assigned a standardized score of 9. We thus observe three scores per individual between 1 and 9 based on the relative performance in each part of the test.

[1] D'Acunto et al. (2018*b*) and D'Acunto et al. (2018*a*) contain detailed descriptions of these data.

The verbal part of the test asks individuals to compare words and pairs of words and find synonyms and antonyms. In the arithmetic part, individuals have to solve simple arithmetic operations, solve verbal problems, or compare pairs of numbers. The visuospatial part is similar to the Raven's progressive matrices test and requires individuals to identify a missing item that completes a pattern.

One might be concerned that the three scores we obtain are highly correlated within individuals and that the different portions of the test are ultimately unable to capture different sources of variation in cognitive abilities across individuals. In fact, we find the point estimates for the pairwise correlations of the three scores in the individual-level data range from 0.56 to 0.66. These statistics suggest that even if, indeed, a positive correlation exists between each pair of scores, we still detect enough variation across the scores of each individual to make our test meaningful.

We merge this individual-level cognitive-ability information with the micro-data underlying the Consumer Survey of Statistics Finland, in which respondents report their numerical 12-month-ahead forecast for inflation on top of several other macro and individual economic expectations and a large set of demographic characteristics. Every month, the survey asks a representative repeated cross section of approximately 1,500 Finnish individuals questions about general and personal economic conditions, inflation expectations, and willingness to spend on consumption goods. Statistics Finland also collects additional information through supplementary questions about households' plans to save and borrow. The sample period is from January 2001 to March 2015. We use the numerical inflation forecasts at the individual level to construct our main outcome of interest – the absolute forecast error for 12-month-ahead inflation. We define this variable as the absolute value of the difference between the 12-month-ahead inflation forecast of individual i in a given month and the ex-post realized inflation rate observed in Finland 12 months later. We then compute the average absolute forecast error across individuals in the same bin by arithmetic, verbal, and visuospatial cognitive abilities.[2]

Figure 1 plots the average absolute forecast error by bin of cognitive abilities ordered from the lowest level of cognitive abilities (IQ=1) to the highest level of cognitive abilities (IQ=9). Panel A refers to arithmetic abilities, panel B to verbal abilities, and panel C to visuospatial abilities.

Note we only have one absolute forecast error per individual. Hence, to the extent we observe different patterns in average absolute forecast errors across different subcategories of IQ, we conclude that individuals perform differently in different subparts of the IQ test.

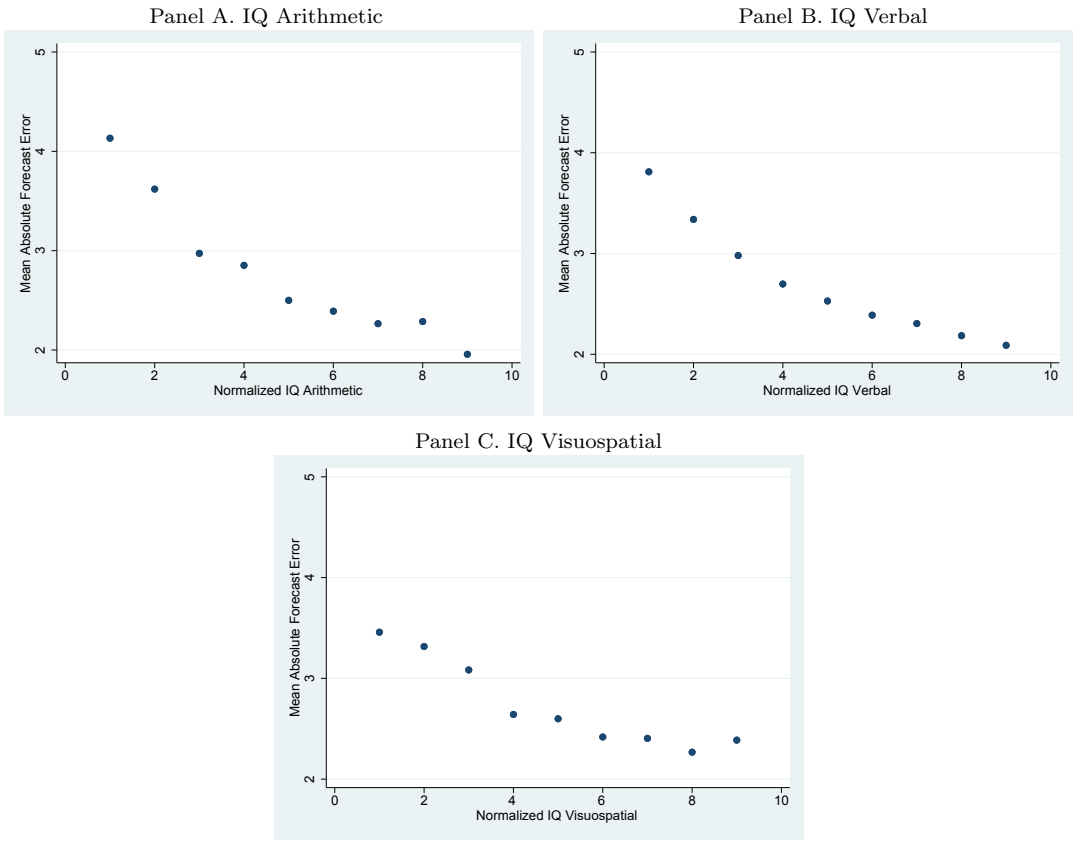
The three panels of Figure 1 beget a few comments. First of all, across all three types of cognitive abilities, we detect a monotonically decreasing association between IQ levels and average absolute forecast errors. This fact suggests none of the types of cognitive abilities behaves differently from the aggregate score for overall cognitive abilities D'Acunto et al. (2018*b*) discuss in earlier research.

