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Consumption per effective labour in Brazil: testing for the optimising behaviour

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Abstract: We contributed to the literature on household consumption in specific ways: firstly, we adopted a long-run cointegration analysis instead of a first-difference one, which was conventional in previous works; second, by building on monthly data, we enlarged the number of observations of our sample, thus overcoming a common problem of low-frequency data in studies based on quarterly or annual time series. We thus confirmed the hypothesis of an optimising behaviour in consumption for the Brazilian economy, although jointly with a relevant role of income. We also inferred the effect of risk aversion in lowering the optimality of consumption after the *Subprime crisis* period, based on a Markov-switching approach.

Keywords: consumption; households; interest rate; income; Brazil.

JEL codes: C5, E2.

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Biographical notes: Ricardo Ramalhete Moreira currently works at the Federal University of Espírito Santo, Brazil. He has researched mainly on monetary and fiscal economics, focusing on empirical aspects. He received his Doctor's in Economics at the Federal University of Rio de Janeiro, in 2009. In 2019, he became a CNPq's researcher.

1 Introduction

Over the last decades, there has been a widely debate on the effects of real interest rate on household consumption. In general, studies that reject these effects usually explain it through some form of banking and/or credit constraint (Zeldes, 1989; Gross and Souleles, 2002), e.g., changes in real basic interest rates would not be appropriately transmitted into changes in personal loan rates, thereby preventing those predicted effects.

Household consumption has been broadly analysed for developed and developing economies, and several works have achieved relevant evidence on the subject. Specifically for Brazil, based on canonical and extended theories, which built on micro-foundation such as Ramsey-Cass-Koopmans, real business cycle and/or dynamic stochastic general equilibrium (DSGE) models, Reis et al. (1998)[1] found an impact of uncertainty on household consumption, besides confirming the hypothesis of credit constraints on the most part of the Brazilian population (80% approximately), which was then totally dependent on its current income.

In turn, Gomes (2010) achieved results rejecting the hypothesis of optimising behaviour in consumption, as its estimates did not find statistically significant coefficients for interest rates. Moreover, the hypothesis of credit constraints was also rejected in its estimation, which covered the annual period from 1948–2005. In another important contribution on consumption for the Brazilian economy, Gomes (2013) tested for substitution and complementary relations between private and public consumption, and its empirical findings rejected both types of relationship, although the hypothesis of excessive sensitivity of consumption to income has been confirmed.

More recently, Barros et al. (2018) contributed to the related literature by means of a generalised method of moments (GMM) approach. Based on quarterly data from Feb./2002 to Mar./2014, the authors obtained findings that were regarded as consistent with the results of the previously published works for the Brazilian economy. The unique explaining factor for aggregate consumption growth in the GMM regressions was the income growth. Thus, interest rates, consumption habits and hours worked did not present statistical significance as drivers of Brazil's consumption growth.

In sum and over the related studies, we can point that a common feature is the rejection of the optimising behaviour hypothesis. As a corollary, there exists an almost-consensus on the strong role of current income as the main explanatory variable of consumption, thereby constraining those studies to focusing on the causes of the relation between income and consumption.

Our current work contributes to such a literature in the following aspects. In general, the related works have been dealing with a problem of *low-frequency* data. For instance, Reis et al. (1998) built on only 76 observations with quarterly data. Gomes (2010) used 57 annual obs.; Gomes (2013) built on 33 observations with annual data; at last, Barros et al. (2018) adopted 50 observations with quarterly data.

Unlike these studies, we adopted monthly data so that we considerably enlarged the number of observations of our sample, thus overcoming the aforementioned problem of low-frequency data based on quarterly or annual time series. Besides, we performed a long-run cointegration analysis instead of a conventional first-difference one. By applying three cointegration alternative approaches (Engle and Granger, 1987; Johansen and Juselius, 1990; Pesaran et al., 2001) and robustly confirming the hypothesis of an optimising behaviour in consumption decisions, we regard this current work as a relevant innovation to the subject. At last, our estimates were also extended by regarding the role of an underlying risk aversion on consumption through a Markov-switching approach.

