# LEARNING ABOUT CONSUMER BEHAVIOUR IN FACE OF A STRUCTURAL BREAK: ARGENTINA AFTER 2002

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***Abstract***

*This paper investigates how consumer behaviour is modified after a major structural break, taking into account two different kinds of models: one of them, an Equilibrium-Correction Model which includes the effects of "wealth perception" and the other one, focussed on deep parameters estimates following the Euler Equation-GMM approach. Liquidity constraints and hyperbolic discount functions are the main features that characterize Argentine consumption patterns after default and devaluation took place. Liquidity constraints are tested by an expectational form of the Equilibrium-Correction model and by asymmetric effects of income changes. A hyperbolic discount factor that allow for distinguishing short run from long run impatience are found to describe consumers' decisions.*

*Key words: Consumer Behaviour – Structural Break – Equilibrium-Correction Model – Wealth Effects – Liquidity Constraints – Euler-Equation – Generalised Method of Moments – Hyperbolic Discount Functions*

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## I. Introduction

Private consumption abruptly fell after Argentine government defaulted and devalued in early 2002 exacerbating the declining trend shown in previous quarters. Although recovery started soon, by the end of 2004 this series were close to the levels of the late nineties following a similar path that the one observed for output. New monetary, exchange rate and financial regimes dramatically change the institutional background that had prevailed for more than ten years. After the devaluation which followed the abandonment of Convertibility regime, real wages decreased and unemployment rose to unprecedented levels. Besides, an asymmetric pesification for deposits and loans left banks insolvent and the economy without financing. Financial constraints were also originated in the lack of external financing, especially after sovereign debt default. Moreover, devaluation, and maybe default, could have altered income expectations and more precisely the "wealth perception" of consumers. In this new environment, consumption patterns derived from econometric models, estimated for samples ending during Convertibility, are difficult to be maintained. Structural breaks are expected to be found. In particular wealth effects vs. liquidity constraints and rationality in consumer decisions under the new regime should be addressed since they are suspected to be altered after a major shift like this took place.

This paper investigates how consumer behaviour is modified after 2002 based on two different kinds of models. One of them follows the "consumption function approach" to obtain an Equilibrium-Correction Model (as started by Davidson et. al., 1978), which includes the effects of "wealth perception" on consumers' expenditure (as suggested by Heymann and Sanguinetti,1998). This is analysed vis a vis "liquidity constraints" (as discussed by Muellbauer and Bover, 1986, Altonji and Siow, 1987 and DeJuan and Seater,1999). The other one is focussed on deep parameters estimates following the Euler Equation-GMM approach (started by Hall, 1978 and Hansen and Singleton, 1982).

On the one hand, the results of Ahumada and Garegnani (2003) are revised for an extended sample. Following the first methodology, which takes into account time series properties, they looked for the determinants of "wealth perception" in the Argentine case. For the sample 1980:1-2000:4 a stable parameter model was obtained, whose main properties are: (i) national disposable income is the only long-run determinant of private consumption, (ii) two proxies for adjusting wealth are adopted by the consumers in the short-run: a measure of real exchange rate and an effect from last peak income (whereas no effect can be detected from real broad money, inflation and sovereign risk ) (iii) consumers' behaviour of Argentina cannot be described by models with liquidity constraints.

On the other hand, Ahumada and Garegnani (2004) estimated structural parameters for 1980:1-2001:3, assuming rationality for consumer decisions in Argentina and approximating the rates of return on assets by real interest rates and the growth rate of real exchange rate. Their results show that parameter estimates have the expected values and signs and are robust to different specifications of the weighting matrix. Although, parameter constancy is jointly rejected, recursive estimates show that the risk aversion and the impatience parameter change as expected for the aggregate behaviour if they respond to different macroeconomic frameworks. In the early nineties, when the new rules under the Convertibility regime were perceived, the representative consumer turned less impatient and less risk averse but, when the Mexican crisis cast doubt on the permanence of this monetary arrangement and the solvency of the financial system, this representative consumer of Argentina became, again, more risk averse. Overall "rational" consumers are found according to the parameter estimates from a standard Euler Equation.

The next section discusses the sample extension for the consumption function model. In particular, the data after the collapse of 2002 provides new results about the permanence of wealth effects and the existence of liquidity constraints on the aggregate consumers' expenditure. Section III presents, for the extended sample, estimates of deep parameters describing consumers´ decisions, using hyperbolic instead of exponential discount functions to obtain estimates of such structural parameters (as in Laibson (1998) and Frederick et. al. (2002), among others). Section IV summarises the main results and concludes.

## II. Wealth Effects vs. Liquidity Constraints in the Consumption Function

*II.1Results before the 2002 break*

After the path-breaking work of Davidson, Hendry, Srba and Yeo (DHSY, 1978), the solved out consumption function has evolved concentrating on time-series properties of the data and became one of the most used empirical approaches to model aggregate consumption decisions (see Muellbauer and Lattimore, 1995). Starting from a general autoregressive-distributed lag model, the relationship between consumption and income could be represented by an Equilibrium-Correction (EC) model which in its simplest version is:

$$\Delta lconspriv_t = \delta_0 + \delta_1 \Delta\, lincdisp_t - \delta_2(\, lconspriv_{t-1} - lincdisp_{t-1}) + \varepsilon_t \qquad (1)$$

where conspriv denotes private consumption, incdisp, disposable income and $\varepsilon_t$, a white noise process; l indicates the logs of the variable and $\Delta$, its first difference.

Hendry and Ungern-Sternberg (1981) continued the DHSY formulation of an ECM including real personal liquid assets as an "integral correction". Liquid assets could be seen as an integral control mechanism over past discrepancies between income and expenditure.

In the case of emerging economies, several studies have analysed the effect of liquid assets, particularly focussing on interest rates and liquidity constraints (see Giovaninni, 1985, Rossi, 1988, Campos and Ericsson, 2000). For unstable economies, Heymann and Sanguinetti (1998) suggested that consumers´ behaviour responds to "wealth perception" but left as an open question how it should be empirically defined. They considered that individuals base their consumption decisions on their beliefs about the economy as a whole and assumed a dynamic learning when the economy experienced important (political and economic) changes. A remarkable issue from their model is the role of the relative price of nontradables to tradables to understand perceived wealth, as often its cycles correspond to fluctuations in the exchange rate.

