E C O N O M I C S B U L L E T I N

Does nonlinear econometrics confirm the macroeconomic models of consumption?

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Abstract

This article aims at checking whether the macroeconomic models of consumption are always verified to reproduce the dynamics of consumption habits. We show that even if the Keynesian theory of consumption is still checked as the disposable income is a significant explanatory variable of household consumption, the dynamics of consumption cannot be reproduced anymore through the Post-Keynesian models like that of Brown (1952). While introducing nonlinearity and using the recent developments of Smooth Transition Regression (STR) models, we propose an extension for Brown's model and develop a Nonlinear Macroeconometric Model of Consumption (NMMC). Nonlinearity is justified by the structural breaks induced by habit formation and the irregularity in the evolution of the saving ratio since the seventies. Based on American and French data, our empirical results show that our model is statistically appropriate and leads to better performance than the usual macroeconomic specification of Brown.

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I. Introduction

The survey of household behavior is not a new research field. Indeed, economists have been showing a remarkable interest in the analysis of consumer behavior for quite a long time. As a matter of fact, since Keynes, who marked the beginning of a systematic reflection in this field, consumption is assimilated to the principal determinant of the economic activity and demand. It also plays an important role in the determination of the macroeconomic equilibrium and the economic mechanism, thanks to the relations that it maintains with saving and investment. Thus, several studies focused on the discussion of consumption modeling, explanatory factors and determinants of consumption [Villa (1994) among others]. To be more precise, this debate has been going on since the seventies, as the saving ratio evolved irregularly[1]. This irregularity, that can be associated to the evolution of the household purchasing power and of the consumer price index, is seen as a source of structural breaks in consumption that implies several problems of misspecification in consumption dynamics.

Consumption modeling was then a central question that united a large literature focusing on the survey of consumption behaviors [Houttaker and Taylor (1970) and Allard (1992) to quote only two references]. Nevertheless, in spite of the predominance of macroeconomic models and empirical studies of consumption, the specification of its determinants and explanatory factors is often problematic and several results are still questionable. Indeed, while most economic theories explain consumption habits in function of the income, they don't agree on the kind of income to be considered: disposable income [Keynes (1936)], permanent income [Friedman (1957], etc. Furthermore, the specification of the dynamic consumption function offers different formulations: some authors introduce the adjustment delays to reproduce the consumption habits whereas others consider the effects of distribution. Among the first formulations, Brown (1952) developed a more flexible modeling of consumption habits. In what follows, our survey will focus on Brown's model in so far as this formulation can be econometrically tested.

In practice, several empirical studies focus on the consumption dynamic and implicitly test the econometric validity of macroeconomic models of consumption such as that of Brown [Flavin (1981), Öcal and Osborn (2000) among others]. They more particularly verify the correlation and interdependence between consumption and income. Nevertheless, while checking the impact of habit formation and past consumption on the current consumption level, most studies, except that of Öcal and Osborn (2000), often model the consumption function using linear techniques. They presuppose that the phases of the economic cycle (expansion and recession) are symmetrical and identically characterized.

However, this hypothesis may appear as strongly restraining for many reasons. Firstly, the phases of a business cycle are rather asymmetric and the habits of consumption are cyclic [Villa (1994), Öcal and Osborn (2000), Dufrénot and Mignon (2004)]. Besides, this is also present in Keynes' affirmation that "*Recessions are more violent but briefer than expansions*", (*The General Theory of Employment, Interest and Money*, 1936, p.314). Secondly, consumption evolution is not stable and consumer behaviors are usually neither steady nor foreseeable, as testified by the different calculations and forecasting from conjecture organisms. Thirdly, the observation of irregular fluctuations in the American aggregate consumption in the second half of 1940 fuels this debate and rejects the hypothesis stating that consumption is a stable and foreseeable component of income. The instability of the consumption function is henceforth admitted in theory and practice, as suggested by Villa (1994) who studies the French long-term consumption and shows its cyclic character.