This paper is structured as follows: Section 2 presents a brief model in order to build a theoretical background about optimising consumption. In turn, Section 3 shows our dataset, while Section 4 describes the empirical strategy. At last, Sections 5 and 6 present and discuss the empirical results, followed by concluding remarks.

2 A background model

The following simple model is based on optimality conditions at the microeconomic level, commonly found in growth research based on Ramsey-Cass-Koopmans, real business cycle or New-Keynesian *DSGE* models (Romer, 2006). The household's problem is to choose the path of consumption per effective labour ($c(t)$) to maximise lifetime utility [equation (1)]:

$$\int_{t=0}^{\infty} e^{-\rho t}\left[\frac{c(t)^{1-\theta}}{1-\theta}\right]dt \tag{1}$$

subject to a budget constraint (2):

$$\int_{t=0}^{\infty} e^{-rt}c(t)e^{(n+g)t}dt \le k(0)+\int_{t=0}^{\infty} e^{-rt}w(t)e^{(n+g)t}dt \tag{2}$$

where ρ stands for the intertemporal discount rate, θ for the relative risk aversion (i.e., the inverse of the *intertemporal substitution elasticity*), n is the population growth rate, g is the knowledge growth rate, $k(0)$ stands for the initial capital stock level, while w stands for the real wage. At last, r represents the real interest rate. We can therefore use the objective function and the budget constraint to setup the Lagrangian:

$$L=\int_{t=0}^{\infty} e^{-\rho t}\left[\frac{c(t)^{1-\theta}}{1-\theta}\right]dt+\lambda\left[k(0)+\int_{t=0}^{\infty} e^{-rt}w(t)e^{(n+g)t}dt-\int_{t=0}^{\infty} e^{-rt}c(t)e^{(n+g)t}dt\right] \tag{3}$$

where λ is the Lagrangian multiplier. The first-order condition for $c(t)$ is:

$$e^{-\rho t}c(t)^{-\theta}=\lambda e^{-rt}e^{(n+g)t} \tag{4}$$

Taking logs of both sides in equation (4), we have,

$$-\rho t-\theta \ln c(t)=\ln\lambda-rt+(n+g)t \tag{5}$$

The derivatives of the two sides of equation (5) with respect to t must be the same. This condition is then,

$$-\rho-\theta\frac{\dot{c}(t)}{c(t)}=-r+(n+g) \tag{6}$$

And thus, we have the following Euler equation:

$$\frac{\dot{c}(t)}{c(t)}=\frac{r-\rho-(n+g)}{\theta} \tag{7}$$

If we account for the fact that $\frac{\dot{c}(t)}{c(t)}=\frac{c_{t+1}^{e}-c_t}{c_t}$, we can then express

$$c_t=\alpha-\frac{1}{\theta}r,\ \alpha\equiv c_{t+1}^{e}\left[\frac{\rho+(n+g)}{\theta}\right] \tag{8}$$

Thus, the optimising behaviour of consumption is consistent with the positive relationship between real interest rate and *consumption growth*, which means that when real interest rate increases we will observe a reduction of *current consumption* (c_t) in relation to the future level (c_{t+n}). It occurs because households decide to allocate a higher part of income to savings, taking advantage of a more attractive real interest rates, so that a rise in future consumption is feasible. Therefore, any empirical consumption analysis which finds evidence of an inverse relationship between real interest rate and contemporaneous consumption is convergent to this underlying optimising behaviour, even when accompanied by other potential factors driving household decisions. In an empirical general set:

$$c_t = \alpha_i V_{it} + \cdots + \alpha^n V_{nt} + \beta_2 r + \epsilon_t \tag{9}$$

where V_{it}, $i = 0, \dots, n$ represents a group of control variables which can be assumed to affect consumption decisions along with the real interest rate. A white noise shock ϵ_t includes the stochasticity into our model. Our main hypothesis is thus validated if one rejects the null of $\beta_2 \geq 0$.