Therefore, for the Argentine case, this literature suggested different measures to adjust "wealth": the real exchange rate as well as real broad money, inflation and the debt default risk premium[i].

Focussing on the effects of "wealth perception" and following "a general -to-specific" econometric approach[ii], Ahumada and Garegnani (2003) modelled an aggregate consumption function for Argentina on quarterly basis during the 1980-2000 period, itself a time of large macroeconomic variability. Briefly, the 1980s were characterised by low and variable levels of activity and consumption along with high inflation and even hyperinflation outbreaks. The 1990s instead showed a period on income and consumption expansion after price stability was obtained under a Convertibility regime, although unemployment and indebteness also significantly increased.

The estimation began with an unrestricted system where consumption, national disposable income and the above-mentioned measures of "wealth" were included[iii]. The

Johansen´s approach indicated that there is only one cointegration relationship, income is the only long run determinant of private consumption and the hypotheses of homogeneity and a valid conditional model of consumption on income are not rejected. Given these findings an autoregressive-distributed lag model (with four lags to each variable and quarterly dummies that allow for homocedastic white-noise and normal residuals) was estimated to model consumption on income. All other variables, although they did not enter the long run relationship, were also included in order to re-evaluate their effects, in this case for the short run. This information set included growth rates of inflation, real broad money, debt default risk and real exchange rate as well as the deviations of current income from its past peak (efpastpeak), which could capture a "Duesenberry effect" [iv]. After simplification, the following model that can be considered as an appropriate representation of Argentine consumption function for 1980-2000 , was obtained[v],

Equation 1

| | | | |
|---|---|---|---|
| Dpondcpriv= | +0.01778 | +0.9366 DLincdisp | +0.2647 efpastpeak |
| (SE) | (0.003988) | (0.08025) | (0.0534) |
| | -0.537 Eqconsprivincdisp_1 | -0.1105 drealexchrate34 | -0.06074 d871 |
| | (0.08814) | (0.03731) | (0.02099) |
| | -0.1137 d881 | -0.04544 d931 | |
| | (0.02082) | (0.02103) | |

$R^2$=0.825275 F(7,71)=47.907 [0.0000] σ=0.0205491 DW=1.99
RSS = 0.02998075994 for 8 variables and 79 observations

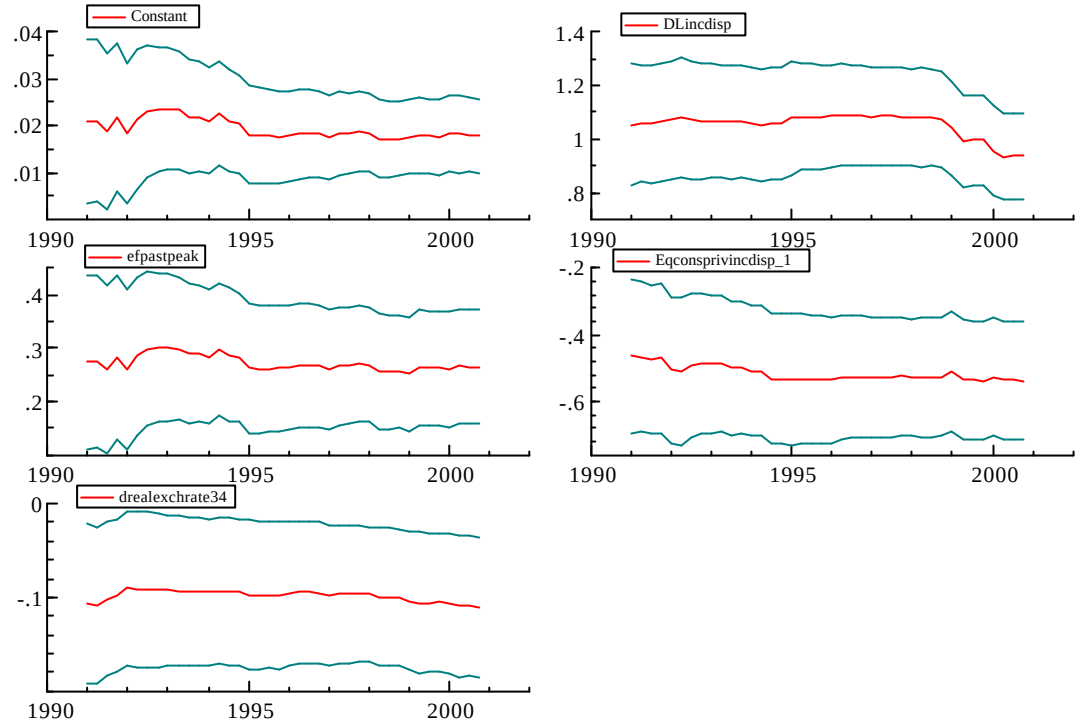
The dependent variable (Dpondcpriv) in Equation 1 is defined as Lconspriv-0.80*$Lconspriv_{-1}$-0.20*$Lconspriv_{-4}$. It is a weighted average of the first and four lags, reflecting a kind of seasonal behaviour.

In Equation 1, the EC term (Eqconsprivincdisp_1) is significant; about half of the disequilibria is corrected in the first quarter in order to adjust the long run homogeneity relationship between consumption and income. There is also a short run effect of national disposable income (DLincdisp) on private consumption: an increase of 1% in the growth rate of income increases the growth rate of private consumption in 0.94%. However, this variation should be corrected with the effect of the last peak income, when current income is lower than its last peak. If disposable income is growing over the last peak, the variable efpastpeak takes the value of zero (current income equals new peak income). If, instead, current income is increasing 1% but its level is lower than the previous peak, the impact effect is lower than 0.94% ( 0.94 minus 0.26 times the difference).

In addition, when the real exchange rate is measured by the ratio of wholesale to consumer prices as a proxy for the relative price of tradables over non-tradables[vi], the change in the real rate of exchange between the third and fourth lag (drealexchrate34) has a significant and negative effect on the private consumption of approximately 0.11. The delay in this effect could be due to the period of time the consumers need to adapt their decisions to variables that affect their perception of wealth[vii,viii].