[1] In France, for instance, the saving ratio increased by 19% between 1970 and 1978; it decreased by 11% from 1979 to 1987 and jumped again between 1988 and 1992 [Dufrénot and Mignon (2004)].

Given the limits of linear and usual macroeconomic models of consumption, using nonlinear modeling should help to reproduce this asymmetric and cyclic behavior of householders. The main advantage of this modeling is to reveal the structural breaks, the asymmetry, the cyclic movements and the shifting regimes induced by the changes in consumption habits and consumer behavior. Among the nonlinear models, the Smooth Transition (Autoregressive) Models (ST(A)R) can provide a privileged setting for aggregate consumption. Indeed, these models permit to specify the consumption dynamics in different regimes, so that these dynamics can change according to the regime and the economic state (recession or expansion). Such models are also useful to reproduce the heterogeneity in householder's behaviors while allowing the adjustment and shifting regimes to be smooth and nonlinear. Furthermore, as suggested by Dufrénot and Mignon (2004), the shifting hypothesis can be justified through the fact that some consumption determinants, such as habit formation, income, Gross National Product and interest rate are characterized by regime shifting. They can achieve some critical point implying different regimes for consumption, persistent deviations and structural breaks in consumption [See also Benhabib and Day (1981), Dockner and Feichtinger (1993)]. Otherwise, the advantage of using STR models is to reproduce the heterogeneity in spending habits, in so far as this modeling can distinguish householders who highly spend their earnings from those who are less spend-thrift [Dufrénot and Mignon (2004)]. These models are also more appropriate and realistic than the two-regime switching mode of Hamilton (1989) and the threshold models of Tsay (1989) because they permit the economy to be in an intermediate state between the extreme regimes of expansion and recession [Öcal and Osborn (2000)].

In practice, the STAR models were used by Luukkonen and Teräsvirta (1991) to replicate the economic cyclical behavior in OECD countries and in the US. However, few articles studied the relationship between consumption habits and the hypothesis of switching regimes, or checked the consumption macroeconomic models of consumption using this nonlinear modeling [Öscar and Osborn (2000), Dufrénot and Mignon (2004)]. In such a context, we propose to econometrically check the contribution of Brown's model. Firstly, we shall estimate the model of Brown (1952). Secondly, we will test the hypothesis of nonlinear consumption adjustment. Finally, we will extend this model by introducing nonlinearity in order to examine whether this may help to reproduce the irregularity and asymmetry characterizing household consumption habits. Therefore, the originality of this paper is to make STR models economically significant, as we use them together with the economic theory of consumption to develop a nonlinear macroeconometric consumption model.

This paper is organized as follows. Section 2 briefly discusses the main teachings of Keynesian and post-Keynesian macroeconomic consumption models. It focuses more particularly on the model of Brown and analyses its limits. The extension of this model to the nonlinear framework and STR methodology is presented in section 3. The fourth section discusses the empirical results. Section 5 presents the principal conclusions.

II. Should We Still Trust Post-Keynesian Macroeconomic Models of Consumption?

According to economic theory, the modeling of household consumption took several shapes. This section does not aim at describing all the consumption theories exposed in macroeconomic books. Instead, we will briefly present some elements of post-Keynesian macroeconomic models, more particularly Brown consumption model, in order to discuss its current validity. We show that the heterogeneity of habits and consumption behaviors is a source of nonlinearity that can actually put this macroeconomic model into question.

To begin with, Keynes (1936) defined household consumption as an important affectation of the disposable income, and saving as a residual. According to the fundamental

psychological law, consumption is linearly bounded to the disposable income and each disposable income increase should generate a less proportional increase of the consumption. This yields:

$$C_t = a + b\,R_t \quad (1)$$

Where: C_t is the household consumption, R_t is the disposable income, *a* and *b* are respectively the autonomous consumption ($a > 0$) and the marginal propensity to consume ($0 < b < 1$).