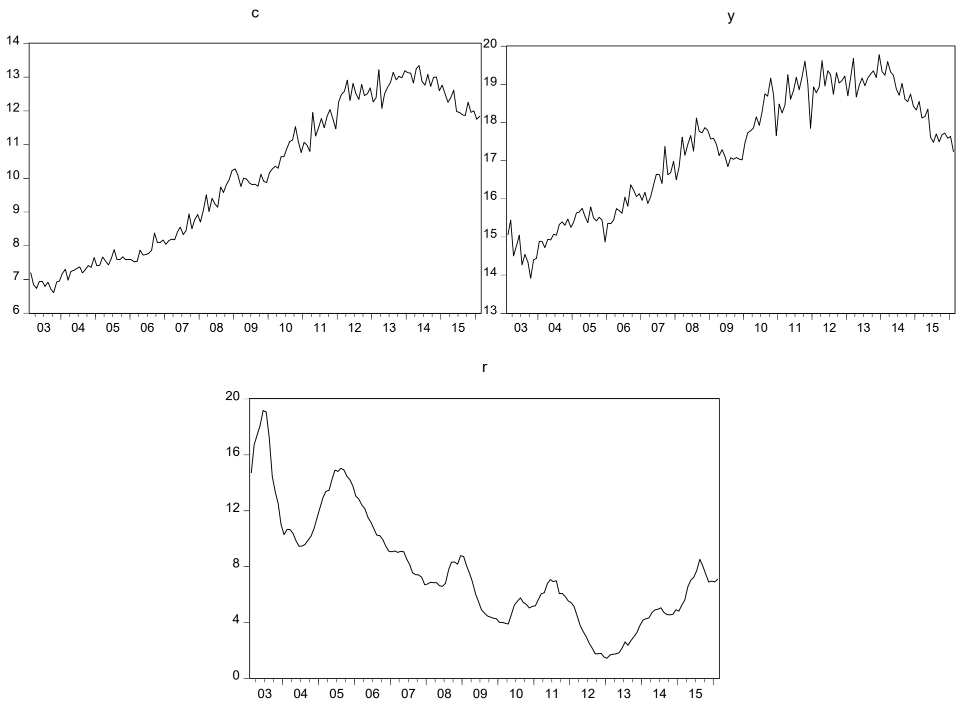
3 Dataset

In order to enlarge the number of observations and so overcome the common problem of low frequency data in studies applied to Brazil, we employed monthly data comprising the period from Feb.-2003 to Feb.-2016, thus encompassing 157 observations. Our time series can described as follow. The *consumption per unit of effective labour* ($c = C / AL$) was calculated based on three other series:

1. the *retail trade index*, which is measured by the *monthly survey of trade* of the *Brazilian Institute of Geography and Statistics* (IBGE). This series is a proxy for macroeconomic consumption (C) in Brazil, as it is measured over the main urban regions of the country and covers the gross revenues of the retail sector. Besides, it allowed us to use monthly data, unlike the *National Accounts System*, which is available only in a quarterly or annual basis.
2. The *industrial output per hours worked* (A), calculated through the *industrial output index* of the IBGE divided by *hours worked in the industrial sector* (available by the *National Confederation of Industry* – CNI).
3. The log of the *economically active population* (L), which is also measured by the IBGE.

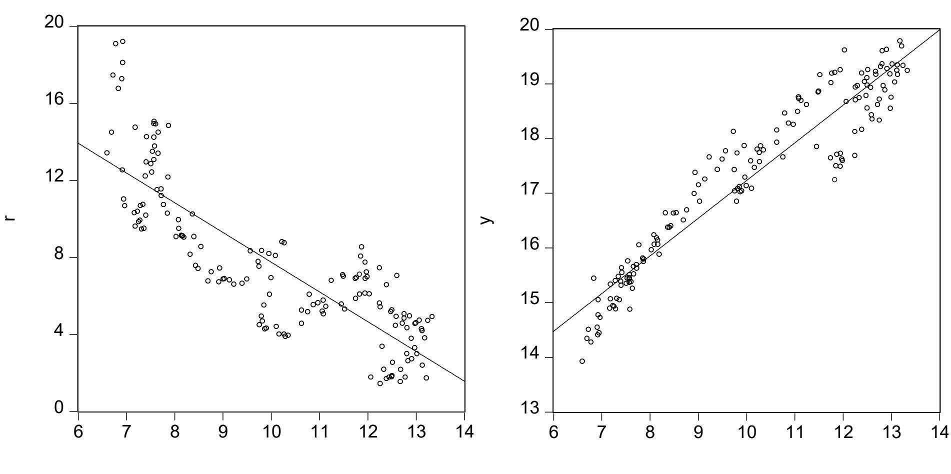
In turn, the real interest rate (r) was calculated from the difference between the nominal Selic rate – which is the basic interest rate in Brazil – and the inflationary expectations for 12 months forward based on the IPCA, both collected from the Brazilian Central Bank's database. Regarding the proxy for domestic income, we computed an *income per unit of effective labour* ($y = Y / AL$) variable. The Brazilian Central Bank's *economic activity index* (IBC-Br) stands for income (Y), while the AL component was measured in the same way as for c. Figure 1 shows the graphical behaviour of c, y and r. A clear trend surrounding them can be seen. In turn, preliminary simple correlations between c and y, as well as between c and r, are presented in Figure 2.

