Is time preference different across incomes and countries?

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Abstract

We offer direct statistical evidence of existing differences in time preference across income classes and countries by estimating and testing an Euler equation for consumption on time series data for six European countries and five income quantiles. We unequivocally reject the hypothesis of homogeneous time preference across countries, whereas heterogeneity across income classes is confirmed to different degrees depending on the country, but with time preference being lowest for the last two quantiles of the income distribution.

KEYWORDS: Time preference, discount rate, Euler equation, GMM testing.

JEL CLASSIFICATION: E21; C32; C36.

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1 Introduction

The subjective discount rate is a fundamental parameter in any economic model that describes problems of intertemporal allocation of resources, consumption or capital. It is also well-known that the degree with which individuals discount the future is a function of a large list of factors, starting with income, wealth, education and culture. This explains at least in part why empirical evidence and experimental procedures to estimate the time preference have delivered an incredibly wide range of values (Frederick et al. 2002).

The idea that the income level is important for the determination of time preference has received empirical support since the work of Hausman (1979), who finds a strong inverse relation from individual consumption choices related to energy efficient appliances, while the policy relevance of time preference heterogeneity has been highlighted by Samwick (1998). Lawrance (1991) explores the influence of income, age, education and race on time preference, highlighting in particular that the discount rate of poorer families are higher than that of richer ones by up to five percentage points, though results are not always in the same direction (e.g. Ogaki and Atkenson, 1997).

The inverse relation between time preference and income level is explained by Lawrance (1991) as a result of imperfect capital markets that prevent impatient individuals from investing in education, but also by appealing to more deep-seated cultural factors. This latter dimension has been investigate only recently, for instance by Wang et al. (2016), who use hypothetical questions to elicit time preferences across a sample of 53 countries, finding that culture accounts for a large amount of observed variation in the discount rate, and by Falk et al. (2018), who construct a large dataset from a global survey over 76 countries revealing strong heterogeneity in time preference that is related to geography and culture.

We offer new evidence on the relation between time preference on one side and income and culture on the other, by estimating discount rates for a set of six European countries and for five different income classes using time series data and calculating an explicit test of these differences. Estimation benefits from the use of a carefully-designed data-driven procedure to select the GMM instruments, which are then combined together in a system GMM estimation that allows a direct test of our hypothesis. We find that there is overwhelming evidence of differences in time preference between countries conditional on the same income class, and a more varied picture as to the within-country differences across income classes, but an overall confirmation that the discount rate is lowest for high-income individuals.

2 Method

To estimate the discount rate we make use of a standard formulation of the Euler equation resulting from the intertemporal optimization problem of the consumer under the hypothesis of rational expectations. We assume the utility function has a standard CRRA form

$$U\left(C_t\right) = \frac{C_t^{1-\gamma}}{1-\gamma}, \tag{1}$$

from which the intertemporal FOC follows as

$$E\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \frac{(1+R_{t+1})}{(1+\rho)}\right] = 1, \tag{2}$$

where C_t is the individual consumption at time t, γ is the coefficient of relative risk aversion, R_{t+1} is the nominal interest rate across the two periods, ρ is the discount rate, and $E[\cdot]$ is the expectation conditional on the information set at time t.

Estimation of model (2) is conducted using GMM on time series data, in a tradition started with Hansen and Singleton (1982). Pros and cons of a time series approach as opposed to a panel data analysis at household level are well-known, but it is worth stressing one main advantage of the first approach over the second, consisting in the opportunity to exploit a long horizon of co-movements in interest rate, prices and consumption, which is fundamental when the priority is to estimate the time preference rate.[1]

[1] Both empirical strategies in the case of nonlinear specifications suffer from measurement error problems; the time series approach is affected by aggregation bias, but its inference is more reliable if we consider that in the absence of complete capital markets shocks are likely to have cross-section correlation, which means that the asymptotic approximation has to rely on a large time dimension of the sample (Attanasio and Low 2004).

We estimate model (2) using non-linear iterated GMM combined with the data-driven method to select the moment conditions suggested by Hall (2005). This method consists in the application of a two-step procedure: in the first step we minimize the "moment selection criterion" across all cumulative lag order for $\frac{C_{t+1}}{C_t}$ and $1 + R_{t+1}$ up to lag 5; in the second step, we search, among all possible combinations of instruments obtainable from the set selected in the first step, that specific one that minimizes the "relevant moment criterion".[2] Although its application is rare, the value of this data-driven method stems from three main reasons: it avoids an arbitrary choice of the instruments, which is important as GMM estimates in general can be very sensitive to the instruments selection; it ensures that validity and relevance of the moment conditions are satisfied in practice; its good performance in finite samples has been shown in simulation studies (Hall and Peixe, 2003; Hall et al. 2007).[3]

After obtaining the estimates for the discount rate for different income classes and countries, we are interested in evaluating the statistical significance of any difference in value. In particular, we want to test two sets of hypotheses: first, the equality across income classes within each country; second, the equality across countries conditional on each income class. With this aim we set up a system in which we stack the moment conditions of the set of structural equations of interest using the instruments already selected in the single-equation estimation, and we implement a system version of the iterated GMM, from which we calculate the D test. We also report the result of the Wald test as an additional source of evidence but we give prominence the D test as this is known to perform better in finite samples and is invariant to the model parameterization.

As income dynamics is dominated by consumption choices at business cycle frequency and the consumption share is very stable over the period of our sample, we use the income data from the Global Consumption and Income Project (Lahoti et al. 2016), which consists in annual observations over the period 1960-2015 of the mean income per

[2] With 5 lags and 2 variables, there are 961 possible sets of instruments with cardinality from 1 to 5.