Although the sample includes the eighties and nineties together, parameters constancy of the model of Equation 1 was not rejected by their recursive estimation, as can be observed in the next graphics (the recursive estimates of the main coefficients are within the previous 2 times standard errors intervals).

Recursive Graphics




*II.2. Testing liquidity constraints*

As de Brouwer (1996) suggested, a long run (cointegration) relationship between consumption and income and the inclusion of an EC term in Equation 1 could respond to the existence of liquidity constraints. With liquidity constraints, the consumption is forced to follow the path of income and, if income is non-stationary, consumption would also be non-stationary and cointegrated with income. However, EC models are also "isomorphic" to autoregressive-distributed lag models of consumption and income. Hence the existence of liquidity constraints should be more carefully evaluated since models of Life Cycle-Permanent Income Hypothesis LC-PIH are also encompassed by autoregressive-distributed lag models. For example, Friedman´s PIH (Friedman, 1957) implies a distributed lag income model and Ando and Modigliani´s LCH (Ando and Modigliani, 1963), a consumption-income autoregressive-distributed lag model (consumption depends on assets and therefore, on past savings, which are the differences between lagged income and lagged consumption).

Muellbauer and Bover (1986) offered an alternative way to link DHSY model with liquidity constraints by solving an intertemporal optimisation problem subject to the credit constraints in a Lagrangian form. In their model the growth rate of consumption depends on the effect of credit rationing through its shadow price. Given that it is not directly observable, it can be derived by solving the whole intertemporal programming problem. In this way, the shadow price of the credit constraints at time ŧ1 resulted to be dependent on the gap between the consumption of credit-constrained agents and future income, that is

$$E_{t-1}\, y_t - c_{t-1} = E_{t-1}\, \Delta y_t + y_{t-1} - c_{t-1} \qquad (2)$$

This expression contains similar terms to those included in the right-hand-side of an ECM (like in DHYS). Therefore an ECM can be viewed as having an expectational interpretation under liquidity constraints.

However, it should be noticed that, in this expectational form of the EC, the estimated coefficient of $\Delta y_t$ and $y_{t-1}$ should be equal ( $\delta_1 = \delta_2$ in (1)).

In the case of Equation 1, which includes an EC term, such interpretation cannot be allowed since the hypothesis of equal response of consumption to Dlincdisp and to the EC term is strongly rejected by the next linear restrictions statistic.(estimates are 0.94 and 0.54 respectively)

Wald test for linear restrictions: $\beta_{Dincdisp}=-\beta_{Eqconsprivincdisp\_1}$
LinRes F( 1, 70) = 168.73 [0.0000] **

Furthermore, another way to evaluate the effect of credit restrictions on consumption consists in verifying an asymmetric response of consumption to rising or falling income as Altonji and Siow (1987) and DeJuan and Seater (1999) proposed. Altonji and Siow (1987) analyzed the rational expectations lifecycle model with capital imperfection markets and found an asymmetric response of consumption to income increases and decreases. Since the rate of returns on assets is higher (lower) when expected income increases (decreases), the growth rate of consumption will be larger (smaller). De Juan and Seater (1999) consider that symmetric effects of income are associated with "rule of thumb" behaviour ($\hat{a}_{Dposincdisp}=\hat{a}_{Dnegincdisp}$). Instead, under liquidity constraints, the consumers' response to positive changes in income should be greater than the response to negative changes ($\hat{a}_{Dposincdisp}>\hat{a}_{Dnegincdisp}$). Given that household panel data are employed in both papers, in order to test this hypothesis for aggregate consumption it is assumed that there are fewer constrained consumers than unconstrained ones when income is increasing and vice versa. Besides, the actual income growth (DLincdisp) is used to proxy the expected income growth.

The next equation shows the results allowing for different coefficient for positive (Dposincdisp) and negative (Dnegincdisp) income growth. Equation 2 also shows the statistic for testing an equal response.

Equation 2

| | | | |
|---|---|---|---|
| Dpondcpriv=+0.02043 | | +0.2685 efpastpeak | -0.5387 Eqconsprivincdisp_1 |
| (SE) | (0.00459) | (0.05597) | (0.08697) |
| | -0.1113drealexchrate34 | -0.06251 d871 | -0.1136 d881 |
| | (0.03714) | (0.02083) | (0.02057) |
| | -0.0471 d931 | **+0.8515 Dposincdisp** | **+0.9968 Dnegincdisp** |
| | (0.02078) | **(0.1478)** | **(0.1515)** |

$R^2$=0.834718 F(9,69)=38.719 [0.0000] $\sigma$=0.0202736 DW=2.05
RSS = 0.0283603686 for 9 variables and 79 observations

Wald test for linear restrictions: $\beta_{Dposincdisp}=\beta_{Dnegincdisp}$
LinRes F( 1, 69) = 0.32877 [0.5682]

From these results the asymmetric effects would not be present since the hypothesis of equal response of consumption to short run increases and decreases of income is not rejected according to the previous linear restrictions tests. It is worthwhile noting that, although the presence of the "efpastpeak" also represents an asymmetric effect of rising and decreasing income, it cannot be understood as derived from liquidity constraints since income deviations are from last peak income and not from its one lagged value.

