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Testing the Optimality of Consumption Decisions of the Representative Household: Evidence from Brazil[*]

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Contents:	1. Introduction; 2. Method of Estimation; 3. Data; 4. Empirical Results; 5. Conclusion.
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This paper investigates whether there is a fraction of consumers that do not behave as fully forward-looking optimal consumers in the Brazilian economy. The generalized method of moments technique was applied to nonlinear Euler equations of the consumption-based capital assets model contemplating utility functions with time separability and non-separability. The results show that when the household utility function was modeled as constant relative risk aversion, external habits and Kreps–Porteus, estimates of the fraction of rule-of-thumb households was, respectively, 89%, 78% and 22%. According to this, a portion of disposable income goes to households who consume their current incomes in violation of the permanent income hypothesis.

Este artigo investiga se existe um comportamento subótimo nas decisões de consumo intertemporal na economia brasileira. O Método Generalizado de Momentos (MGM) foi aplicado ao modelo de precificação de ativos baseados no consumo (CCAPM) contemplando funções de utilidade separáveis e não separáveis. Os resultados mostram a existência de uma parcela da população que segue esse comportamento conhecido também como rule of thumb. Em termos mais concretos a fração de indivíduos que segue a regra de bolso é, respectivamente, de 89%, 78% e 22% para as funções de utilidade modeladas segundo as hipóteses de aversão relativa ao risco constante, hábitos externos e Kreps–Porteus. De acordo com esses resultados, uma grande parcela da população consome totalmente a sua renda corrente o que implica em violação da hipótese da renda permanente.

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1. INTRODUCTION

The permanent income hypothesis (PIH), described by Friedman (1957), states that transitory changes in income have little effect on consumer spending, while permanent income is responsible for most of the variation in consumption. In his seminal work, Hall (1978) founded a new approach to study aggregate consumption. By using Euler equations for the optimal choice of a representative consumer, he showed that consumption should follow a random walk and argued that this holds in empirical applications, for instance that postwar U.S. data are consistent with this implication. In contrast, Flavin (1981), using a rational expectations structure, argued that consumption is sensitive to current income and it is greater than that predicted by the permanent income hypothesis. This conclusion has been widely interpreted as evidence of the existence of liquidity constraint. Empirical evidence shows that liquidity constraint is one of the main reasons why it is difficult to observe consumption smoothing in the data. Based on this evidence, Campbell & Mankiw (1989, 1990) suggested that aggregated data on consumption would be better characterized if there were two types of consumers. They nested the PIH in a more general model in which a proportion λ of consumers follow the rule of thumb,[1] consuming their current income (myopic spenders), while the remaining $(1 - \lambda)$ individuals consume optimally (optimizing savers). Using log-linearization of the model and instrumental variable estimates, they established by empirical application that there was a strong violation of the permanent income hypothesis because a significant fraction of the households have suboptimal behavior.

Cushing (1992) and Weber (2002) used intertemporally non-separable utility functions to study the behavior of American consumers. Cushing used a quadratic utility function modeled with current consumption and once-lagged consumption. Weber (2002) generalized Cushing's analysis by modeling the rule of thumb in nonlinear Euler equations and using the generalized method of moments (GMM) estimation technique. In particular, he tested if the lifetime utility function is time non-separable and concluded that the effect of the rule of thumb was small and not statistically significant.

In this article, we follow the insight of Weber, who considered that consumption of the optimizing agent is aggregate consumption minus rule-of-thumb consumption. In addition, we use the consumption-based asset pricing model (CCAPM) of Breeden (1979) and Lucas (1978) as a base of modeling and testing. The CCAPM setup considers not only an interest rate as studied in Hall (1978), Flavin (1981), Campbell & Mankiw (1989) or Weber (2002), but several assets in the economy. For instance, Hansen & Singleton (1982, 1983) developed and tested the empirical implications of the PIH when asset returns are time-varying and stochastic. They used the S&P 500 index and Treasury Bill yield as a risk-free rates of return. Epstein & Zin (1991) used five individual stock return indexes which give value-weighted returns for broad groups of industrial stocks and Treasury Bill yields as a risk-free rates of return.

Regarding Brazilian data, some authors have tested the PIH by incorporating rule-of-thumb behavior, but no one has used this procedure of testing in the CCAPM setup[2]. Among the papers that have studied the rule-of-thumb proportion of consumption for the Brazilian economy are the articles of Cavalcanti (1993), Reis, lssler, Blanco, & de Carvalho (1998), Issler & Piqueira (2000), Gomes (2004) and Gomes & Paz (2004).

Cavalcanti (1993), studying the intertemporal elasticity of substitution with data from 1,980 to 1989, contemplated a budget constrained consumer in one of the models. He found that 32% of the population followed the rule of thumb. Reis et al. (1998), as Campbell & Mankiw (1989), used a model in which a portion of the population was restricted to consume only current income in order to test the validity of the PIH. Their study ranged from 1947 to 1994. The econometric tests revealed that about 80% of the population was restricted to consume only their current income. Issler & Piqueira (2000) conducted a study on the temporal series of consumption in Brazil from 1947 to 1994, aiming to examine theoretical

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[1]These consumers are restricted to consuming their current income, with no optimizing behavior

[2]Issler & Piqueira (2000) tested the implication of different consumption models in the CCAPM setup but did not test rule-of-thumb behavior.

issues of the PIH. The main results pointed to the acceptance of cointegration between consumption and income, and they also found that about 74% of the individuals are restricted in terms of liquidity. Gomes (2004) used Beveridge and Nelson's decomposition to disclose a cyclical component in consumption when testing the PIH. When he adopted the habit formation specification he found similar results to those of Reis et al. (1998).