The empirical verifications of this model confirm its validity only at short-term. The marginal propensity to consume is lower than the unit, but it varies according to the type of consumers. This implies a problem of heterogeneity due to the addition of the individual consumptions of heterogeneous households. Besides, the important autocorrelations suspects the omission of some important explanatory variables of consumption in this model. In such a context, while using American data over the period 1869-1938, Kuznets (1942) shows, the equality between the middle and the marginal propensity to consume defining the "Kuznets Puzzle" and rejecting the Keynesian theory. Then, several theories of consumption have been developed. For example, to take into account the adjustment delays between consumption and income, several post-Keynesian theories have been introduced [Theory of the relative income of Dusenbery (1949), Theory of Modigliani (1949), Theory of habit formation of Brown (1952), etc] and other theories of consumption [Theory of life cycle of Brumberg and Modigliani (1954), Theory of the permanent income of Friedman (1957), etc.]. We shall focus our discussion on the habit formation theory.

Brown (1952) allows the slow and smoothing character of consumer behavior to be reproduced, while introducing into his model a variable that reproduces the influence of previous consumption on its current level. His model can be seen as an autoregressive model of one order and is written as follows:

$$C_t = \alpha + \beta Y_t + \delta C_{t-1} \quad (2)$$

Where: $0 < \alpha < 1$, $0 \leq \beta \leq 1$ and α is the minimum autonomous consumption.

In this formulation, the persistence and consumption habits are captured by the effect of previous consumption. Thus, the more elevated β is, the more important the memory effect of previous consumption on the present consumption level is, which induces persistence and smoothness in the consumption adjustment dynamics. As a result of the simplicity in specifying these memory effect and consumption habit formation, several econometric applications adopted this formulation. However, most applications are limited to the linear setting, implying linear and symmetric adjustment for consumption. But, the introduction of delayed consumption in equation (2) might induce some inertia effects, persistence and slowness. Consequently, the consumption habit dynamics would be rather smooth, gradual and asymmetric and could escape linear modeling and Brown formulation. The latter limits consumption to be symmetric and defined it in only one regime. So, because of the asymmetry between the phases of the business cycle, the effect of habit consumption and the heterogeneity of consumer behavior, Brown model is rather inoperative and should *a priori* be rejected.

Besides, several tangible empirical proofs [Öcal and Osborn (2000) among others] showed that the adjustment dynamics of household consumption is rather smooth. Consumers do not necessarily have the same preferences or the same initial endowments. Also, they may not have the same wealth and as a result, they are not simultaneously and identically revising their consumption and formation habits. Therefore, this heterogeneity of consumers and

preferences can be transmitted to their habit consumption and induce discontinuity, asymmetry and persistence in consumption dynamics.

While introducing the nonlinearity and the switching regime hypothesis in the consumption adjustment dynamics, an extension of the model (2) would offer a more appropriate general specification to replicate the householders' behaviors. The advantage of this modeling is double. On the one hand, it could reproduce the irregular movements, the asymmetry and the persistence characterizing the consumption function. On the other hand, it would make it possible to assign different regimes for consumption, depending on whether the economy is in phase of growth or decrease.

III. A Nonlinear Macroeconometric Consumption Model

The idea of this nonlinear macroeconometric modeling is to extend Brown's model while introducing nonlinearity. In particular, we specify the household consumption dynamics while distinguishing two regimes that make it possible to describe the household consumption per regime depending on the business cycle phase. The first regime describes the consumer behavior in periods of recession, whereas the second one reproduces the household consumption dynamics in phases of expansion. Our model stipulates that consumption dynamics depends on the level reached by previous consumption. Indeed, the idea of this nonlinear specification is that when habit formation exceeds some threshold or critical level, it induces several consumption fluctuations and yields a shifting-regime in the consumption dynamics. Thus, the main advantage of this NMMC is to offer a specification that replicates the extreme states of consumption corresponding to a higher and a lower economic growth, as well as a continuum of intermediate states characterizing an economy with moderate growth rate and activity. Furthermore, the transition between these extreme regimes is assumed to be smooth and this smoothness is justified by the heterogeneity of consumer behavior and the persistence induced by habit formation [Benhabib and Day (1981), Dockner and Feichtinger (1993)].