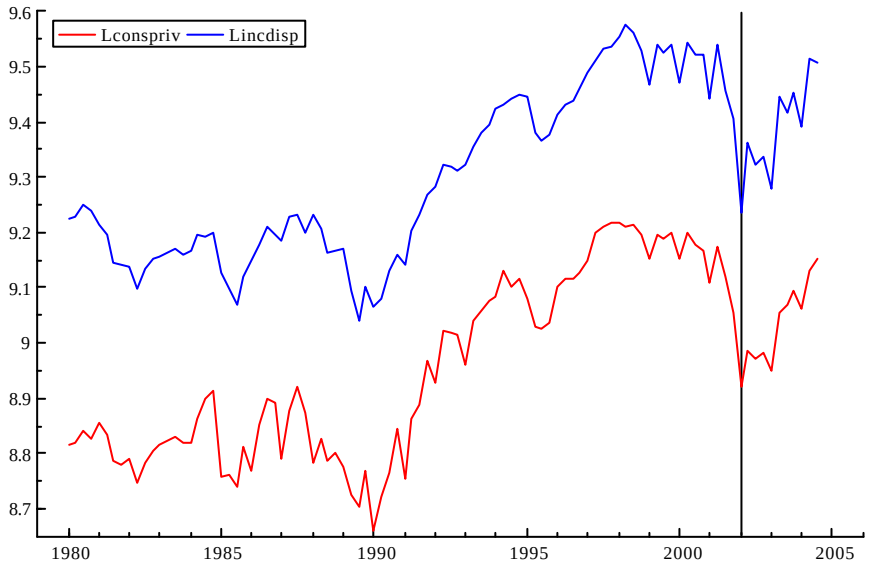
Given these findings, the consumers' behaviour in Argentina cannot be interpreted neither in terms of models of liquidity constraints which imply asymmetric effects nor as from the expectational form of ECM but a sort of "rule of thumb" behaviour could still be assumed following DeJuan and Seater's view on the symmetric effect of current income changes.

However, the relationship between consumption and income derived from the estimate of the econometric model admits another interpretation. The LC-PIH could be assumed from the proportionality between consumers' expenditure and income derived as a long run solution. And as Carroll (2001) said, "neither liquidity constraints nor myopia is necessary to generate the high average marginal propensity to consume that Friedman (1957) deemed consistent with his conception of the permanent income hypothesis". In the short run, not only the EC term affects the consumers' expenditure. The presence of the "efpastpeak" can also be part of the adjustment to "wealth" as Ando and Modigliani (1963, p.80) express, "… if we interpret the role of highest previous income as that of a proxy for net worth, then Duesenberry-Modigliani consumption function can be considered as providing a good empirical approximation to the consumption function…". For the eighties and nineties, the Argentine "wealth perception" was based in the maximum value experienced by income but needed to be further adjusted by the behaviour of the real exchange rate as suggested by Heymann and Sanguinetti (1998).

II.*3. Results after the structural break*

Figure 1 shows the behaviour of the (logs of) consumers' private expenditure and national disposable income for the extended sample (1980:1-2004:3). After default and the abandonment of Convertibility, Argentine economy deteriorated. As can be observed, consumption and income fell, showing similar levels of the end of 1991 and the beginning of 1992. However, the effect was soon reverted and the variables recovered the values observed before the break took place.

Figure 1




For the extended sample (1980:1 to 2004:3) and by the same approach followed for Equation 1, the model obtained after simplification was,

Equation 3

| | | | |
|---|---|---|---|
| Dpondcpriv= | -0.1048 | +0.8834 DLincdisp | -0.3489 DLincdisp0204 |
| (SE) | (0.01993) | (0.08152) | (0.1077) |
| | +0.2182efpastpeak80022 | -0.5607 Eqconsprivincdisp_1 | -0.128 drealexchrate34 |

```
          (0.04248)             (0.09002)                (0.03963)
          -0.06227 dIQ889193    -0.02877 d992            -0.03816 d0223
          (0.01406)             (0.02417)                (0.01717)

R^2=0.7998  F(8,83)=41.468 [0.0000]  σ=0.0232  DW=1.95
RSS=0.0450007349 for 9 variables and 92 observations
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*Residual and Specification Tests*

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AR 1- 1 F( 1, 82) =   0.061121 [0.8054]
AR 1- 5 F( 5, 78) =     0.9155 [0.4755]
ARCH 1  F( 1, 81) =     0.5142 [0.4754]
ARCH 4  F( 4, 75) =    0.82941 [0.5106]
Normality Chi^2(2)=     0.2457 [0.8844]
Xi^2    F(13, 69) =    0.88043 [0.5766]
Xi*Xj   F(25, 57) =     1.1299 [0.3428]
RESET   F( 1, 82) =   0.012672 [0.9106]
```

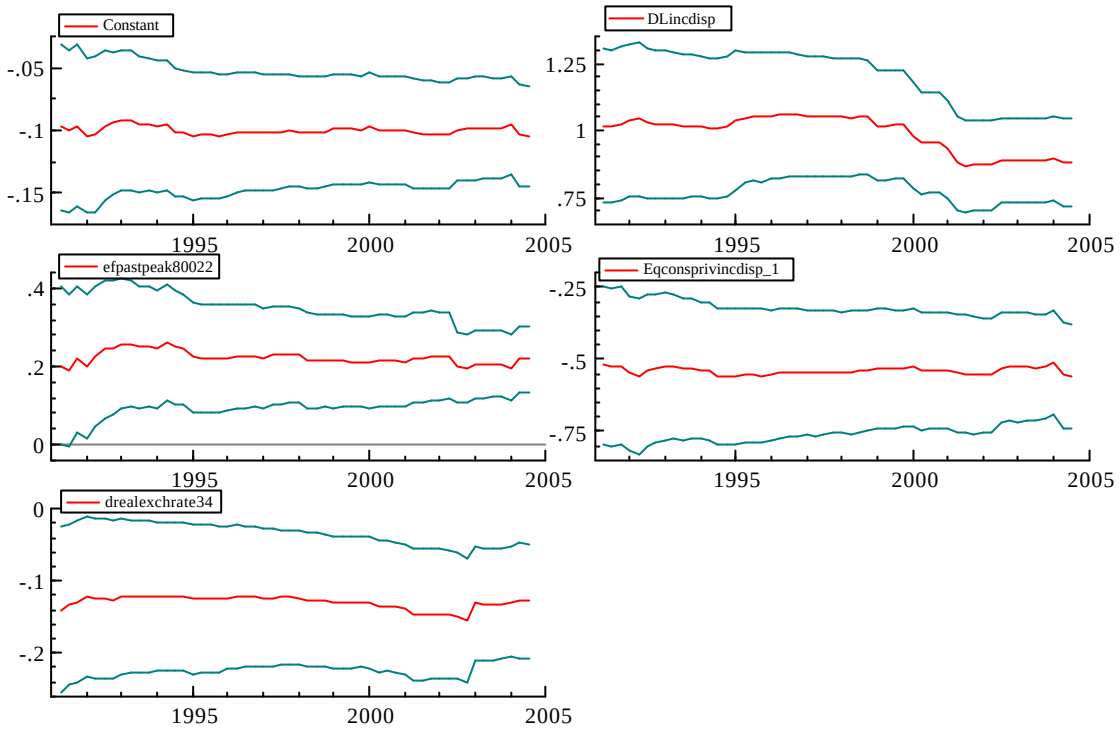
Similarly to previous results, the model presented in Equation 3 indicates that private consumption adjusts to reach the long run proportionality[ix] with national disposable income (about a half of the deviations is corrected in the first quarter). However, the results show a different short run effect of national disposable income on private consumption when the sample is cut by the Convertibility end. For the first period, an increase of 1% in the growth rate of income increases the growth rate of private consumption in 0.88%. During the second period, this coefficient should be corrected with the coefficient of the variable Dlincdisp0204, a multiplicative dummy that takes the value 0 before 2001:4 and the Dlincdisp value after this period. The correction indicates that during the period 2002:1 to 2004:3 the impact effect of national disposable income is lower than before. An increase of 1% in the growth rate of income increases the growth rate of private consumption in 0.53%.

