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Estimating the elasticity of intertemporal substitution taking into account the precautionary savings motive

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ABSTRACT

This paper estimates the elasticity of intertemporal substitution for U.S. aggregate time series data, taking into account the precautionary savings motive. By making use of a recursive utility function, we estimate an Euler equation, via GMM. This procedure leads consumption growth rate to depend on asset returns, and on a time-varying variance, which captures the precautionary motive. When significant, the elasticity of intertemporal substitution estimates ranges from 0.4 to 1.8, which are higher than most of the results found in the literature. Furthermore, the evidence suggests that consumers react to risk; however, the contribution of precautionary motive to consumption growth seems to be limited.

1. Introduction

In modern consumption theory, there are two important sources of adjustment in consumption-savings allocation: the movement in expected asset returns and the level of risk that consumers face. Under the usual CRRA utility, a higher (lower) expected return makes consumers defer (anticipate) consumption, everything held constant, and the elasticity of intertemporal substitution (EIS) measures the magnitude of this adjustment (Hansen and Singleton, 1983; Hall, 1988). Leland (1968) and Sandmo (1970) showed that, whereas the utility function exhibits a positive third derivative, the introduction of uncertainty slows down consumption. Thus, uncertainty generates the so-called precautionary savings.

The majority of the literature has focused on the EIS estimates, ignoring the precautionary motive for saving. However, some studies have shown that precaution seems to be responsible for a large part of consumers' savings. For instance, Kazarosian (1997) and Carroll and Samwick (1998) concluded that the precautionary component of wealth for a typical U.S. household ranges from 20% to 50%.

The empirical strategy commonly employed to estimate the EIS consists of estimating Eq. (1), which approximates the consumer Euler equation under CRRA utility.

$$\Delta \ln(C_t) = \alpha_{1,i} + \psi r_{i,t} + \varepsilon_{i,t}, \quad i = 1, \ldots, N \tag{1}$$

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where C_t is the consumption level, $r_{i,t}$ is the return of the *i-th* asset held by the consumer, N is the number of assets in the economy, and $\varepsilon_{i,t}$ is the error term. Therefore, the consumption growth rate should move along with consumer portfolio returns. The parameters to be estimated are the EIS, ψ, and the intercept, $\alpha_{1,i} = \psi(\ln\beta + 0.5\sigma_i^2)$, where β is the subjective discount factor and σ_i^2 is the variance of $r_{i,t} - \psi^{-1}\Delta\ln(C_t)$, as detailed in Section 2.

Several studies have estimated Eq. (1), finding estimates of EIS below 0.4 for the U.S. aggregate time-series data. Indeed, only some of them found statistically significant values. Among those we can mention Mankiw (1981), Hall (1988), Campbell and Mankiw (1989), Patterson and Pesaran (1992), Hahm (1998), Campbell (2003), Yogo (2004) and Gomes and Paz (2011, 2013).

In Eq. (1) the constant variance σ_i^2 cannot be distinguished from the intercept and, as a consequence, the strength of the precautionary motive cannot be evaluated. This situation is reverted if the variance changes over time. However, if the variance is mistakenly assumed to be constant over-time, then Eq. (1) omits a relevant variable, which endangers the EIS estimation. In order to circumvent these problems, the non-observable variance should be estimated and included in the test equation. For instance, in order to measure a time-varying variance, Yi and Choi (2006) estimated an ARCH model for the consumption growth rate. After that, they estimated a series of reduced-form Euler equations so that no inference was carried out for the structural parameters. Despite that, the variance coefficient was significant in specifications based on Epstein and Zin (1989) preferences. Jorion and Giovannini (1993) also used parametric models to estimate a time-varying variance along with Epstein and Zin (1989) preferences. They estimated the structural-form Euler equation, but the structural parameters estimates were not significant.

Our concern here is with regard to the proper estimation of the EIS for the U.S. aggregate time-series data. On this matter, Eq. (1) assumes CRRA utility, which implies that the EIS is the reciprocal of the relative risk aversion (RRA) coefficient. In order to avoid such restriction, we adopt Epstein and Zin (1989) preferences and, the resulting Euler equation leads the consumption growth rate to depend on the consumer portfolio return and a single asset return. As uncertainty comes from these variables, there is a need to use a multivariate technique to estimate the time-varying risk. In our case, this approach is applied by means of multivariate GARCH models. After that, we estimate a series of structural-form Euler equations, including the time-varying risk measure. Finally, we assess the performance of the model by both overidentification tests and its ability to provide precise parameter estimates.

Neely et al. (2001) and Campbell (2003) noted that, as asset returns are difficult to predict, weak instrument problems may arise when estimating the EIS. However, researchers tend to ignore such problems.[2] In order to circumvent this problem, we estimate our testing equation by means of the continuous updating estimator (CUE-GMM), which is recommended under weak instruments (Hansen et al., 1996; Stock et al., 2002).[3]

We also deal with another problem in EIS estimations, and this has to do with the consumer portfolio return. Mulligan (2002) and Dacy and Hasanov (2011) argued that a single asset is not able to mimic consumer portfolio return, as consumers invest in different assets. Thus, we check the robustness of our results substituting the habitual stock return by a synthetic mutual fund (SMF) asset return built by Dacy and Hasanov (2011), which is a share-weighted average of the returns on the financial and residential housing assets held by the representative household.

In summary, to estimate the EIS we develop a novel empirical approach composed by: (i) a structural-form Euler equation estimated by CUE-GMM method, which allows for the identification of the EIS and also for the evaluation of the precautionary savings motive; (ii) an appropriate identification of sources of risk, estimated by multivariate techniques; (iii) a proxy for a typical consumer portfolio return, which allows for a robustness analysis.

Our approach leads to significant estimates of the RRA coefficient and the EIS. When significant, the EIS estimates ranged from 0.4 to 1.8, which is higher than most estimates in the literature, while the RRA coefficient varied from 0.6 to 2.2, and no specification led to unreasonable values. Furthermore, while the Hansen-J overidentification test did not reject any of the specifications used, at a 5% significance level, the null hypothesis that RRA is the reciprocal of the EIS was always rejected. In this sense, there is strong evidence against the CRRA utility function. Finally, the results showed that consumers care about risk, but the contribution of precautionary motive to consumption growth seems to be limited.

The paper is structured as follows. In Section 2 the consumption model used to motivate the empirical specification is laid out, as well as the related literature. Section 3 presents the data set and the econometric methodology. Results are presented in Section 4. Finally, Section 5 summarizes our conclusions.

2. Precautionary motive

The idea that consumers maximize lifetime utility by smoothing consumption is almost undisputable among economists. Indeed, this broad notion leads to a life-cycle model with empirical content only when a particular setup is chosen (Browning and Crossley, 2001). Initially, papers focused on precautionary motive employed exponential (CARA) utility, obtaining closed-form solutions for consumption function. However, as detailed in Section 2.1, such utility led to undesirable features and, as a consequence, the literature moved towards incorporating isoelastic (CRRA) utility. We adopt nonexpected-utility preferences introduced by Epstein and Zin (1989) and, in Section 2.2 we connect this approach with the precautionary

[2] An exception is Yogo (2004), who found that EIS estimates conducted for the U.S. based on Eq. (1) were plagued by weak instruments, unless the T-bill is used. Gomes and Paz (2011) further scrutinized Yogo's (2004) results by means of different instrument sets, finding similar results.

[3] We also employ the usual two-step and iterated GMM estimators.