Economics Department Working Paper Series

No. 36-2012

Macroeconomic volatility, consumption behaviour and welfare: A cross-country analysis

Alessandro Federici
Italian National Agency for New Technologies, Energy and Sustainable Economic Development
alessandro.federici@enea.it

Pierluigi Montalbano
University of Sussex and Sapienza University.
pierluigi.montalbano@uniroma1.it

Abstract:

This work presents a robust empirical approach to dealing with the issue of the long run relationship between macroeconomic volatility, consumption behaviour and welfare for a large sample of countries. Differing from previous works, our empirical strategy is grounded on consumption and takes account of the role of persistence in consumption/income volatility.

Our main conclusion is twofold: on one hand, we determine that aggregate volatility exerts, on average and *ceteris paribus*, a significant impact in deviating consumption from its smoothing path, producing aggregate extra saving, and in hampering future consumption prospects. This relationship holds across countries, including the poorest ones, and is becoming more significant in recent years. On the other hand, by deliberately proposing conservative estimates, we confirm Lucas' (1987) intuition about the low value of stabilisation policies, both across-countries and in the long-run. Our empirical evidence provides new insights into the long standing debate about the costs of fluctuations. First, it shows that the poorest countries hold a significant amount of "extra saving" too, because of economic fluctuations. Second, it underlies that, on average, uncertainty affects not only the volatility of consumption around its mean but the mean itself (Elbers and Gunning, 2003).

JEL Classification: E21, F40, C82, O10, O57

Key Words: consumption, volatility, precautionary saving, welfare, developing countries

Acknowledgements: Our main debt is to L. Alan Winters for his valuable support and guidance. We are also grateful to Andy McKay and all the participants in the Seminar held at the Department of Economics, University of Sussex, the 7th of March 2012 for useful comments and suggestions. An earlier version of this paper has been presented at the DIAL International Conference "Shocks in Developing Countries" held in Paris, June 30th and July 1st, 2011. An updated one has been presented at the Scottish Economic Society annual Conference held in Perth, April 16th-18th, 2012. The usual disclaimers apply.

1 Background, aims and caveats

For a high proportion of low and middle income countries there exists a phenomenon of excessive fluctuation of economic variables which is increasing over time (Agenor & al., 2000; Kose & al., 2003; Wolf 2005, Loayza & al., 2007). As a result, a large amount of empirical literature has been devoted to the investigation of both its determinants and economic consequences (Ramey & Ramey, 1995; Aizenman & Marion, 1999; Fatas, 2000; Pallage & Robe, 2003; Kose & al., 2003; Wolf, 2005; Hnatkovska & Loayza, 2005; Loayza et al., 2007; Demir, 2009). However, empirical results are mixed and often inconsistent across studies. More recently, practitioners and scholars have been tempted to link macro-fluctuation to the presence of "excessive saving" or "saving glut" in developing countries (Bernake, 2005; Carroll & Jeane, 2009; Furth, 2010) with the correlated risk of "global imbalances" (Bordo, 2005; Caballero & Krishnamurthy, 2009; Claessens & al., 2010). According to this view, also the remarkable accumulation of foreign reserves in the fast-growing emerging economies, which has been registered in recent times, reflect extra saving against the risk associated with economic globalisation (Stiglitz, 2004; Lane and Milesi-Ferretti, 2007).

We believe the above issues need more rigorous empirical investigation, by looking directly at consumption behaviour under uncertainty. Specifically, three main questions need to be addressed: does macro-volatility cause deviations from consumption smoothing? does consumption behaviour under uncertainty hamper future consumption? and, following on from this, are developing countries a special case? Previous empirical literature has overlooked these research questions. On one hand, it has largely focused on income, leaving outside the analysis a thorough investigation of consumption behaviour, which is at the core of households choices under uncertainty. On the other hand, the welfare cost of volatility has essentially been derived in an indirect way by looking to alternative measures of compensation parameters which are supposed to assess people's preference for stability (see Appendix A).

The aim of this work is to submit to rigorous investigation the hypothesis of the presence of direct welfare costs of macro-volatility as well as indirect ones made by previous empirical literature (see Loayza et al., 2007 for an overview). As a corollary, we wish to assess whether developing countries are a special case. To this end, we propose a cross-country empirical analysis to look at the impact of aggregate volatility on consumption smoothing behaviour. As in other similar studies, the aim is not, at this stage, to distinguish among the various sources of macroeconomic fluctuation (productivity or monetary shocks; pure business cycles; long run uncertainty; policy mismanagement, etc.)[1], nor to address the issue of the portfolio choices beneath consumption behaviour,[2] rather to assess the links between macro-volatility, consumption smoothing, and extra-saving, in terms of magnitude; short-run versus long-run dynamics; robustness to countries' heterogeneity.

The main innovations to existing literature are the following: focusing on consumption behaviour rather than income; adopting both consumption and income fluctuations as proxies for economic instability; proposing a way to look at the cost of volatility on welfare alternative to compensation parameters of household preference for stability; using long panel data for a large sample of countries (ideal for testing the theory of consumption, but virtually unavailable at the micro level). The empirical strategy is grounded on the Friedman (1957)'s classical consumption model, amended to take into account both the impact of income and consumption fluctuations as well as their persistence in consumption (see Appendix A). We provide estimates by income deciles as well in order to assess the role of country heterogeneity and to investigate whether the poorest countries actually represent a special case (i.e. to assess whether differences in countries' income levels actually produces diversified effects in their precautionary saving behaviour to macro-fluctuations).