In the case of the past peak income, the estimation shows that this asymmetric effect is only significant for the period 1980:1 to 2002:2 (efpastpeak80022). The consumers have memory of the last peak income (second quarter of 1998) until the second quarter of 2002. The abrupt devaluation of the beginning of 2002, the new monetary regime and the financial restrictions, would alter previous wealth perceptions and make consumers forget the highest previous income as a proxy for net worth.

The only measure of "wealth perception" that again resulted significant (and for the whole sample) is the real exchange rate measured by the ratio of wholesale to consumer prices. The change in the real rate of exchange between the third and fourth lag has a significant and negative effect on private consumption of approximately 0.13%, close to the estimate obtained before extending the sample[x].

For this reformulated model, parameters constancy was evaluated and not rejected by their recursive estimation, as observed in the next graphics.

Recursive Graphics




*II.4 Liquidity constraints reconsidered*

Although the results obtained with the extended sample would appear to be similar to those obtained in the previous sections (once income effects were dummy corrected), they can be shown differently when liquidity constraints are re-evaluated. One could suspect that liquidity constraints are binding after the 2002 break because the Argentine access to capital markets was severely restricted, reverting the effect of the financial liberalization experienced during the 90's. Although financial flows to emerging countries had been decreasing since the Russian crisis (the "sudden stop" of Calvo, Izquierdo and Talvi, 2002), after the sovereign debt default, the Argentine economy has faced further credit restrictions arising from both external and domestic sources. Not only capital outflows accelerated but also, at the same time, there was a domestic credit disruption because of financial restrictions and the asymmetric pesification of bank deposits and loans which took place after devaluation (Miller, et.al., 2004). Although the Argentine financial system tended to recover in the following months, credit to the private sector has remained below the previous levels.

It is worthwhile reminding that before the extension of the sample, the behaviour of Argentine consumers cannot be described by models with liquidity constraints during neither the 90´s nor the 80´s, tested following Muellbauer and Bover (1986) and Altonji and Siow (1987) and DeJuan and Seater (1999).

As previously explained, in the expectational form of the EC of Muellbauer and Bover (1986) the estimated coefficient of $\Delta y_t$ and $y_{t-1}$ should be equal. Based on Equation 3, such restriction is re-evaluated. The multiplicative dummy indicates different behaviour before and after 2002. Before 2002 liquidity constraints are not found as binding. In this period, the hypothesis of equal response of consumption to Dlincdisp and to the EC term is strongly rejected as could be seen in the next test.

Wald test for linear restrictions: $\beta_{Dincdisp} = -\beta_{Eqconsprivincdisp-1}$
LinRes F( 1, 83) = 7.2202 [0.0087] **

However, when this restriction is evaluated for the ex-post Convertibility period, the corrected short run effect of Dlincdisp (because of the multiplicative dummy) equals the adjustment coefficient of the EC term.

Wald test for linear restrictions: $\beta_{Dincdisp}+\beta_{Dincdisp0204} = -\beta_{Eqconsprivincdisp-1}$
LinRes F( 1, 83) = 0.066297 [0.7974]

These findings suggest that Argentine consumers suffer liquidity constraints since the first quarter of 2002, according to the expectational form of the EC of Muellbauer and Bover (1986).

As discussed before, the other way to interpret liquidity constraints restrictions consists in verifying an asymmetric response of consumption to rising or falling income as Altonji and Siow (1987) and DeJuan and Seater (1999) tested. The next equation shows the results for different coefficient of income increases (Dposincdisp and Dposincdisp0204) and decreases (Dnegincdisp and Dnegincdisp0204) distinguishing the effect for 2002-2004 period.

Equation 4

| | | | |
|---|---|---|---|
| Dpondcpriv = | -0.1063 | +0.8372 Dposincdisp | -0.2501 Dposincdisp0204 |
| (SE) | (0.02026) | (0.1545) | (0.1738) |
| | +0.9155 Dnegincdisp | -0.4532 Dnegincdisp0204 | +0.2211 efdues80022 |
| | (0.1513) | (0.165) | (0.04737) |
| | -0.5705Eqconsprivincdisp_1 | -0.1348 drealexchrate34 | -0.06209 dIQ889193 |
| | (0.09135) | (0.04067) | (0.01419) |
| | -0.02578 d992 | -0.04398 d0223 | |
| | (0.02524) | (0.01848) | |

$R^2$ =0.801844 F(10,81)=32.777 [0.0000] $\sigma$=0.023 DW=1.95
RSS = 0.04455841104 for 11 variables and 92 observations

Estimates show that income increases and decreases have similar effect on the growth rate of consumption during the period 1980-2001 and that although the income decreases resulted significant for the period 2002-2004, the income increases resulted not significant at traditional levels. It is worthwhile noting that during 2002-2004 income increases have near two times the effect of the income decreases on consumption growth rate. Then the joint test of both hypotheses is presented below.