[3] By contrast, the alternative strategy to aim for optimal instruments faces important obstacles in terms of feasibility, as economic theory does not provide enough basis for defining the assumptions needed on the data generating process, it does not help in making sure orthogonality holds, and its performance in finite sample is at least doubtful.

capita in 2005 constant prices, converted in 2005 PPP dollars, divided in 5 quintiles, for six European countries, namely France, Germany, Italy, Spain, Sweden and the UK.[4] For the interest rate we use the 3-month rate on Treasury bonds for each country, collected from the Main Economic Indicators of the OECD. Data limitation on this variable determines the effective time span used in estimation, which ranges from 37 of Italy to 56 of Germany. The price index is the CPI obtained from the International Financial Statistics of the IMF. The real interest rate is calculated by deflating the nominal interest rate by the increase in the annual average CPI.

3 Results

The results from the single-equation iterated GMM estimation with the data-driven selection of instruments are displayed in Table 1. In all 30 estimations we get strong statistical significance with virtually zero pvalues in most cases. As we can notice, the discount rate does not change monotonically across each income class, but for all countries except Italy the last two income quintiles are lower than the first three quintiles. In the case of France, Sweden and the UK, both the 4th and 5th quintiles are individually lower than the first three quintiles, while for Germany and Spain their average is. This outcome suggests that there is a common threshold in terms of income level above which time preference becomes markedly lower. This level of income appears very similar among France, Germany, Sweden, and UK as the mean income of the 4th quintile is around 18,000 in 2005, though substantially lower for Spain where it is roughly 13,000.

As the differences in estimates might reflect only sampling variability, we proceed in testing these differences. The first hypothesis under test is the equality across income classes within each country. First we assess the overall statistical difference across all income classes. Then, we consider two groups, the first three quintiles and the last two quintiles. We test the homogeneity within the groups, and if this is not rejected we also test the difference between groups. In practice, as the within group homogeneity is almost

[4]This dataset combines different existing datasets, such as the European Union Survey of Living conditions (EU-SILC), Luxembourg Income Study, UNU-WIDER World Income Inequality Database, and Branko Milanovics WYD database.

Table 1: Discount rate estimates

	Income quintile				
	1st	***2nd***	***3rd***	***4th***	***5th***
France	0.0163	0.0177	0.0190	0.0111	0.0124
Germany	0.0230	0.0237	0.0241	0.0232	0.0211
Italy	0.0272	0.0298	0.0245	0.0318	0.0254
Spain	0.0214	0.0160	0.0120	0.0067	0.0131
Sweden	0.0262	0.0279	0.0373	0.0081	0.0125
UK	0.0340	0.0250	0.0263	0.0246	0.0222

Note: All estimates are significant with pvalue < 0.01.

always rejected we do not proceed forward in testing the between group difference.

The outcome of these tests is shown in Table 2. In only one instance, Germany, the evidence unequivocally points to no statistical difference in the discount rate of different income classes. In all the other cases, the D test rejects the null, though this is not conclusive in the case of Italy and Sweden as the J test suggests at 5% the risk that misspecification might contaminate the result. In Spain result is strongest in rejecting the null as also the Wald test rejects with very small pvalue. When we test the statistical difference within the two groups, the D test rejects all times with very small pvalues, again with the exception of Germany.

Table 2: Equality across income classes

		all quintiles		within group	
	J	***D***	***W***	***D***	***W***
France	0.231	0.000	0.390	0.000	0.318
Germany	0.168	0.962	0.967	0.943	0.955
Italy	0.045	0.000	0.068	0.000	0.111
Spain	0.574	0.000	0.000	0.000	0.000
Sweden	0.004	0.000	0.456	0.000	0.309
UK	0.307	0.000	0.091	0.000	0.048

Note: J, D, and W are pvalues of respectively the J, D, and Wald test statistic.

The second hypothesis under test is the equality across countries, conditional on a specific income class. We assess the overall statistical difference across all countries, and then we consider three geographically-determined groups: south (Italy, Spain), center (France, Germany), and north (Sweden, UK). We test the within group equality, and if not rejecting we move to testing the between group equality. As in practice we never fail to reject the within group equality, we do not end up performing the second test.

The outcome of these tests is displayed in Table 3. Here, unequivocally and strongly, whether using the D or the Wald tests, we reject the equality of discount rates across countries, for every income classes, with very small pvalues and without the risk of contamination due to model misspecification. Finally, we also reject the within group equality in all income classes with very small pvalues.

Table 3: Equality across countries

		All countries		**within group**	
Quintile	***J***	***D***	***W***	***D***	***W***
1st	0.113	0.000	0.000	0.000	0.000
2nd	0.179	0.000	0.000	0.000	0.000
3rd	0.283	0.000	0.000	0.000	0.000
4th	0.057	0.000	0.000	0.000	0.000
5th	0.189	0.000	0.001	0.000	0.044

Note: J, D, and W are pvalues of respectively the J, D, and Wald test statistic.

4 Conclusion

Theory predicts an important relationship between time preference on one side and income and country-specific factors on the other, and substantive amount of evidence has supported such hypothesis, though no attempt has been made in terms of directly testing the difference in time preference across income classes and countries. We performed such test using time series data on six European countries distinguishing five income classes. Results showed that discount rates does not decrease monotonically across income classes, but there is almost always a threshold level of income beyond which the discount rate is substantially smaller. We found that these differences are statistically significant, though with dissimilar degrees of strength depending on the country, whereas the differences in time preference between countries are unequivocally confirmed at all income levels, reflecting country-specific factors such as culture and institutions.

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