The second notable feature of Figure 1 is the three scatter plots have different slopes, especially for the levels of cognitive abilities up to the median bins (IQ=5). Specifically, the curve is steepest at lower values by arithmetic IQ followed by verbal IQ and is flattest at lower values by visuospatial IQ. One way to interpret this fact is that the variation in visuospatial cognitive abilities across individuals is less relevant in explaining the cross section of inflation forecasts relative to the variation in arithmetic and verbal IQ.

A third relevant result – not depicted in Figure 1 – relates to statistical inference. We can reject the null hypothesis that any of the forecast errors in any bin are equal to zero, as well as the null hypothesis that

[2]Because we compute the absolute value, we treat deviations from the realized inflation rate in either direction identically. Our results are qualitatively unchanged if we repeat the whole analysis computing the average forecast error within each bin and hence allowing for positive and negative forecast errors across individuals within the same IQ bin to wash away.

FIGURE 1. **Mean Absolute Forecast Error for Inflation by Subcomponenents of IQ**



This figure plots the average absolute forecast error for inflation across IQ levels of Finnish men. Forecast error is the difference between the numerical forecast for 12-month-ahead inflation and ex-post realized inflation. IQ is the standardized test score from the Finnish Armed Forces that obtains integer values between 1 and 9. Panel A reports results for arithmetic IQ, panel B reports results for verbal IQ, and panel C reports results for visuospatial IQ. The sample period is from January 2001 to March 2015.

the averages across any adjacent bins across each of the three sorting schemes are equal for most bins. This result suggests that even though the relevance of different types of cognitive abilities in explaining the cross section of forecast errors for inflation might be higher or lower, higher scores in any of the three components of IQ are systematically associated with lower forecast errors on average, and hence each component might matter.

Based on our data, we conclude that arithmetic, verbal, and visuospatial cognitive abilities are all likely to be relevant in explaining the cross section of inflation expectations in a representative population of men, even though arithmetic cognitive abilities seem to be most relevant, especially for those scoring lowest.

III. Concluding Remarks

Large heterogeneity exists in how individuals form, update, and act upon their expectations, which previous research relates to individual-level cognitive abilities. We show that all three subcomponents of cognitive abilities we observe – arithmetic, verbal, and visuospatial – matter for the forecast accuracy for inflation, with the effect of arithmetic cognitive abilities being strongest.

The results could suggest policymakers should design targeted communication strategies for different subpopulations. For instance, short and vivid messages such tweets might be more successful in reaching the lowest part of the population by cognitive abilities, whereas more detailed and

technical reports could still be relevant to shape the expectations and choices of high-IQ individuals.

Moreover, policymakers might propose simple and salient policy measures to ensure large parts of the targeted population react to the policy and to alleviate concerns about unintended consequences, such as a redistribution from lower parts of the IQ distribution to higher parts (D'Acunto, Hoang and Weber (2018)).

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