Gomes & Paz (2004) used panel data to test the applicability of the Keynesian theory, the PIH and the hybrid model to consumption decisions for Argentina, Brazil, Chile, Colombia, Peru, Paraguay and Uruguay. They used data from 1951 to 2000, and found values of λ that ranged from 47% for Peru to 79% for Argentina. The fraction of Brazilian income that belongs to consumers constrained to spend their current income was 61% in their study. Arreaza (2000) examined wether liquidity constraints or voracity effects could explain consumption and saving in Latin America, using panel data from the period 1973 to 1993. She rejected the PIH, since around 20% of the consumption in Latin American follows predicted current income.

This article makes some contributions to the literature on aggregate consumption. First, we use a new procedure to test the rule-of-thumb behavior for Brazilian consumers. We use the consumption-based asset pricing model (CCAPM), which allows more than one interest rate. Second, this paper generalizes the rule-of-thumb model to allow intertemporal non-separability in the representative household's preferences considering external habits (Abel, 1990). In addition, the Kreps–Porteus (Epstein & Zin, 1989, 1991) expected lifetime utility function, which separates the coefficient of relative risk aversion from the intertemporal elasticity of substitution, is employed. As complementary analysis, we study the traditional utility functional forms of constant relative risk aversion (CRRA). These different types of utility functions permit estimating the structural parameters: intertemporal discount factor, intertemporal elasticity of substitution, relative risk aversion coefficient and the habit formation parameter. The purpose of this work is not to criticize the methods employed in previous articles, but instead to show a new procedure to test rule-of-thumb behavior for the Brazilian economy.

The empirical results in this paper provide evidences of rule-of-thumb behavior in the Brazilian case. In other words, there is a proportion of the individuals consuming their current income, and another group of individuals that consume optimally in each period. Therefore, there was a strong violation of the permanent income hypothesis.

The remainder of this paper is organized as follows. In section 2, the model with rule-of-thumb behavior is briefly discussed in the Euler equations for three different specifications. The estimation and results are detailed in section 3. Finally, the conclusions are in section 4.

2. METHOD OF ESTIMATION

2.1. Testing rule of thumb in the CCAPM framework

The idea behind the consumption-based capital assets model (CCAPM), established by Lucas (1978) and Breeden (1979), is that agents accumulate assets to ensure their future consumption plan, so the asset return series are related with the consumption series. The maximization problem faced by the agents is:

$$\max_{\left[C_{2,t+s}, \theta_{t+s+1}\right]_{s=0}^{\infty}} U_t(\cdot) \qquad \text{s.t.} \begin{cases} C_{2,t} + \theta_{t+1} P_t = \theta_t P_t + \theta_t d_t + Y_t \\ C_{2,t}, \theta_{t+1} \geq 0 \\ \text{and } \theta_0 \text{ is exogenous} \end{cases}, \qquad (1)$$

where U_t is the utility function in period t; $C_{2,t}$ is the aggregated household's consumption that consumes according to optimizing behavior; θ_t is a vector of the N assets; P_t is the assets' pricing vector for each period; and d_t is the assets' dividends vector.[3] In each period, the agent receives an

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[3] $\theta_t P_t + \theta_t d_t$ is the total wealth the investor in period t, also called A_t; $\theta_{t+1} P_t$ is the total wealth the investor will take from period t to period $t+1$, also denoted A_{t+1}.

exogenous income Y_t, which is a state variable in the consumer problem. Solving this problem for $U_t = \mathrm{E}_t \left[\sum_{s=0}^{\infty} \beta^s u(C_{2,t+s}) \right]$ yields the Euler equations:

$$P_{j,t} = \mathrm{E}_t \left[\beta \frac{\partial u_{t+1}/\partial C_{2,t+1}}{\partial u_t/\partial C_{2,t}} (P_{j,t+1} + d_{j,t+1}) \right], \qquad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t, \tag{2}$$

where $u_t(\cdot)$ is the instantaneous utility function; β is the intertemporal discount coefficient; the index j refer to each available asset, and

$$\beta \frac{\partial u_{t+1}/\partial C_{2,t+1}}{\partial u_t/\partial C_{2,t}}$$

is the stochastic discount factor at $t+1$. Dividing both sides by $P_{j,t}$ and placing the rights side under $(P_{j,t+1} + d_{j,t+1})$, it is possible to replace $(P_{j,t+1} + d_{j,t+1})/P_{j,t}$ by $R_{j,t+1}$, the gross return of asset j at $t+1$, so that

$$1 = \mathrm{E}_t \left[\beta \frac{\partial u_{t+1}/\partial C_{2,t+1}}{\partial u_t/\partial C_{2,t}} R_{j,t+1} \right] \qquad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{3}$$

Hall (1978), using a quadratic utility functional form and fixed return rate, reached the conclusion that the aggregate consumption series behaves as a random walk:

$$\Delta C_{2,t} = \epsilon_t, \tag{4}$$

where $\Delta C_{2,t}$ is the variation in consumption and ϵ_t was called innovation. Campbell & Mankiw (1989) divided consumers into two groups. The first group receives a share, λ, of the disposable income and consumes all their current income $Y_{1,t}$; the second group receives a share $(1 - \lambda)$ of the disposable income, follows the PIH and their income is $Y_{2,t}$. Hence, the total income of the economy is $Y_t = Y_{1,t} + Y_{2,t}$, or

$$Y_t = \lambda Y_t + (1 - \lambda)Y_t. \tag{5}$$

The consumers from the first group have $\Delta C_{1,t} = \Delta Y_{1,t} = \lambda \Delta Y_t$, while the consumers from the second group follow equation (4). The total variation in consumption can be stated as $\Delta C_t = \Delta C_{1,t} + \Delta C_{2,t}$, and replacing this yields Campbell and Mankiw's test equation:

$$\Delta C_t = \lambda \Delta Y_t + (1 - \lambda)\epsilon_t. \tag{6}$$

This equation says that the variation in consumption is a weighted average between the variation of the income of the first group and the unpredictable variation in the permanent income of the second group. They specified their hypotheses as

$$\begin{aligned} &H_0 : \Delta C_t = \epsilon_t, \text{ hence } \lambda = 0 \\ &H_1 : \Delta C_t = \Delta Y_{1,t} = \lambda \Delta Y_t, \text{ hence } \lambda > 0. \end{aligned} \tag{7}$$

When $\lambda = 0$, the permanent income hypothesis holds. Under the alternative hypothesis the change in consumption is a weighted average of changes in current income. Equation (6) should not be estimated by ordinary least squares (OLS) since the error component may be correlated with changes in income.