Formally, a two-regime NMMC is then developed while incorporating Brown formulation into a Smooth Transition Regression (STR) model. STR models were developed by Teräsvirta and Anderson (1992), Granger and Teräsvirta (1993) and Teräsvirta (1994) and their complete methodology was recently discussed by Van Dijk *et al.* (2002). Thus, this NMMC defines two extreme regimes that are dependent on a transition function F(.) that is continuous and bounded between 0 and 1. Their main statistical property is that the transition between regimes is smooth, because of the presence of many consumers each of whom may switch sharply but at different times.

The NMMC is given by:

$$C_t = \alpha + \beta Y_t + \delta C_{t-1} + [\alpha' + \beta' Y_t + \delta' C_{t-1}] \times F\left(C_{t-1}, \gamma, c\right) + \varepsilon_t \qquad (3)$$

Where: γ is the transition speed ($\gamma > 0$), c is the threshold parameter, F (.) is the transition function and $\varepsilon_t \rightarrow N(0, \sigma^2)$.

The main idea of this model is to identify two consumption regimes. In the first regime corresponding to dull market, the consumers may be careful and reduce their consumption, whereas they increase it in the second one, in a context of economic growth. However, since consumers can be heterogeneous, this can imply several structural breaks and intermediate states and the transition speed between the extreme regimes will depend on the consumer group that dominates the market. This would be captured by the intermediate values of F(.).

According to Teräsvirta (1994), the transition function can be either logistic or exponential defining respectively the Logistic MMC model and the Exponential MMC. The

logistic function can be defined as: $F(c_{t-1}, \gamma, c) = (1+\exp\{-\gamma (c_{t-1}-c)\})^{-1}$ whereas the exponential one is defined by $F(c_{t-1}, \gamma, c) = 1-\exp\{-\gamma (c_{t-1}-c)^2\}$.

In practice, the logistic function has often been mobilized to study the asymmetry, persistence and nonlinearity characterizing the industrial production series and unemployment rate sets [Teräsvirta (1994)], whereas the exponential function has been used by several studies to reproduce the financial asset price dynamics [Manzan (2003), Boswik *et al.* (2006)]. Van Dijk *et al.* (2002) more explicitly presented the STR modeling. In the next section, we adopt this modeling to apprehend household consumption using the aforesaid NMMC.

IV. Empirical Results

The aim of this section is to study household consumption dynamics within a nonlinear framework and to test Brown's model against its NMMC alternative. Besides the comparison between Brown's model and NMMC, our empirical study concerns the American and French data that also implies a comparison between two different sets of consumer habits and behaviors. Our empirical study focuses on quarterly American and French data. For the USA, data are obtained from the WEFA Easy Data from IMF-IFS (International Financial Statistics), whereas French data are obtained from the National Institute for Statistics and Economic Studies (NISES). Data cover the period: January-1970 / January-2000 and are adjusted from seasonal variations. As far as consumption is concerned, data correspond to the personal consumption of non-durable goods for both countries, whereas the disposable income is retained as a measure for household income. All data are real and are deflated by the Consumer Price Index (CPI) in order to take the inflation effect into account. Besides, all series are transformed in logarithm in order to reduce their variations. The observation number is sufficient to apply the techniques of nonlinear modeling.