Wald test for linear restrictions: $\beta_{Dposincdisp}=\beta_{Dnegincdisp}$; $\beta_{Dposincdisp0204}=0$
LinRes F( 2, 81) = 2.3297 [0.1038]

As these linear restrictions could jointly not be rejected with a p-value of 0.1038, it could be concluded that there is some evidence of liquidity constraints after default and devaluation but not during the period 1980:1-2001:4,.

To sum up, during the period 1980:1 to 2001:4 liquidity constraints are found not to be binding when they are tested by asymmetric effects and by the expectational form of EC terms[xi]. For this period, “wealth effects” are derived from the past peak income and, for the whole sample, from the real exchange rate. They appear to adjust "wealth perception" in the short run. The presence of an EC term suggests that consumption responds proportionally to income in the long run as it was maintained by LC-PIH.

The sample extension shows quite different results about liquidity constraints. Constraints are binding after the default of the sovereign debt and the abandonment of the Convertibility regime, when consumers seem to suffer restrictions to obtain the necessary financial resources to fulfil their optimal consumption plans.

The impact of "wealth effects" versus "liquidity constraints" over the aggregate consumers' behaviour can be analysed from a historical perspective. During the unstable eighties consumers learned about the high costs of inflation and tried to avoid contracts of more than a few weeks and in this way credit restrictions were not unusual. However, liquidity constraints were not found as significant in the aggregate[xii]. On the one hand wealthier consumers could have been using their liquid assets to mitigate these restrictions and to avoid consumption falls. On the other hand, seignorage revenues could be another source of soft budget constraints which can be used to subsidy consumption. The nineties were characterized by price stabilization and increases in output and consumption. The political and economic reforms, the liquidity of banking system and the international willingness to finance the economy, made consumers showed an optimistic behaviour entering into debt contracts and holding assets in dollar value. They did not seem to consider that the growth trend reached during Convertibility was temporarily and could be downward at some time. This explains the absence of liquidity constraints in the model until the end of Convertibility. Instead, default and devaluation of early 2002 generated a reversion in the international and domestic credit behaviour and a breakdown on contracts that is captured by the model as the existence of liquidity constraints until the end of the sample. As Galiani, Heymann and Tommasi (2002) said "...One of the big challenges that the Argentine economy (and its policymakers) will be facing is to gradually reconstitute a credit system in which "typical" macroeconomic contingencies (such as movements in the real exchange rate) do not cause the danger of a breakdown".

## III. Exponential vs. Hyperbolic Discount Functions in the Euler Equation

For the period 1980:1-2001:3, an exponential model (a constant discount factor) can be assumed to describe Argentine consumers' behaviour (Ahumada and Garegnani, 2004). However, when the sample is extended to include 2002-2004 period, the new macroeconomic environment may imply a different perception about the realization of future rewards. As it is known the contrast between long-run patience and short-run impatience is captured with discount functions that take the hyperbolic form (Loewenstein and Prelec, 1992, Laibson, 1997, Harris and Laibson, 2001). Sozou (1998) recognizes that the systematic preference for an immediate reward over a future reward of the same magnitude has been often observed. He added that a plausible reason for this behaviour is the risk that a future reward will not be realized.

Laibson (1998) recognized that the hyperbolic model "replicate the general properties of the buffer stock framework, notably consumption-income tracking". In the buffer stock model consumers buffer consumption against high-frequency income shocks but they are not patient to undertake low frequency life-time smoothing. He also found that "the hyperbolic model goes beyond the buffer stock predictions, explaining a wide range of additional anomalous empirical regularities", such as the one related to the missing of precautionary savings effect.

Frederick, Loewenstein and O'Donoghue (2002) suggest that some observed consumers' behaviour can usually be interpreted as evidence for hyperbolic discounting, for example: (i) when people are asked to compare smaller-sooner reward to a larger-later reward, the implicit discount rate over longer time horizons is lower than the implicit discount rate over shorter time horizons; (ii) the hyperbolic functional form fits the data better than the exponential functional form, which imposes constant discount rates and (iii) preferences

between two delayed rewards can reverse in favour of the more proximate reward as the time to both rewards diminishes.

As in Garegnani (2005) an empirical approximation of Harris and Laibson (2001) is performed to obtain deep parameters from Hyperbolic Euler Equations using quarterly data during the period 1980:1 to 2004:3 applying Generalised Method of Moments (GMM) .

Laibson (1997) and Harris and Laibson (2001) used the hyperbolic discounting for consuming vs. saving behaviour. In order to reflect the empirical pattern of discount rates that fall with the horizon Laibson (1997) and Harris and Laibson (2001) adopted a discrete-time discount function, $\{1, \beta\delta, \beta\delta^2, \beta\delta^3, \beta\delta^4, \ldots\}$ . This "quasi-hyperbolic function" reflects a faster rate of decline in the short run than in the long run. The short run discount factor is $\beta\delta$, and the long run discount factor is $\delta$. The hyperbolic discounting function nests the standard case of exponential discounting when $\beta$=1.

Table 1 presents the estimates[xiii] for Argentina of deep parameters of the Hyperbolic Euler Equation (HEE) when the utility function is of a constant relative risk aversion form (CRRA)[xiv],

$$C_t^{-\gamma} = E_t[R(C'_t\beta\delta + (1 - C'_t)\delta)C_{t+1}^{-\gamma}] \qquad (3)$$

where $C$ is the per capita private consumer's expenditure, $R$ is the gross return on savings, $C'$ is the derivative of $C$ with respect to cash-on-hand, $\beta$ and $\delta$ are the discount factors, $\beta\delta$ is the short-run discount factor and $\delta$ is the long-run discount factor and finally $\gamma$ is the (absolute value of) risk aversion parameter. In this empirical application, as in Ahumada and Garegnani (2004), returns were approximated by the real deposit interest rates and the growth rate of real exchange rate[xv] and $C'$ is approximated by the actual ratio of current consumption to current cash-on hand (current income plus cash holding)[xvi].

A remarkable property of the HEE is that it varies with the levels of cash-on -hand. As Harris and Laibson (2001) suggests when it is expected low levels of cash- on- hand, $C'$ wiil be close to one and the effective discount factor will be $\beta\delta$ while high levels of cash-on-hand are expected $C'$ will be close to zero and the discount factor will be $\delta$ . In general the effective discount factor will be a weighted average of them, the weights are determined by the marginal propensity to consume out of liquid wealth. As low levels of cash-on hand imply that agents are liquidity constrained the HEE appear as appropriate to describe consumer decisions when these constraints are binding.