Weber (2002) modeled consumption in nonlinear Euler equations, by isolating the consumption of the second group, $C_{2,t}$.[4] So, let $C_t = C_{1,t} + C_{2,t}$, then $C_{2,t} = C_t - C_{1,t}$, and $C_{1,t} = \lambda Y_t$, then

$$C_{2,t} = C_t - \lambda Y_t. \tag{8}$$

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[4] $C_{2,t}$ is the consumption of the second group, optimizers. The consumers of the first group follow the rule of thumb, so their consumption cannot be modeled by the CCAPM. Note that we already use this notation in the maximization problem (equation (1)).

The Euler equations of the CCAPM problem are only valid for optimizing consumers, replacing (8) in equation (3), and yields

$$E_t\left[\beta\frac{u'(C_{t+1}-\lambda Y_{t+1})}{u'(C_t-\lambda Y_t)}R_{j,t+1}\right]=1 \qquad \text{for } j=1,2,\ldots,N \quad \text{and} \quad \forall t. \tag{9}$$

Equation (9) can be used to estimate and to test the parameters of the model by the GMM technique. GMM estimators were developed by Peter Hansen in 1982. Since then this technique has enabled several breakthroughs in macroeconomics and finance research. The essence behind the GMM is to find a sample moment as close as possible to the population moment. Let $\tilde{\theta}$ be a vector of parameters and h an $r\times 1$ vector, where the lines are the orthogonality conditions. Then $\tilde{\theta}$ satisfies $E\left[h(\tilde{\theta},w_t)\right]=0$. In application with two assets' returns, the number of orthogonality conditions are $r=2M$, where M is the number of instruments to be used in estimation. Let X_t be a vector of chosen instruments. Then the orthogonality conditions are

$$h(\tilde{\theta},w_t)=\begin{bmatrix}\left(1-\beta\frac{u'(C_{t+1}-\lambda Y_{t+1})}{u'(C_t-\lambda Y_t)}R_{1,t+1}\right)X_t\\\left(1-\beta\frac{u'(C_{t+1}-\lambda Y_{t+1})}{u'(C_t-\lambda Y_t)}R_{2,t+1}\right)X_t\end{bmatrix}_{2M\times 1}. \tag{10}$$

Therefore $E[(1-\beta\frac{u'(C_{t+1}-\lambda Y_{t+1})}{u'(C_t-\lambda Y_t)}R_{j,t+1})\otimes X_t]=0$, for $j=1,2$. The sample moment is defined as $g(\tilde{\theta},y_t)=\frac{1}{T}\sum_{t=1}^{T}h(\tilde{\theta},w_t)$ and the GMM's estimator $\tilde{\theta}$ is the one that minimizes the scalar $Q(\tilde{\theta},y_t)=[g(\tilde{\theta},y_t)]'W[g(\tilde{\theta},y_t)]$, where W is the weighting matrix which acts to weight the various moment conditions to build the distance measure.

A test for the over-identifying restrictions (TJ-test) allows checking whether the model's moment conditions match the data well or not. The TJ statistic employed is asymptotically chi-squared with $r-k$ degrees of freedom, where r is the number of orthogonality conditions and k the number of parameters in the structural model.

2.2. Utility functions

The utility's functional forms Constant Relative Risk Aversion Preferences (CRRA), external habits and Kreps–Porteus address time separability and non-separability.

The Constant Relative Risk Aversion Preferences

In the first model, the instantaneous utility funciton is parameterized as

$$u(C_{2,t})=\frac{C_{2,t}^{1-\gamma}-1}{1-\gamma},$$

and the utility funtion U_t is

$$U_t=E_t\left[\sum_{s=0}^{\infty}\beta^s u(C_{2,t+s})\right]=E_t\left[\sum_{s=0}^{\infty}\beta^s\left\{\frac{C_{2,t+s}^{1-\gamma}-1}{1-\gamma}\right\}\right], \tag{11}$$

where γ is the relative risk aversion coefficient and the reciprocal of the consumption's intertemporal elasticity of substitution $\psi=1/\gamma$.

The Euler equations are

$$1=E_t\left[\beta\left(\frac{C_{2,t+1}}{C_{2,t}}\right)^{-\gamma}R_{j,t+1}\right] \quad \text{for } j=1,2,\ldots,N \quad \text{and} \quad \forall t. \tag{12}$$

Replacing (8) in (12), yields

$$1 = E_t \left[\beta \left(\frac{C_{t+1} - \lambda Y_{t+1}}{C_t - \lambda Y_t} \right)^{-\gamma} R_{j,t+1} \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{13}$$

Stationary regressors are obtained dividing through C_t, therefore

$$1 = E_t \left[\beta \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}} \right)^{-\gamma} R_{j,t+1} \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{14}$$

Let X_t be a vector of chosen instruments, thus the orthogonality conditions are

$$E \left[\left(1 - \beta \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}} \right)^{-\gamma} R_{j,t+1} \right) \otimes X_t \right] = 0 \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{15}$$

The External Habits Preferences

This parametric form of the individual preferece assume that individual keeps the history of her own consumption, viewed as consumer's habit, allowing for non-separability of the utility function over time. The instantaneous utility funciton for External Habits used is

$$u(C_{2,t}, v_t) = \frac{\left[\frac{C_{2,t}}{v_t} \right]^{1-\gamma}}{1 - \gamma}.$$

Following Abel (1990), we specify the function $v_t(\cdot)$ here as $v_t = \left[C_{2,t-1}^D \overline{C}_{2,t-1}^{1-D} \right]^\kappa$. In order to have "external habit", we set $D = 0$ and $\kappa > 0$. Therefore $v_t = \left[\overline{C}_{2,t-1} \right]^\kappa$ and the utility funtion U_t is

$$U_t = E_t \left[\sum_{s=0}^{\infty} \beta^s u(C_{2,t+s}, v_{t+s-1}) \right] = E_t \left[\sum_{s=0}^{\infty} \beta^s \left[\frac{\left[\frac{C_{2,t+s}}{(\overline{C}_{2,t+s-1})^\kappa} \right]^{1-\gamma}}{1 - \gamma} \right] \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t, \tag{16}$$

where $C_{2,t}$ is the individual consumption at t; $\overline{C}_{2,t-1}$ is the per capita aggregated consumption at $t-1$; κ is a parameter controlling the time separability in the function.