First, the household consumption graphics show that their dynamics are not *a priori* stationary. Consumption dynamics have notably increased in the recent years and many cyclical movements particularly characterize the American data. According respectively to Skewness and Kurtosis tests, we show that the dynamics of consumption studied are rather asymmetric and leptokurtic. This implies the rejection of the normality hypothesis when applying the Jarque-Bera test. We also apply the filter of Hodrick and Prescott (1980) that helps to specify the asymmetry type while extracting from the sets the trend or the cyclic component that is useful to study the asymmetry hypothesis and specify its type. The asymmetry hypothesis is then studied taking into account the level of the consumption series as well as the consumption growth rate. Our results show the presence of significant asymmetry effects, notably for the cyclical movement after 1973. For example, for the USA, the phases of expansion are gradual while recession phases are more abrupt[2].

Overall, all these empirical stylized facts can be seen as a sign of irregularity, nonlinearity, asymmetry and persistence that characterize the American and French consumer behaviors. Consequently, the linear modeling and Brown model cannot be appropriate to reproduce this persistence and cyclical behavior inherent to consumption dynamics. In order to reproduce these dynamics, nonlinearity is required. In particular, introducing the nonlinearity hypothesis can be helpful to capture the abnormal distribution, the asymmetry, the cyclical formation habits and the structural breaks inherent to the business cycles of the American and French consumption.

4-1 Preliminary Tests

The hypothesis of stationarity is required before checking the nonlinear adjustment hypothesis. Thus, we will first test this hypothesis for both consumption and income using the

[2] These results can be obtained from the author upon request.

ADF tests. Our results show that for both countries consumption and income are not stationary in level but stationary in the first difference, indicating that all series are I(1). Therefore, our estimations and modeling of NMMC concern the consumption growth rate for both countries. Secondly, we apply the test of "Runs" in order to apprehend the dependence structure characterizing the distribution of household consumption and the dynamics of their habit formation. This is a nonparametric test that tests the serial correlation hypothesis. According to our results, the number of runs is low for both countries, indicating the presence of strong positive dependence and rejecting the null hypothesis of independence and random walk for the American and French consumption growth rates[3]. This implies a change in signs which also suggests that consumption dynamics might be cyclical. We shall, finally, check these results while studying household consumption dynamics within a nonlinear framework.

4-2 Estimation Results

We estimate the NMMC through the Nonlinear Least Squares (NLS) Method according to Teräsvirta (1994) who suggests several modeling steps. Firstly, we estimate Brown's model through the Linear Ordinary Least Squares while supposing that consumption adjustment is rather symmetric and linear. Secondly, even though several economic justifications argue that consumption dynamics is rather nonlinear, we prefer to empirically test the null hypothesis of linearity against its alternative of nonlinearity using the Multiplier Lagrange test of Luukkonnen *et al.* (1988). Thirdly, we check whether the transition function is logistic or exponential. Finally, we estimate the NMMC through the NLS Method.

4-2-1 BROWN Model Estimation

We first estimate Brown's model for both countries through the OLS method and we present the results in the appendices (table 1). Our results indicate different implications infirming the hypotheses of Brown's model, notably for French data since the explanatory variables are not significant at 5%. The estimation results of the parameters of Brown's model are statistically significant only in the American case. Indeed, for France, the previous consumption has not a significant effect and the effect of the disposable income is statistically significant only at 10%. This can be due to a misspecification problem. Thus, we propose to check the nonlinear adjustment hypothesis and to extend this model to a nonlinear framework.

4-2-2 Linearity Tests

We apply the linearity tests of Luukkonen *et al.* (1988) and Teräsvirta (1994) that test the null hypothesis of linearity (H_0) against its alternative hypothesis of nonlinearity of STR type (H_1)[4]. Under the null hypothesis, the expenditure model is that of Brown whereas, the consumption model is given by the nonlinear macroeconometric representation (equation (3)) under H_1. The transition variable is assumed to be a delayed endogenous variable and according to Teräsvirta (1994), the linearity is tested for several values for d[5] : $1 \leq d \leq 4$ since data are quarterly. The optimal value ($\hat{d}$) is that for which the linearity hypothesis is strongly rejected. For both countries, the linearity hypothesis is strongly rejected for $\hat{d} = 1$ indicating that the American and French household consumption dynamics are rather nonlinear. The next step of NMMC specification regards the choice of the transition function.