Figure 1 Graphical behaviour of *c*, *y* and *r*



Source: Own elaboration

Figure 2 Simple correlations



Source: Own elaboration

4 Methodological strategy

Unlike the most part of the reviewed works on consumption, we adopted a long-run relationship approach to test for the hypothesis of household optimising behaviour in Brazil. Such a choice was important because it avoided the loss of information in consequence of removing trend behaviour with first-difference equations. Although the Euler equation in growth models establishes a differential behaviour consistent with the optimising consumption, the latter is enclosed in a deterministic model.

On the one hand, when one estimates an econometric model, there are several stochastic events and shocks occurring over time, and removing the data trend leads to short-term regressions. On the other hand, when one applies level equations to a theoretical issue, it is important to take into account the risk of spurious estimates, as well pointed out in Granger and Newbold (1974). Thus, when one deals with problems regarding level equations and so long-run macroeconomic relationships, an appropriate cointegration approach becomes necessary to avoid a misspecification of the regressions.

After identifying the integration order ($I(1)$) of the time series through ADF and PP tests, the first estimation methodology was straightforward: we tested for a *cointegrating equation* of c, y and r, by means of Engle and Granger (1987)'s stationarity of residuals conventional technique. Such a first estimation was made with the *GMM*, as it is regarded a useful method to overcome potential problems of heteroskedasticity, autocorrelation and endogeneity (Hansen, 1982). In turn, the instrumental variables set was based on the i-period lag of the time series (from $t - 1$ to $t - 6$), which thus satisfied the hypothesis of exogeneity of the instruments (Johnston, 1984). To assure the appropriate specification of the instrumental variables, an analysis of *overidentification* was performed by the J-test (Cragg, 1983; Hansen, 1982).

In order to confirm the preliminary findings, we then applied another cointegration approach (Johansen and Juselius, 1990), which allows for a *vector error correction* (VEC) model representation. Initially, we tested for the best lag order of the *unrestricted VAR* model based on information criteria. In turn, *trace and maximum eigenvalue statistics* were used to identify the existence of cointegrating equations.

However, these cointegration approaches are subject to problems of misclassification of the integration order in time series (Pesaran et al., 2001). Indeed, either Engle and Granger (1987) or Johansen and Juselius (1990) built their approaches on the principle of time series with the same integration order [generally $I(1)$ time series]. Therefore, Pesaran et al. (2001) developed a strategy for allowing cointegration tests regardless the integration order of the regressors, thereby extending cointegration for cases in which one or more of the regressors are stationary, while others can be $I(1)$. Such a procedure was based on an *auto-regressive distributed lag (ARDL)* model and on the *F-bounds test*. If the F-statistic is above the upper bound ($I(1)$) value, we then can reject the null hypothesis of no long-run relationships.