The Euler equations are

$$1 = E_t \left[\beta \left(\frac{C_{2,t+1}}{C_{2,t}} \right)^{-\gamma} \left(\frac{C_{2,t}}{C_{2,t-1}} \right)^{\kappa(\gamma-1)} R_{j,t+1} \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{17}$$

Replacing (8) in (17), yields

$$1 = E_t \left[\beta \left(\frac{C_{t+1} - \lambda Y_{t+1}}{C_t - \lambda Y_t} \right)^{-\gamma} \left(\frac{C_t - \lambda Y_t}{C_{t-1} - \lambda Y_{t-1}} \right)^{\kappa(\gamma-1)} R_{j,t+1} \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{18}$$

Stationary regressors are obtained dividing through C_t and C_{t-1}, therefore

$$1 = E_t \left[\beta \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}} \right)^{-\gamma} \left(\frac{\frac{C_t}{C_{t-1}} - \lambda \frac{Y_t}{C_{t-1}}}{1 - \lambda \frac{Y_{t-1}}{C_{t-1}}} \right)^{\kappa(\gamma-1)} R_{j,t+1} \right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{19}$$

Representing in the unconditional form,

$$
\mathrm{E}\left[\left(1 - \beta \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}}\right)^{-\gamma} \left(\frac{\frac{C_t}{C_{t-1}} - \lambda \frac{Y_t}{C_{t-1}}}{1 - \lambda \frac{Y_{t-1}}{C_{t-1}}}\right)^{\kappa(\gamma-1)} R_{j,t+1}\right) \otimes X_t\right] = 0 \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{20}
$$

The Kreps–Porteus Preferences

The third utility preference treated here follow the Epstein & Zin (1989), being a generalization of the utility function proposed by Kreps & Porteus (1978). The aggregating function is parameterized as a constant elasticity of substitution (CES) function:

$$
U_t = \left[(1 - \beta)C_{2,t}^{\rho} + \beta \left(\mathrm{E}_t \, \tilde{U}_{t+1}^{\alpha}\right)^{\frac{\rho}{\alpha}}\right]^{\frac{1}{\rho}}, \quad \text{for } 0 \neq \rho < 1, \tag{21}
$$

where E_t is the conditional expectation operator given the information avaliable to the agent in the planning period and $\tilde{U}_{t+1}$ is the agent's future utility. The consumption's intertemporal elasticity of substitution is $\psi = 1/(1 - \rho)$. The relative risk aversion coefficient γ is constant, $\gamma = 1 - \alpha$ where the parameter α reflects the agent's behavior towards risk. In particular, when $\alpha = 0$, we are back to the expected utility function with logarithmic preference. When $\alpha = \rho$, we have and additively separable utility function.

The Euler equations are

$$
1 = \mathrm{E}_t\left[\beta^{\eta} \left(\frac{C_{2,t+1}}{C_{2,t}}\right)^{\eta(\rho-1)} \tilde{B}_{t+1}^{\eta-1} R_{j,t+1}\right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t, \tag{22}
$$

where $\eta = \alpha/\rho$ and $\tilde{B}_{t+1}$ is the optimum portfolio's gross return.

Replacing (8) in (22) yields

$$
1 = \mathrm{E}_t\left[\beta^{\eta} \left(\frac{C_{t+1} - \lambda Y_{t+1}}{C_t - \lambda Y_t}\right)^{\eta(\rho-1)} \tilde{B}_{t+1}^{\eta-1} R_{j,t+1}\right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{23}
$$

Stationary regressors are obtained dividing through C_t, therefore

$$
1 = \mathrm{E}_t\left[\beta^{\eta} \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}}\right)^{\eta(\rho-1)} \tilde{B}_{t+1}^{\eta-1} R_{j,t+1}\right] \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{24}
$$

In the unconditional form representation we have:

$$
\mathrm{E}\left[\left(1 - \beta^{\eta} \left(\frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}}\right)^{\eta(\rho-1)} \tilde{B}_{t+1}^{\eta-1} R_{j,t+1}\right) \otimes X_t\right] = 0 \quad \text{for } j = 1, 2, \ldots, N \quad \text{and} \quad \forall t. \tag{25}
$$

3. DATA

The series used for the estimation were the real per capita household consumption, real per capita gross domestic product (GDP), real gross returns of risky assets, and real gross returns of the riskless asset. The series of aggregate consumption, GDP and population are available at the website of IPEA (*Instituto de Pesquisa Economica Aplicada*), while the series of return on assets and rates of inflation are posted at the website of the Central Bank of Brazil.

The data range from 1995.Q1 to 2011.Q2. This period starts with the implementation of the *Plano Real*, the plan the Brazilian government launched that finally managed to end the persistently high inflation (with bouts of hyperinflation) that had held sway over the previous two decades. Another factor that contributed to this choice was that Reis et al. (1998) and Gomes (2004) suggested that the high value of λ they found was due to the credit constraint the Brazilian population encountered (high and unpredictable inflation with indexation not necessarily matched with salary indexation, making debt service as a proportion of household income extremely volatile). The lower inflation rates through the period studied in this paper resulted in credit expansion, the availability of funding to finance consumption was not at the same level as in the developed countries but was much higher than in the periods of the others studies. Therefore, a smaller part of the population following the rule of thumb was expected.