4-2-3 Transition Function: Exponential or Logistic?

In order to answer this question and specify the transition function allowing the transition between the business cycle phases of American and French consumption (expansion

[3] The results of the Run and ADF tests can also be obtained upon request to the author.
[4] For more details on these tests, see Van Dijk *et al.* (2002).
[5] d is the delay parameter.

and recession), we use two kinds of choice tests: the tests of Teräsvirta (1994) and the tests of Escribano and Jorda (1999). Both sets of tests conclude in favor of the exponential for both countries. The central regime of the exponential function can be associated with the recession regime whereas the outer regimes can reproduce the expansion regime. This result is in keeping with that of Öcal and Osborn (2000) who also preferred the exponential function to the logistic one to capture the business cycle characteristics of the UK consumption and reproduce the dynamics of the quarterly seasonally adjusted real consumers' expenditure over the period 1955:1-1994:1. The authors also showed that the UK consumption has two business cycle regimes: expansion and recession and found support for the proposition which stipulates that the dynamic properties of UK consumption can change over the business cycle. In order to check this assumption on American and French data, a NMMC for which the transition function is exponential is estimated for both countries.

4-2-4 NMMC Estimation

We apply the nonlinear modeling of STR models to estimate the NMMC-ESTR(1,1) on the growth rate of American and French household consumption in order to reproduce the asymmetry characterizing their dynamics[6]. The estimation is done through the NLS method, which is equivalent to the "quasi-maximum" likelihood method. However, the nonlinear procedure requires the initialization of the NMMC-ESTR parameters. To do this, we first estimate the model through the OLS method. We define, secondly, the initial values for the NMMC parameters from the estimates of linear parameters. However, in reason of the transition parameter (γ), the NMMC is sometimes difficult to estimate. To solve this problem, we standardize γ, according to Teräsvirta (1994), while dividing it by the variance of the transition variable; we then define a grid search to find an appropriate initial value for γ. The estimation procedure is done for several initial values to check whether the maximum is absolute and not local. The obtained results are reported in table 2 in the appendices.

Our results suggest that American and French household consumption can be characterized using a two-regime-NMM. The presence of two regimes in the consumption indicates that the dynamic properties of consumption change over the economic business cycle and confirms the existence of heterogeneity in the consumption decision and the coexistence of heterogeneous behaviors among householders. Firstly, according to these results and, notably, to the residual variance ratio of NMMC and Brown's model (BM) given by $\frac{\sigma_{NMMC}}{\sigma_{BM}}$, the NMMC seems to be more appropriate than Brow's model to reproduce the adjustment dynamics and the business cycle in the American and French consumption. Secondly, the intercept is often not significant. Most AR parameters of NMMC are statistically significant but per regime. More particularly, our results imply an important feature. Indeed, in the first regime, previous consumption has a significant impact indicating that in the short term, the householders revise their behaviors depending on what they had consumed in the last period; the income is not significant for both countries. This implies that in this regime, the formation habits are more important than financial and economic variables (income) in explaining consumer behavior. The formation habit effect is negative for French consumers and positive for the USA. But, in the second regime, particularly, when the formation habits exceed some level, the disposable income becomes significant for both householders to maintain the consumer equilibrium, confirming the Keynesian hypothesis.