5 Analysis of results

All the estimates were conducted in log-log equations so as to allow for elasticity relations. The first estimation was based on a GMM regression of the following form:

$$\log c_t = \beta_1 \log y_t + \beta_2 \log r_t + \varepsilon_t \text{ f} \tag{10}$$

According to our estimates, a 1% of increase in real interest rate was accompanied by a statistically significant decrease of 0.21% in consumption per effective labour (Table 1). This correlation corroborates the *prima facie* relationship in Figure 1 and indicates an optimising behaviour of consumption in Brazil over the time sample. In turn, a rise of 1% in income per effective labour was contemporaneously followed by an increase of 0.94% in consumption with statistical significance. Therefore, although our preliminary estimates suggest a role of the real interest rate, and so of the monetary policy on consumption decisions, income changes still perform expressive effects on household consumption in Brazil, thereby also validating the common evidence of credit constraints over relevant part of the population. The GMM regression also presents a J-stat. (prob. > 0.1) which was compatible with the hypothesis of overidentification and so the validity of the adopted instrument list.

Table 1 GMM, Johansen and Pesaran cointegrated equation estimates

	GMM	*Johansen*	*Pesaran*
log(*y*)	0.943***	0.979***	0.973***
	(0.011)	(0.023)	(0.048)
	[84.211]	[42.401]	[20.005]
log(*r*)	–0.216***	–0.233***	–0.149**
	(0.081)	(0.033)	(0.061)
	[–2.656]	[–6.957]	[–2.445]
Adj. R^2	0.824	-	-
Prob. (J-stat.)	0.150	-	-
AIC	-	–13.243	-
F-stat.	-	-	5.481
I(1) at 1%	-	-	5.300

Notes: Dependent variable: log(*c*).
Instruments into the GMM regression: log(*c*(–1)), log(*r*(–1)), log(*y*((–1)), log(*c*((–2)), log(*r*((–2)), log(*y*((–2)), log(*c*((–3)), log(*r*((–3)), log(*y*((–3)), log(*c*((–4)), log(*r*((–4)), log(*y*((–4)), log(*c*((–5)), log(*r*((–5)), log(*y*((–5)), log(*c*((–6)), log(*r*((–6)) and log(*y*((–6)).
***For 1% of statistical significance.

Source: Own elaboration

Table 2 Optimal lag choice for the VEC model

Lag	*AIC*	*SC*	*HQ*
1	–12.19725	–12.01977	–12.12516
2	–13.03267	–12.67770*	–12.88848
3	–13.19830*	–12.66584	–12.98202*

Note: *Indicates the optimal statistics.

Source: Own elaboration

Moreover, we performed a parsimonious Johansen cointegrated regression so as to test the robustness of the GMM estimates. Firstly, the optimal lag of the VEC model was identified by means of AIC, SC and HQ criteria (Table 2). We then adopted three lags for the VEC model. Besides, the *trace and maximum eigenvalue* tests jointly identified one cointegrated equation based on the model without constant and no trend in data (Table 3). Although the trace test showed the possibility of two cointegrated equations, the maximum value test pointed to only 01 (both at 5%). Thus, we adopted the more parsimonious structure. We can observe that the responses of consumption per effective labour to both income and real interest rate based on the Johansen regression were closely similar to those through the GMM approach (Table 1).

Table 3 Trace and maximum value tests

No. of CE(s)	*Eigenvalue*	*Stat.*	*Critical value*	*Prob.*
Unrestricted cointegration rank test (trace)				
None	0.131	34.681	24.276	0.002
At most 1	0.070	13.195	12.321	0.036
At most 2*	0.013	2.055	4.130	0.179
Unrestricted cointegration rank test (maximum eigenvalue)				
None	0.131	21.486	17.797	0.013
At most 1*	0.070	11.140	11.225	0.052
At most 2	0.013	2.055	4.130	0.179

Note: *Indicates the choice at 5%.

Source: Own elaboration

At last, the Pesaran's *ARDL* cointegrated model also corroborated the previous estimates: an increase of 1% in y and r is followed by, respectively, 0.97% and –0.14% in consumption per effective labour.

Our main evidence of an inverse relationship between real interest rates and household consumption over all these three cointegrating methods indicates the existence of an optimising behaviour in Brazil, yet the relevant role of the income in explaining our models. In other words, when Brazil's central bank performs a monetary policy leading to a rise (a reduction) in real interest rates it stimulates a higher (lower) consumption growth rate, which is expressed by a decrease (rise) of the contemporaneous consumption per effective labour. Such a finding is a type of validation of the conventional micro-foundation hypothesis in canonical growth and cycle models, such as Ramsey-Cass-Koopmans and real business cycle models.