The series of the household consumption was calculated the same way as in Reis et al. (1998), where the gross fixed investment and current account balance series were subtracted from the GDP series to obtain a consumption of non-durable goods series.[5]

The returns of the IBOVESPA index were used to represent the returns of risky assets, because it is the most important index of average returns of the Brazilian stock market. Another interesting option would be IBrX, an index comprising more stocks that is widely used in the financial market for the static CAPM. However, the IBOVESPA series is longer and more suitable for the studied period. In order to represent the returns of the riskless asset in the Brazilian economy, the rate paid on government debt (SELIC rate) was used.[6] The general price index (IGP-DI) calculated by *Fundação Getulio Vargas* (FGV) was used to deflate income, consumption and returns of both assets. The consumption and income data were also subject to seasonal adjustments. Figure 1 shows the data in quarterly frequencies.

4. EMPIRICAL RESULTS

In this section, we present GMM estimates of the rule-of-thumb models for the utility preferences shown in the previous section. In order to estimate the orthogonality conditions, generated by the Euler equa-

Figure 1. Data on Quarterly Frequency (1995.Q1 to 2011.Q2).

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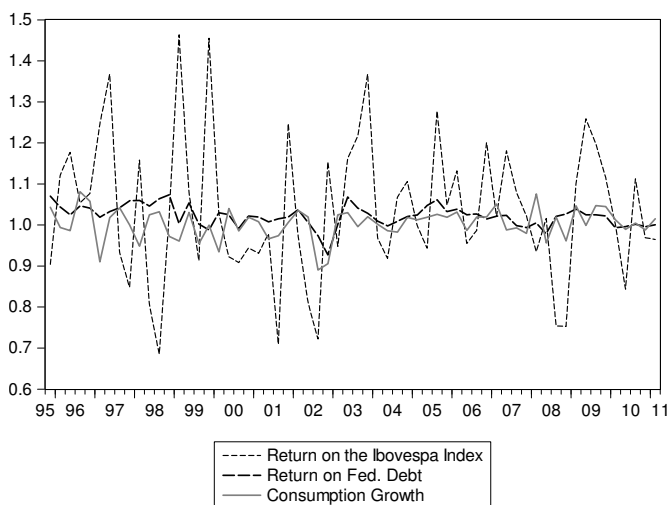
[5]Income and consumption series were divided by the population series. Linear interpolation and extrapolation were applied to transform an annual population series into a quarterly basis series.

[6]The regular savings account return rate was ruled out because its return rate is calculated by adding a fixed return to an inflation index, hence there would be no co-movement between the real returns of the regular savings account rate and consumption.

tions, we use several sets of instruments. The instruments correspond to lagged values of the growth in consumption and real interest rate.[7] We also use the tests of the overidentifying restrictions (TJ-test) to assess the joint validity of each model and the set of instruments. In this paper, several sets of instruments were tested and none were rejected at the 5% level.

The results are presented in Tables 1, 2 and 3, where only display those where the parameter λ estimate was between 0 and 1.

For the CRRA utility, Table 1, the median estimate of the parameter λ was $\hat{\lambda} = 0.8945$ and all but one of them were significant at the 5% level.

That is, results for λ show that around 89% of the population follows the rule of thumb. All the estimates of the intertemporal discount coefficient, β, were significant at the 5% level, and their median was $\hat{\beta} = 0.9783$. The median for the relative risk aversion coefficient was $\hat{\gamma} = -0.0974$.

Table 2 reports the findings of the estimation of Euler equations (20) which correspond for the external habits utility model. Results show that overall estimations of the parameter λ for the most part were significant at the 5% level. The median of all valid estimates was $\hat{\lambda} = 0.7817$. It shows that around 78% of the Brazilian population follows the rule of thumb. All the results for the intertemporal discount coefficient, β, were significant at the 5% level and their median was $\hat{\beta} = 0.9793$. For the parameter κ this study found $\hat{\kappa} = 0.1518$, but only three of the estimates were significant at the 5% level. One positive feature of this κ estimation is that it does not violate the external habit basic assumption: if $\kappa > 0$ than $\gamma > 0$ or if $\kappa < 0$ than $\gamma < 0$. The relative risk aversion coefficient estimate was $\hat{\gamma} = 0.0548$ and only four of them were significant at the 5% level and only one at the 10% level.

For the Kreps–Porteus utility function model, the findings for the estimation of the Euler equations (25) are shown in Table 3. We found $\hat{\lambda} = 0.2263$, but in almost all cases λ estimates are not significant at the 5% level. The intertemporal discount coefficient, β, was significant at the 5% level in 21 estimations, and the median of all estimations was $\hat{\beta} = 0.9743$. Almost all the findings for $\eta = \alpha/\rho$ were very close to zero,[8] however all the estimates, but one, were significantly different than zero. The median of all estimates was $\hat{\eta} = -0.00017$, which yields $\hat{\alpha} = 0.00013$ and $\hat{\gamma} = 1.00013$. For the parameter ρ, six estimates were significant at the 5% level and the median of all estimates was $\hat{\rho} = 0.7721$. The intertemporal elasticity of was captured by solving for each estimate $\psi = 1/(1-\rho)$ and the median of all estimates was $\hat{\psi} = 3.5798$.[9]

In Table 4 we compare the estimates for β, γ and ψ with studies that also used the CCAPM framework but did not contemplate the rule of thumb parameter in the model, such as Issler & Piqueira (2000), Bonomo & Domingues (2002), Catalão & Yoshino (2006).[10] Table 4 shows the results of these studies for β, γ and ψ.

The results for the intertemporal discount coefficient, β, were all significant at the 5% level, for the three functional forms and in line with the previous studies.