A first estimation of a HEE for the period 1980:1 to 2004:3 showed that the $\beta$ parameter does not resulted different from 1 for the whole period which means that the standard Exponential Euler Equation represents Argentine consumers' behaviour reinforcing the results in Ahumada and Garegnani (2004). When $\beta$=1 the term $(C'_t\beta\delta + (1 - C'_t)\delta)$ is equal to $\delta$ and the exponential discounting case is obtained.

However, as results in section 2 show that for the period started in 2002 consumers could be considered as facing liquidity constraints, the estimations presented in Table 1 were performed considering that the weights $C'_t$ only appears in the period 2002:1 to 2004:3 through a multiplicative dummy for such a period. If coefficient $\beta$ is less than one, consumer behaviour could be represented by HEE in the new regime[xvii]. Table 1 also

shows the robustness of the estimations to the choice of the method to estimate the weighting matrix.

Table 1. GMM Estimates and Standard Errors (S.E) of Deep Parameters

| GMM estimates | Weighting Matrix Estimator | | |
|---|---|---|---|
| HEE-CRRA 1980:1-2004:3 | Newey-West (nw) Fixed (3)* | Andrews (3.64)* | Variable Newey-West (7)* |
| **b** | 0.9624 | 0.9632 | 0.9594 |
| *Std. Error* | *0.0024* | *0.0026* | *0.0018* |
| **g** | 0.1315 | 0.1267 | 0.1791 |
| *Std. Error* | *0.0481* | *0.0523* | *0.0320* |
| **d** | 1.0012 | 1.0009 | 1.0014 |
| *Std. Error* | *0.0008* | *0.0010* | *0.0007* |
| **J-statistic** | 0.1532 | 0.1611 | 0.1084 |

*Lag truncations are in brackets

As can be observed, $b$ parameter estimate is 0.96 which resulted different from 1 when HEE is assumed since 2002. Table 2 shows that the Wald statistic do reject this hypothesis[xviii].

Table 1 and 2 also show that the discount factor $d$ does not be different from 1, at traditional levels. This value of the discount factor match with a discount function of the form *{1,b, b, b, b,...}* which is used by Akerlof (1991). Such a function represents decision makers who weight every day reward more than any in the future. A key feature of this kind of behaviour is procrastination. The (absolute) value of the relative risk aversion coefficient is positive representing concave preferences.

Table 2. Wald coefficient restrictions

| *Null Hypothesis= b=1* | |
|---|---|
| Test Statistic | Probability |
| Chi-square | 0.0000 |
| Wald Test: *Null Hypothesis= d =1* | |
| Test Statistic | Probability |
| Chi-square | 0.1467 |

Since the number of orthogonality conditions exceeds the number of parameters to be estimated, the validity of the overidentifying restrictions are tested using the statistic suggested by Hansen (1982)[xix] ($T.J-statistic$ = 10.08 (57)), thus the null hypothesis of validity of instruments is not rejected at traditional significance level.

To sum up, parameter estimates have the expected values and signs. Estimates are also robust to different specifications of the weighting matrix. The exponential model describes Argentine consumers' behaviour during the period ended in 2001. Since then a kind of hyperbolic function could be fitted to describe consumer behaviour. This means that after the break consumers differentiate short and long run decisions becoming more impatient in the short run. These results are consistent with those obtained in section II

where liquidity constraints begins after default and devaluation. While EER can be used to describe Argentine consumers' behaviour until the third quarter of 2001, HEE can help to do so in the last period because of the existence of liquidity constraints.

## IV. Conclusions

The episodes of early 2002 becomes a critical "break point" for consumers' decisions in Argentina inasmuch as liquidity constraints and hyperbolic discount functions are found after the default on sovereign debt and the abandonment of the Convertibility regime. These findings have been obtained following the two main approaches to empirically model consumption decisions: a solved out consumption function approach and an Euler Equation-GMM approach.

On the one hand, an EC model based on the first approach allows for testing liquidity constraints by considering its expecational form under credit constraints and asymmetric effects of rising and decreasing income. In both cases, liquidity constraints were rejected for the period 1980:1-2001:4. For this sample the estimated model was interpreted as one from the LC-PIH adapted to the Argentine experience by two short run indicators of wealth perception: the deviations between current income and its last peak and a lagged growth rate of the real exchange rate. Although the sample includes the 80's and 90's the stability of estimations can not be rejected.

After 2002, instead, the same tests indicate that the hypothesis of liquidity constraints is not rejected, as consumers seem to feel the lack of the necessary financial resources to fulfil their optimal consumption plans.

The results found by this approach have also been consistent with those obtained by the Euler Equation-GMM approach. While for 1980-2001 period an EER discount function can be used to describe consumers' decisions, for 2002-2004 a hyperbolic discount function can instead be used to obtain the deep parameters behind their consumption-saving decisions. The new macroeconomic environment may imply a different perception about the realization of future rewards that can be reflected by the hyperbolic discount factor that allow for distinguishing short run from long run impatience.

Thus liquidity constraints and hyperbolic discount functions are the main features that characterize Argentine consumption patterns after the 2002 break, which implies a financial collapse that lead to private sector insolvency. Although financial restrictions were gradually mitigated over time the empirical findings seem to indicate that, in the aggregate, consumers have remained suffering financial restrictions to fulfil their optimal plans and their "wealth perception" has not yet been adjusted, at least until the end of 2004. Evidence of this behaviour could be derived from the end of sample results: current and not past peak income effects on aggregate consumption and an overvaluation of short run rewards. Therefore, in spite of the two different empirical approaches used to understand consumers' behaviour both suggest consistent patterns of consumption when they were considered for different environments.