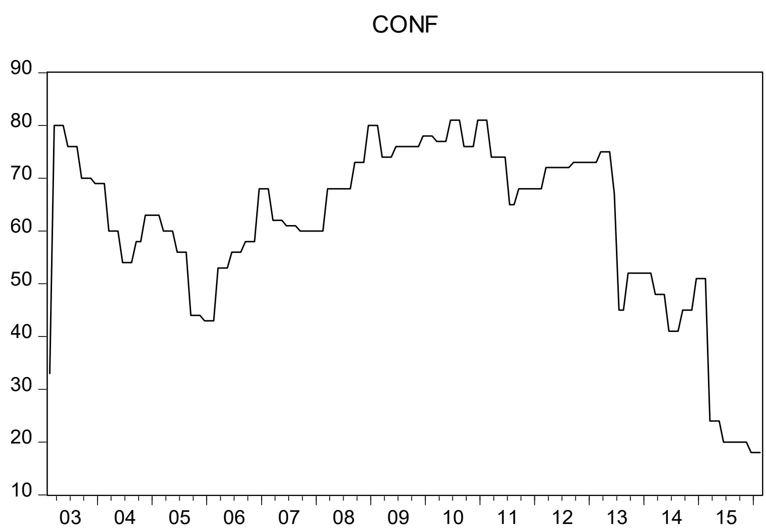
6 An extension: underlying risk aversion

The optimising behaviour of household – assessed by the previous estimates – is supposedly conditional to the parameter of risk aversion, which was represented in our background model by θ. The higher the risk aversion, the lower the effect of a change in real interest rate on current consumption. We thus explored such hypothesis by testing for potential structural breaks of the relationships between interest rates and household consumption into our time sample. To do so, we employed the so-called *Markov-switching regression* method, in order to capture the underlying (i.e., non-directly observable) effect of risk aversion on β_2. Our idea is straightforward: if it is possible to identify different regimes of β_2 over time, and these distinct regimes have a clear sample division, so we will be able to associate higher or lower risk aversion degrees with each of these estimated states of nature.

The Markov-switching model (Hamilton, 1989) estimates varying correlations according to different regimes or states of nature, which are assumed as random states over time. So, a structure is possibly substituted by others through a stochastic path, which is thereby shaped based on a Markov chain.

Moreover, we used a proxy for the *household confidence* as an additional control variable. Consumer confidence can also be regarded as a proxy for assessing expected future consumption c_{t+1}^{e}. Thus, according to our background model, it stimulates an increase of consumption growth [$\frac{\dot{c}(t)}{c(t)} = \frac{r - \rho - (n+g)}{\theta}$, equation (7)]. Hence, we expect an inverse relation between confidence and current consumption. This time series (*conf*) is measured by the *Getúlio Vargas Foundation* (FGV). We present its graphical behaviour (*conf*) in Figure 3.

Figure 3 Household confidence in Brazil



Source: Own elaboration

The MS-estimates (Table 4) found a confirmation of the inverse relationship between real interest rates and aggregate consumption, despite the existence of different structures regarding the magnitudes of such a relation. Specifically, Regime 2 was followed by a stronger inverse response of consumption to real interest rates (–0.148). It means that there was a higher *intertemporal substitution elasticity*, or a lower underlying risk aversion θ over Regime 2; in contrast, Regime 1 was a period of increased risk version, so that consumption was less sensitive to real interest rates (–0.136).