Comparing the relative risk aversion results to the previous studies, we obtained lower values for the CRRA and the external habits utility models. Both models' estimates were very close to zero. For the Kreps–Porteus utility function, the median of all estimates of the risk aversion parameter was $\hat{\gamma} = 1.00013$, in contrast what was found in Issler & Piqueira $\hat{\gamma} = 0.68$ and Bonomo & Domingues $\hat{\gamma} = 3.226$. The intertemporal elasticity of substitution was captured by solving for each estimate $\psi = 1/(1-\rho)$ and the median of all estimates was $\hat{\psi} = 3.5798$, while estimates by Issler & Piqueira, and Bonomo & Domingues (2002) are $\hat{\psi} = 0.29$ and $\hat{\psi} = 0.371$, respectively.

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[7]A large number of instruments or a high number of assets can cause problems to find the optimal weighting matrix or influence the quality of asymptotic approximation, therefore the data must meet the following condition: $\frac{NM(NM+1)}{2} < NT$, where N are the number of Euler equations and T are the number of observations (Driscoll & Kraay, 1998). In this study, the number of instruments in the worst case the relation is $78 < 122$.

[8]When $\alpha = 0$ and $\gamma = 0$, the preferences are logarithmic and it is not possible to test the separability in intertemporal consumption.

[9]If the intertemporal elasticity of substitution was reached through $\hat{\psi} = 1/(1-\hat{\rho})$, the estimate would be $\psi = 4.3879$.

[10]The period of their estimations was from 1994 to 2003.

Table 1. Euler Equations for the CRRA Utility Function with Rule of Thumb.

$$\mathrm{E}\left[\left(1 - \beta\left(\frac{\frac{C_{t+1}}{C_t} - \lambda\frac{Y_{t+1}}{C_t}}{1 - \lambda\frac{Y_t}{C_t}}\right)^{-\gamma} R_{j,t+1}\right)\otimes X_t\right] = 0, \text{ for } j = 1, 2$$

where $N = 2$, $R_{1,t+1}$ = Ibovespa returns, and $R_{2,t+1}$ = Returns on Selic.

Inst./Mtx	β	γ	λ	P-value $(T \times J)$
I3/ASI	0.984***	0.944	0.1530	0.414
	(0.052)	(0.7365)	(1.1568)	
I5/ASI	0.981***	0.050	0.8049***	0.462
	(0.0035)	(0.0517)	(0.0246)	
I1/NWFSI	0.974***	−0.974***	0.8906***	0.255
	(0.0041)	(0.0263)	(0.0006)	
I4/NWFSI	0.979***	−0.072	0.8945***	0.806
	(0.0029)	(0.0435)	(0.0099)	
I3/NWFSI	0.978***	−0.138	0.8992***	0.560
	(0.0035)	(0.1198)	(0.0204)	
I6/NWFSI	0.971***	−0.240	0.9522***	0.252
	(0.0032)	(0.3293)	(0.1109)	
I4/NWVSI	0.969	−1.275***	0.9853***	0.991
	(0.0004)	(0.0572)	(0.0042)	
Median estimates	0.9783	−0.0974	0.8945	

Confidence interval for the median: $0.87 \leq \lambda \leq 0.915$

Notes: (i) *, ** and *** denote, respectively, significance of parameter by the t-test at the 10%, 5% and 1% levels. (ii) The number in parentheses are the respective standard-deviation estimates, robust to heteroscedasticity and to serial correlation. (iii) The last line of the table shows the median of all estimates. (iv) List of instruments: I1 uses $R_{2,t}$ $R_{2,t-1}$, C_t/C_{t-1}, C_{t-1}/C_{t-2}; I3 uses $R_{2,t-1}$, $R_{2,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I4 uses $R_{2,t-1}$, $R_{2,t-2}$, $R_{1,t-1}$, $R_{1,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I5 uses $R_{1,t-1}$, $R_{1,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I6 uses $R_{2,t}$, $R_{2,t-1}$, $R_{1,t}$, $R_{1,t-1}$, C_t/C_{t-1}, and C_{t-1}/C_{t-2}. (v) The p-value of Hansen's overidentifying restrictions test results are shown in the last column. (vi) The table only reports the results that reached convergence in less than 1,000 iterations and was not rejected by Hansen's (1982) test. (vii) The first column shows the method by which the weighting matrix was reached, ASI denotes Andrews (1991), NWFSI denotes Newey & West (1987) with fixed windows, and NWVSI denotes Newey & West (1994), with variable windows.

Table 2. Euler Equations for the External Habits' Utility Function with Rule of Thumb.

$$\mathrm{E}\left[\left[\left(1-\beta\left(\frac{\frac{C_{t+1}}{C_t}-\lambda\frac{Y_{t+1}}{C_t}}{1-\lambda\frac{Y_t}{C_t}}\right)^{-\gamma}\left(\frac{\frac{C_t}{C_{t-1}}-\lambda\frac{Y_t}{C_{t-1}}}{1-\lambda\frac{Y_{t-1}}{C_{t-1}}}\right)^{\kappa(\gamma-1)}R_{j,t+1}\right)\otimes X_t\right]=0,\text{ for }j=1,2\right.$$

where $N=2$, $R_{1,t+1}=$ Ibovespa returns, and $R_{2,t+1}=$ Returns on Gov.Debt-Selic.