***Appendix 1: Data Definitions and Sources***

- *Private Consumption*: Addition of the expenditure in goods and services of private residents and non-profit institutions (thousands of pesos at 1986 prices). ECLAC Bs.As. and Dirección Nacional de Cuentas Nacionales (INDEC).
- *Gross National Disposable Income*: Sum of the gross national income and the current net transfers (thousands of pesos at 1986 prices). ECLAC Bs.As. and Dirección Nacional de Cuentas Nacionales (INDEC).
- *Real Exchange Rate*: Ratio of wholesale to consumer prices. INDEC.
- *Interest Rate*: 30-59 days deposit interest rate. Banco Central de la República Argentina (B.C.R.A.)
- *Sovereign Risk:* EMBI of Argentina. Carta Económica (Estudio Broda). This variable is expressed in logs of (1+r) where r is 0.0001 times the usual measure of risks in basic points.
- *Inflation*: $(p_t - p_{t-1})$ being $p_t$ the log of general level of consumers' prices. INDEC.
- *M3:* Narrow money and all kind of bank deposits in pesos. *M3** also includes deposits in dollars. B.C.R.A.
- *Merval:* Stock prices aggregate index. Mercado de Valores de Buenos Aires.
- *Real Wages:* Industrial real wages. ECLAC Bs.As.
- *Unemployment*: Rate of unemployment. INDEC.
- *Economically Active Population*: Millions of people. INDEC.

***Appendix 5: Testing liquidity constraints during the 80's with the sample extension***

```
Dpondcpriv = -0.1027               +0.7919 DLincdisp           -0.2619 DLincdisp0204
(SE)         (0.01987)             (0.1037)                    (0.1235)
             +0.224 efpastpeak80022 -0.5537 Eqconsprivincdisp_1 -0.1244 drealexchrate34
             (0.04243)             (0.08962)                   (0.03948)
             -0.06277 dIQ889193    -0.02259 d992               -0.03784 d0223
             (0.01398)             (0.02442)                   (0.01707)
             +0.2143 Dlincdisp80911
             (0.1515)

R^2=0.804642  F(9,82)=37.527 [0.0000]  σ=0.0231456  DW=1.89
RSS=0.04392913052 for 10 variables and 92 observations
```

Wald test for linear restrictions: $\beta_{Dincdisp} + \beta_{Dincdisp80911} = -\beta_{Eqconsprivincdisp-1}$
LinRes F( 1, 82)=9.0312 [0.0035] **

```
Dpondcpriv =-0.1064                +0.8081 DLincdisp           -0.2645 DLincdisp0204
(SE)         (0.02023)             (0.105)                     (0.1236)
             +0.2006 efpastpeak80022 -0.5717 Eqconsprivincdisp_1 -0.1257drealexchrate34
             (0.0487)              (0.09151)                   (0.03951)
             -0.06105 dIQ889193    -0.02442 d992               -0.04127 d0223
             (0.0141)              (0.0245)                    (0.01743)
             +0.03163 Dposincdisp80911 +0.3489 Dnegincdisp80911
             (0.2402)              (0.2045)

R^2 = 0.806931  F(10,81)=33.854 [0.0000]  σ=0.0231512  DW=1.87
RSS = 0.04341432344 for 11 variables and 92 observations
```

Wald test for linear restrictions: $\beta_{Dposincdisp80911} = \beta_{Dnegincdisp80911}$
LinRes F( 1, 81)=0.9605 [0.3300]

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[i] Wealth measurement are not available for Argentina

[ii] PcGive and Pcfiml were used (see Hendry and Doornik, 1996)

[iii] See Appendix 1 for data definitions and sources.

[iv] Duesenberry (1949) emphasised the effect of cyclical factors incorporated in his Relative Income Hypothesis (RIH). In the RIH, the ratio of current saving to current income depends on the ratio of current income to past peak income.

[v] The different systems and corresponding statistics are reported in Ahumada and Garegnani(2003).

[vi] As the exchange rate remained fixed during the Convertibility regime, the ratio of wholesale to consumer prices was taken into account as a proxy given the greater weight of non-tradables in the last index.

[vii] Dummy variables included in Equation 1 for the first quarter of 1987 (d871) and the first quarter of 1988 (d881) coincide with periods of acceleration in the rate of prices growth. Instead, the dummy variable for the first quarter of 1993 (d931) could be due to a change in the measure of national accounts from this quarter. However, since all the dummy variables were for the first quarter, they could reflect a different seasonality for this quarter.

[viii] Once the previous measures of "wealth perception" were taken into account, the role of interest rates, labour income (real wages and unemployment), stock prices and demographic variables were also evaluated with no significant additional effects.

[ix] Johansen´s tests also show a long-run relationship of homogeneity for the extended sample.

[x] Similarly to the previous period a dummy variable for the first quarter of 1988, 1991 and 1993 (dIQ889193) was included, it could reflect a different seasonality for this quarter. Other dummy for the second quarter of 1999 was also included, this dummy may represent a lagged effect of the Brazil's devaluation. Although it is not significant at traditional levels, it contributes to both, goodness of fit and stability of the income coefficient. The dummy variable for the second and third quarter of 2002 may reflect a lagged effect of the episodes previously described.

[xi] In Appendix 2 the existence of liquidity constraints is re-evaluated using both approaches 1980:1-1991:1 and the results show that the consumers' behaviour cannot be described by models with liquidity constraints. Liquidity constraints would be also not binding when these tests are performed for different subperiods of the eighties.

[xii] Dummy variables for different income effects during the eighties were proved but resulted as not significant.

[xiii] Eviews was used. See user's guide for a description of each weighting matrix estimator.

[xiv] This equation corresponds to Equation 11 in Harris and Laibson (2001).

[xv] Since the exchange rate was nominally fixed under Convertibility, it was approximated in real terms by the ratio of wholesale to consumer prices. Returns are included in I(0) form.

[xvi] In this case the marginal propensity to consume is approximated by the mean propensity to consume.

[xvii] The instruments used are three and four lagged values of consumption, the growth rate of real exchange rate and the real interest rate separated in both components, nominal interest rate and inflation.

[xviii] It is worthwhile noting that Harris and Laibson (2001) used $\hat{a}=0.7$ as benchmark value for calibration, a very close value to the one obtained in this estimation.

[xix] This statistic is computed for the results obtained using the Variable Newey-West estimator of the weighting matrix (the less restricted form).