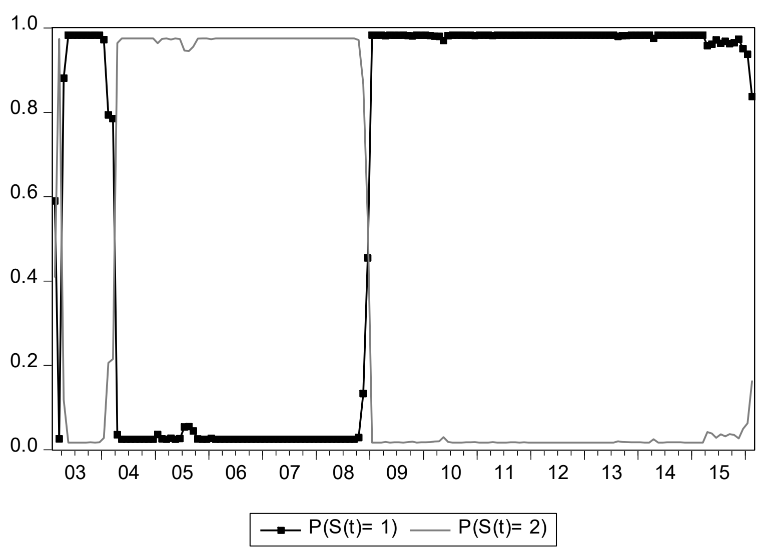
A way of better understanding it is through the subsamples associated with each estimated regime. Figure 4 shows the probabilities of each regime prevalence over our time sample. As we can observe, Regime 1 was more adherent (closer to 1.0) to the years after 2009, suggesting that the *Subprime crisis* probably affected household behaviour by increasing the risk aversion, so that consumption reacted less to real interest rates over this subsample. In contrast, previously to that crisis (Regime 2 in general), we had a stronger effect of real interest rates on Brazil's consumption, because, as we suppose, there existed a lower risk aversion into the household's objective function.

Table 4 MS-regression

Variable	*Coef.*	*Std. error*	*z-stat.*
Regime 1: switching regressors			
R	–0.136***	0.009	–15.046
Conf	–0.031***	0.001	–16.829
Regime 2: switching regressors			
R	–0.148***	0.013	–11.282
Conf	–0.048***	0.002	–17.038
Common variable			
Y	0.779***	0.006	117.515
DW stat		0.832	
AIC		0.926	

Notes: *c*: dependent variable.
***For 1% of statistical significance.
Source: Own elaboration

Figure 4 Markov-switching one-step ahead predicted regime probabilities



Source: Own elaboration

Furthermore, over both the regimes consumption was inversely influenced by confidence, thereby meaning that periods of a high household confidence were associated with high consumption growth, which was represented in our estimates by a reduction of current consumption. However, in Regime 1, such an effect was lower than in Regime 2. Supposedly, it occurred because after the Subprime crisis there would be an increase of ρ, i.e., the intertemporal discount rate, so that changes in confidence were less able to affect intertemporal substitution over time.

In turn, we adopted y as a common variable. It is noteworthy that in this MS experiment the role of income on consumption decisions was diminished (0.799) compared to the previous cointegration regressions. Yet overall, we cannot reject the relevant effect of long-run income level on household consumption decisions in Brazil. We can interpret it in two different forms:

a the existence of liquidity constraints in the Brazilian credit market (e.g., high spreads to households in borrowing) gives more weight to income levels on consumption decisions, such as Zeldes (1989) and Gross and Souleles (2002) had observed for international data.

b If we take into account the long-run (cointegrated) nature of our estimates, the *transitory income variance* becomes less important than the *permanent income variance* (Friedman, 1957; Flavin, 1981), so that we can interpret changes in y mainly as changes in expected permanent income. In such a case, the estimated response of consumption to y is consistent with its predicted optimising behaviour.

7 Concluding remarks

The international literature on consumption behaviour did not achieve a consensus about the relative role of each factor driving consumer decisions (Romer, 2006). Yet, there exists robust pieces of evidence on some important factors which cannot be disregarded. Although the evolution of such a literature gradually diminished the relevance of disposable income (the canonical Keynesian hypothesis) as the main driving motive, we still find it as one of the important elements influencing households. Uncertainty, precautionary savings, credit constraints and real interest fluctuations are other necessary variables to take into account.

In this current paper, we found robust evidence about the influence of real interest rates on household consumption in Brazil, based on three long-run methods. Such a result points to the optimising behaviour as a valid hypothesis for this large emerging economy, thus diverging of some previous articles. Furthermore, by considering nonlinearities through MS regressions, we obtained results indicating an important effect of the Subprime crisis period on risk aversion over the further years. This finding suggests that monetary policy's effectiveness was reduced during moments of high volatility and uncertainty.

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Notes

1 Particularly, Reis et al. (1998) had Campbell and Mankiw's (1989) approach as their main reference.