Inst./Mtx	β	γ	λ	κ	*P*-value $(T\times J)$
I6/ASI	0.986***	0.689**	0.122	0.582	0.398
	(0.0031)	(0.259)	(0.5302)	(0.4940)	
I5/NWFSI	0.626***	10.655**	0.419	1.6164***	0.545
	(0.2216)	(5.0581)	(0.2719)	(0.4853)	
I5/ASI	0.467***	10.111***	0.594**	1.280***	0.784
	(0.2111)	(7.9961)	(0.2240)	(0.4685)	
I4/ASI	0.977***	0.067	0.769***	0.1540	0.248
	(0.0034)	(0.0921)	(0.0861)	(0.1658)	
I4/NWFSI	0.979***	0.054	0.775***	0.1517	0.497
	(0.0021)	(0.0632)	(0.0644)	(0.1245)	
I8/NWFSI	0.978***	0.035	0.7784***	0.1978	0.149
	(0.0034)	(0.0734)	(0.0594)	(0.1711)	
I7/NWFSI	0.979***	0.011	0.7817***	0.2008	0.550
	(0.0033)	(0.0906)	(0.0813)	(0.2471)	
I6/NWVSI	0.977***	0.120*	0.7956***	0.0475	0.374
	(0.0030)	(0.0669)	(0.0272)	(0.0327)	
I3/NWFSI	0.983***	0.0579	0.7983***	0.0065	0.542
	(0.0031)	(0.0523)	(0.0355)	(0.0214)	
I3/ASI	0.981***	0.0458	0.8063***	0.0057	0.330
	(0.0034)	(0.0526)	(0.0219)	(0.0239)	
I2/ASI	0.979	−0.065**	0.8905***	−0.0283**	0.284
	(0.0048)	(0.0272)	(0.0008)	(0.0134)	
I2/NWFSI	0.972	−0.262	0.9177***	−0.1206	0.287
	(0.0044)	(0.3563)	(0.0817)	(0.1859)	
Median estimates	0.9793	0.0548	0.7817	0.1518	

Confidence interval for the median: $0.717\leq\lambda\leq0.846$

Notes: (i) *, ** and *** denote, respectively, significance of parameter by the *t*-test at the 10%, 5% and 1% levels. (ii) The number in parentheses are the respective standard-deviation estimates, robust to heteroscedasticity and to serial correlation. (iii) The last line of the table shows the median of all estimates. (iv) List of instruments: I2 uses $R_{1,t}$ $R_{1,t-1}$, C_t/C_{t-1}, C_{t-1}/C_{t-2}; I3 uses $R_{2,t-1}$, $R_{2,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I4 uses $R_{2,t-1}$, $R_{2,t-2}$, $R_{1,t-1}$, $R_{1,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I5 uses $R_{1,t-1}$, $R_{1,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I6 uses $R_{2,t}$, $R_{2,t-1}$, $R_{1,t}$, $R_{1,t-1}$, C_t/C_{t-1}, and C_{t-1}/C_{t-2}; I7 uses $R_{2,t}$, $R_{2,t-1}$, $R_{2,t-2}$, $R_{1,t}$, $R_{1,t-1}$, and $R_{1,t-2}$; I8 uses $R_{2,t-2}$, $R_{2,t-3}$, $R_{1,t-2}$, and $R_{1,t-3}$. (v) The *p*-value of Hansen's overidentifying restrictions test results are shown in the last column. (vi) The table only reports the results that reached convergence in less than 1,000 iterations and was not rejected by Hansen's (1982) test. (vii) The first column shows the method by which the weighting matrix was reached, ASI denotes Andrews (1991), NWFSI denotes Newey & West (1987) with fixed windows, and NWVSI denotes Newey & West (1994), with variable windows.

Table 3. Euler Equations for the Kreps–Porteus Utility Function with Rule of Thumb.

$$\mathrm{E}\left[\left[\left(1 - \beta^{\eta} \frac{\frac{C_{t+1}}{C_t} - \lambda \frac{Y_{t+1}}{C_t}}{1 - \lambda \frac{Y_t}{C_t}}\right)^{\eta(\rho-1)} \bar{B}_{t+1}^{\eta-1} R_{j,t+1}\right] \otimes X_t\right] = 0, \text{ for } j = 1,2$$

where $N = 2$, $\bar{B}_{t+1}$ = Ibovespa returns, $R_{2,t+1}$ = Returns on Gov.Debt-Selic, and

$$\eta = \frac{\alpha}{\rho}, \qquad \psi = \frac{1}{1-\rho}, \qquad \gamma = 1 - \alpha$$

Inst./Mtx	β	γ	λ	ρ	ψ	P-value $(T \times J)$
I3/ASI	0.9679***	1.00006**	0.7692***	0.8759***	8.0590	0.2984
	(0.0048)	(0.21349)	(0.1685)	(0.2775)	(18.0265)	
I5/ASI	0.9733***	1.000***	0.0314	−0.3779	0.7257	0.1146
	(0.0087)	(0.03566)	(1.4838)	(1.1368)	(0.5987)	
I6/ASI	0.9743***	1.0001***	0.2263	0.5219**	2.0919**	0.3767
	(0.0042)	(0.05109)	(0.5098)	(0.2257)	(0.9880)	
I6/NWFSI	0.9772***	1.0003***	0.0297	0.5438***	2.1923***	0.5140
	(0.0036)	(0.00507)	(0.6660)	(0.1708)	(0.8212)	
I7/NWFSI	0.9751***	1.0001***	0.6572*	0.8127***	5.3409	0.3917
	(0.00375)	(0.0632)	(0.35836)	(0.2419)	(6.9020)	
I1/NWVSI	0.9738***	1.0000***	0.1048	0.9136***	11.5762	0.4359
	(0.00356)	(0.0632)	(4.5702)	(0.1729)	(23.1740)	
I7/NWVSI	0.9768***	1.0002***	0.5843	0.7220***	3.5978	0.5225
	(0.00368)	(0.14673)	(0.3813)	(0.2511)	(3.2504)	
Median estimates	0.9793	0.0548	0.7817	0.1518		
Confidence interval for the median: $0.717 \le \lambda \le 0.846$						