Thirdly, the estimators of the exponential function are also statistically significant for both countries, thus highlighting the choice of the exponential representation to describe the transition between the business cycle in household consumption. The estimation of the

[6] For both series, the NMMC incorporates only one delay in each regime and the transition variable is ΔlC_{t-1}.

transition parameter is more elevated for the American case, indicating that the transition between regimes is rather abrupt. This implies that, notably for the USA, the estimated transition function is effectively different from unity for only very small values around the threshold. This can be supported and justified by the American economic situation and growth during the last decade of the period of our study. Otherwise, this result is in line with that of Öcal and Osborn (2000) for whom the estimation of γ for the UK consumption is around 197. This implies that the expansion regime is more significant in the USA than in France and that the changes in consumption are also more important in the American case, which can be associated with the differential between these countries in the inflation variation, the tax change and the degree of currency appreciation over the period 1970-2000.

Finally, the application of misspecification tests shows that the residuals of NMMC are symmetrical and normal, indicating that the introduction of nonlinearity has absorbed the asymmetry characterizing the data. For both countries, there is neither any substantial residual ARCH effect nor any one-order autocorrelation. But, some significant nonlinearity remains according to the additional nonlinearity test.

V. Conclusion

In this paper, we studied the validity of the post-Keynesian macroeconomic model of consumption to reproduce the dynamic properties of American and French consumption and their evolution over the business cycle. In particular, we estimated the model of Brown (1952) using quarterly growth rates for seasonally adjusted real American and French consumers' expenditure. Our results suggested that this modeling failed to reproduce the business cycle regimes of consumption. While introducing nonlinearity and incorporating Brown's model into a Smooth Transition Regression, we proposed an extension of Brown's model and developed a NMMC. This new modeling seems to be more adequate to specify the household behavior per regime depending on the economic business cycle: recession or expansion. More precisely, it allows nonlinearity, asymmetry and structural breaks characterizing the consumption dynamics to be reproduced. It also defines two regimes: A regime of habits formation corresponding to recession and a regime of consumption that can be assimilated to the Keynesian approach. A further extension would be to check the contribution of non-linearity while studying consumption habits and the relationship between consumption and income in the long-run.

References

Allard, P., 1992, « La modélisation de la consommation des ménages en France », *Revue d'économie Politique*, 102, pp.727-765.

Benhabib, J. and R.H. Day, 1981, "Rational Choice and Erratic Behavior", Review of Economic Studies, 48, pp.459-471.

Boswijk, H. P., C. H. Hommes and S. Manzan, 2006, "Behavioral Heterogeneity in Stock Prices", *Journal of Economic Dynamics and Control*, Forthcoming.

Brown T.M., 1952, "Habit Persistence and Lags in Consumer Behavior", *Econometrica*, Vol.20, n°3, 355-371.

Brumberg R., and F. Modigliani, 1954, "Utility Analysis and The Consumption Function: An Interpretation of Cross-Section Data", in Kurihora, *Postkeynesian Economics*, Rutgers University Press.

Dockner, E.J. and G. Feichtinger, 1993, "Cyclical Consumption Patterns and Rational Addiction", American Economic Review, 83, 256-263.

Dufrenot, G., and V. Mignon, 2004, "Modeling the French Consumption Function Using SETAR Models", *Economics Bulletin,* Vol. 3, No. 20 pp. 1−16.