Notes: (i) *, ** and *** denote, respectively, significance of parameter by the t-test at the 10%, 5% and 1% levels. (ii) The number in parentheses are the respective standard-deviation estimates, robust to heteroscedasticity and to serial correlation. (iii) The last line of the table shows the median of all estimates. (iv) List of instruments: I1 uses $R_{2,t}$ $R_{2,t-1}$, C_t/C_{t-1}, C_{t-1}/C_{t-2}; I3 uses $R_{2,t-1}$, $R_{2,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I5 uses $R_{1,t-1}$, $R_{1,t-2}$, C_{t-1}/C_{t-2}, and C_{t-2}/C_{t-3}; I6 uses $R_{2,t}$, $R_{2,t-1}$, $R_{1,t}$, $R_{1,t-1}$, C_t/C_{t-1}, and C_{t-1}/C_{t-2}; I7 uses $R_{2,t}$, $R_{2,t-1}$, $R_{2,t-2}$, $R_{1,t}$, $R_{1,t-1}$, and $R_{1,t-2}$. (v) The p-value of Hansen's overidentifying restrictions test results are shown in the last column. (vi) The table only reports the results that reached convergence in less than 1000 iterations and was not rejected by Hansen's (1982) test. (vii) The first column shows the method by which the weighting matrix was reached, ASI denotes Andrews (1991), NWFSI denotes Newey & West (1987) with fixed windows, and NWVSI denotes Newey & West (1994), with variable windows. (viii) The parameters γ and ψ in the Kreps–Porteus utility function model were estimated indirectly using the delta method (see Greene, 2008).

Table 4. Results of parameters β, γ, and ψ in CCAPM studies.

	β	γ	$\psi = 1/\gamma$
CRRA			
This paper (with Rule of Thumb)	0.9783	-0.0974	-10.2669
Issler & Piqueira (2000)	0.99	0.62	1.61
Catalão & Yoshino (2006)	0.9711	2.1192	0.47
External Habits			
This paper (with Rule of Thumb)	0.9793	0.0548	18.2482
Issler & Piqueira (2000)	0.99	0.46	2.17
Kreps–Porteus			
This paper (with Rule of Thumb)	0.9743	1.00013	3.5798
Issler & Piqueira (2000)	0.96	0.68	0.29
Bonomo & Domingues (2002)	0.9505	3.23	0.37

Table 5 compares the results for the rule of thumb parameter with the previous findings with Brazilian data. The estimates for the CRRA and external habits were close to the findings of Reis et al. (1998), Issler & Piqueira (2000) and Gomes (2004), $\hat{\lambda} \approx 0.80$, $\hat{\lambda} \approx 0.74$ and $\hat{\lambda} \approx 0.85$ respectively. For the Kreps–Porteus model, the median estimate was $\hat{\lambda} = 0.2263$, but in almost all cases λ estimates are not significant at the 5% level. This number differs from the results for the two preference forms treated above and for the previous studies. If we took a different approach and considered only the results significant at the 5% level, the estimate for this parameter would be $\hat{\lambda} = 0.7692$, very close to all the other results.

For the CRRA and the external habits models, which yielded various significant results for λ at the 5% level, we built confidence intervals. For the CRRA, $[0.87, 0.91]$ and for External habits, $[0.72, 0.85]$.

One possible reason pointed out for a high λ was the lack of credit available to the Brazilian population during the period of study. After the end of the hyperinflation in 1994, the Brazilian economy experienced a strong expansion of credit, so some agents who followed the rule of thumb due to credit constraint in the previous studies could have started to optimize their consumption decisions.

Gomes & Paz (2004) and Arreaza (2000) results for λ suggests rejection of the PIH for Latin American data. This study comes to the same conclusion for Brazilian data, but reached to slightly different values for the fraction of myopic consumption.

Table 5. Results in the literature for the estimation of consumers' share who follow the rule of thumb in the Brazilian economy.

Authors	Period studied	Estimates
Cavalcanti (1993)	1980 a 1989	0.32
Reis et al. (1998)	1947 a 1994	0.80
Issler & Piqueira (2000)	1947 a 1994	0.74
Gomes (2004)	1947 a 1999	0.85
Gomes & Paz (2004)	1951 a 2000	0.61
Gomes & Paz (2010)	1950 a 2003	$[0.83, 0.91]$ (IPA)
		$[0.73, 1.06]$ (IGP-DI)
This paper	1995 a 2011	$[0.87, 0.91]$ (CRRA)
	1995 a 2011	$[0.72, 0.85]$ (External Habits)

5. CONCLUSION

This paper investigated whether there is a fraction of consumers that do not behave as fully forward-looking optimal consumers in the Brazilian economy. We used different utility functional forms in the CCAPM framework. Beginning from Euler equations of the optimizing consumer utility problem, we estimated the structural parameters using the generalized method of moments (GMM) and tested the model's over-identifying restrictions using Hansen's TJ test (Hansen & Singleton, 1982).

Regarding the model's performance, we conclude that in the Brazilian case there is a proportion of the individuals consuming their current income, and another group of individuals that consume optimally in each period. These findings suggest that a significant fraction of the Brazilian disposable income went to households who consumed their current income, following the rule of thumb. Therefore, there was a strong violation of the permanent income hypothesis.

The results found can be summarized as follows:

1. The main results show that for the CRRA and external habits utilities, most of the estimates of the rule-of-thumb parameters were statistically significant at conventional levels. The interval of confidence estimates results were $[0.72, 0.85]$ and $[0.87, 0.91]$ respectively.

2. For the Kreps–Porteus utility function almost all estimates of λ were statistically insignificant, therefore the 22% median estimate is not robust enough to say there was a fraction of myopic consumers.

3. The results for the intertemporal discount coefficient, β, were all significant at the 5% level, for the three functional forms and in line with the previous studies.

4. Comparing the relative risk aversion results to the previous studies, we obtained lower values for the CRRA and the external habits utility models.

There are two possible explanations of the higher λ reached in the present study. One possible reason for a high λ was the lack of credit available to the Brazilian population during the period of study. After the end of the hyperinflation in 1994, the Brazilian economy experienced strong expansion of the credit, so some agents who followed the rule of thumb due to credit constraint in the previous studies could have started to optimize their consumption decisions. On the other hand, the long period with no funds to finance consumption caused a large pent-up demand during the period of this study. Another explanation is that great increase in income experienced by the lower social classes, especially after 2002, caused them to increase spending in a Keynesian way, assuming that those social classes spend their current income.

Interesting extensions of this paper could be to use factor model analysis to build portfolios in order to consider more than two assets or to explore other functional forms.

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