Dusenbery, J.S., 1949, *Income, Saving and the Theory of Consumer behavior*, Harvard University Press, Cambridge, Mass.
Escribano, A., and Jordã, 1999, " Improving Testing and Specification of Smooth Transition Regression Models", In Rothman P. (ed), *Nonlinear Times Series Analysis of Economic and Financial Data,Boston: kluwer*, pp. 298-319.
Flavin, M. A., *1981*," The Adjustment of Consumption to Changing Expectations About Future Income", *Journal of Political Economy.89, 974-1009.*
Friedman, M., 1957, *A Theory of the Consumption Function*, Princeton, NJ: Princeton University Press.
Granger, C.W.J., and T. Teräsvirta, 1993, *Modelling Nonlinear Economic RelationShips*, Oxford University Press.
Hamilton, J. D., 1989, "A new approach to the economic analysis of nonstationary time series and the business cycle", *Econometrica*, *57*, 357–384.
Hodrick R. and E. Prescott, 1980, "Post-war U.S. Business Cycle: An empirical Investigation, *Mimeo*, Carnegie-Mellon University.
Houttaker, H. S., and L. D. Taylor, 1970, *Consumer Demand in the United States: Analysis and projections*, Harvard University Press, Cambridge.
Keynes J.M., 1936, *The General Theory of Employment, Interest and Money*, Macmillan Cambridge University Press, London.
Kuznets, S., 1942, Use of National Income in Peace and War, *National Bureau of Economic Research (NBER)*. New York.
Luukkonen, R., and T. Teräsvirta, 1991, ''Testing Linearity of Economic Time Series against Cyclical Asymmetry'', *Annales d'économie et de statistique*, No. 20/21, 125-142.
Luukkonen, R., P. Saikkonen, and T. Teräsvirta, 1988, "Testing Linearity against Smooth Transition Autoregressive Models'', *Biometrika*, 75, 491-499.
Manzan, S. (2003), *Essays on Nonlinear Economic Dynamics*, PhD, University of Amsterdam.
Modigliani, F., "Fluctuations in the Saving-Income Ratio: A Problem in Economic Forecasting," *Studies in Income and Wealth*, 11, National Bureau of Economic Research, New York, 1949.
Öscar, N., and Osborn D.R., 2000, "Business Cycle Non-Linearities in UK Consumption and Production", *Journal of Applied Econometrics*, 15, pp.27-43.
Teräsvirta, T. (1994), "Specification, Estimation and Evaluation of STAR Models", *Journal of the American Statistical Association*, 89, 208-218.
Teräsvirta, T., and H.M. Anderson, 1992, "Characterizing Nonlinearities in Business Cycles using Smooth Transition Autoregressive Models", in *Nonlinear Dynamics, Chaos and Econometrics*, Edited by Pesaran M.H. and Potter S.M., pp.111-128.
Tsay, R., 1989, "Testing and Modelling Threshold Autoregressive Processes", *Journal of the American Statistical Association, 84*, 231–240.
Van Dijk, D., T. Teräsvirta and P.H. Franses, 2002, "Smooth Transition Autoregressive Models- A Survey of Recent Developments", *Econometric Reviews*, 21, pp.1-47.
Villa P., 1994, « La fonction de consommation sur longue période en France », *Working paper*, CEPPI, n°94-07.

Appendices

Table 1: Brown's Estimation Model

Model	USA	France
α	0.004 (1.08)	0.006 (1.74)**
β	0.273 (2.15)*	0.227 (1.64)**
δ	0.245 (1.98)*	0.002 (0.56)
$\overline{R}^2$	0.60	0.10

This table shows the estimation of Brown's model. Values in bracket are the t-ratios.
(*) and (**) designate respectively the significativity at 5% and 10%.

Table 2: NMMC Estimation Results

Model	USA	France
α	0.0005 (0.01)	0.011 (1.78)**
δ	0.339 (2.46)*	-0.728 (-1.89)**
β	0.249 (1.42)	0.001 (0.17)
α '	-0.016 (-1.38)	-0.005 (-0.80)
δ '	-0.24 (-1.09)	0.668 (1.59)
β '	0.805 (2.61)*	0.006 (1.99)*
γ	264.42 (2.83)*	7.44 (1.94)**
c	0.009 (2.01)*	0.001 (2.06)*
JB	0.51	0.65
$\frac{\sigma_{NMMC}}{\sigma_{BM}}$	0.82	0.90
DW	1.89	2.01
ARCH	0.91	0.56

Note: This table shows the estimation of NMMC. Values in bracket are the t-ratios.
ARCH, JB and DW are respectively the statistics of DW, Jarque-Bera and ARCH tests.
(*) and (**) designate respectively the significativity at 5% and 10%.