A number of caveats must be taken in performing this empirical task. The main drawback is represented by the implicit assumption of a representative agent (i.e., no individual differences). While convenient - it permits the adoption of an invariant felicity function and reduces the problem of measurement error - it implies that incomes are perfectly pooled across individuals (i.e., full domestic risk sharing) and, hence, limits the analysis to aggregate uncertainty

[1]Parker and Preston (2005) underline four proximate causes of fluctuations in aggregate consumption growth: new information, real interest rate, consumption preference, and risk.

[2]In this respect, our results should be assumed to be conditional to asset prices. While direct estimates of precautionary wealth may be advisable in letting data speaking in a much less filtered way (Carroll, 2001b; Carroll and Samwick, 1997), data on wealth cannot be estimated reliably and in a comparable way across countries. Furthermore, it is not yet clear how to translate estimates on wealth into a set of behavioural parameters (Carroll and Kimball, 2008)

only. [3] In this respect, our empirical results can be seen as a conservative estimate of the phenomena under analysis since the direction of distortion of our aggregate estimates is likely to reduce the impact of volatility rather than emphasise it (the average variability of the individual is greater than the variability of individuals whose behaviour is being averaged). A more pervasive source of concern is that the representative agent story can be misleading in the presence of borrowing restrictions that could alter uniformity across individuals. However, as Krussel and Smith (1998), Heaton and Lucas (1996) and Constantinides and Duffie (1996) argue, household heterogeneity arises mostly from idiosyncratic transitory shocks, which are easy to insure by only a modest amount of saving (Gourinchas, 2000). Conversely, in a world full of uncertainty, the precautionary demand for saving is likely to be strengthened, generally speaking, if access to credit is limited when it is most required (Deaton, 1992; Lee and Sawada, 2010). Another issue to be addressed is that economic theory also predicts full international risk sharing (i.e., perfect consumption smoothing across countries and states of nature) in the hypothesis of complete markets (Obstfeld and Rogoff, 1996).[4] However, the empirical literature has systematically rejected the null hypothesis of complete risk sharing, acknowledging a much larger degree of risk sharing within countries than cross-countries (Crucini and Hess, 2000; Kose et al., 2003, 2007, 2009 and 2011; Asdrubali and Kim, 2008; Broner and Ventura, 2011, Pierucci and Ventura, 2012). Last but not least, this work focuses on consumption (and saving) behaviour as key tools in explaining household's choices under uncertainty. It must be acknowledged that consumption smoothing is not the only behavioural mechanism to respond to risk and uncertainty. For instance, prudent households may well decide to reduce their health care and school expenditure, contributing in this way to a reduction in permanent income and welfare. Moreover, consumption smoothing actually engenders a set of behavioural changes apt to produce likely effects on household welfare too such as: smoothing asset/income; self-insurance, risk-sharing arrangements, diversification, migration, etc. (Morduch, 1994; Rosenzweig & Wolpin, 1993; Townsend, 1994, 1995; Zimmerman

[3] The usual concern is that the representative consumer model reduces the relevance of precautionary saving. To avoid this, Carroll (2000) proposes relying on multiple classes of households characterised by differing wealth availability and marginal propensity to consume.

[4] In this framework, the only type of risk reflected by consumption is due to aggregate uncertainty about world output (i.e., systemic risk).

and Carter 2003). However, this does not undermine the relevance of consumption behaviour as one of the most relevant tools in explaining household choices under uncertainty. Since saving-ratios tend to be pro-cyclical (rising in boom times and falling in times of crisis) consumption should be assumed, in a macroeconomic perspective, to be protected against business-cycle fluctuations (Deaton, 1992). Violation of this assumption is normally expressed in relation to liquidity constraints and/or uncertainty about the future. The two issues are indeed closely related. Uncertainty could generate a behaviour virtually indistinguishable from that generated by a liquidity constraint by inducing self-imposed reluctance to borrow (Caroll, 2001a) and liquidity constraints could make people accumulate precautionary wealth in the attempt to insure themselves (Lee & Sawada, 2010). Madsen and McAleer (2000) provide some support in favour of the uncertainty hypothesis, using panel data for 22 OECD countries. However, we cannot assume this to be the case for developing countries too. To conclude, in all the above cases the possible direction of distortion is in reducing the impact of aggregate volatility on consumption not in emphasising it. Hence, our estimates of the phenomena under analysis should be assumed to be conservative.

The obvious theoretical reference for our empirical exercise is the literature on precautionary saving. According to this literature, consumption fluctuations are seen as optimal responses to shocks since meaningful uncertainty in future income provides a modification of optimal behaviour by encouraging additional savings and reducing current consumption (Caroll, 2001a; Kimball, 1990; Caballero, 1990, Deaton, 1992). The literature on precautionary saving is mainly focused on individuals in a closed economy setting. Ghosh and Ostry (1997) were among the first to note that surprisingly little attention has been devoted to its aggregate counterpart (relevant exceptions are Ghosh and Ostry, 1995 and 1997; Krussell and Smith, 1998; Carroll, 2000). We think their warning is still effective, especially with reference to developing countries.

Our main conclusion confirms that macro volatility has, on average and *ceteris paribus*, a negative and significant impact on current consumption, producing aggregate "extra saving", and in hampering future consumption. This relationship holds across countries, including the poorest ones, and has become more significant in recent years. On the one hand, these results are consistent with previous empirical literature and the theory of precautionary saving, even if they ask for additional research on household wealth concerning the empirical evidence of a negative relationship of aggregate volatility with consumption growth. On the other hand, our empirical estimates confirm that welfare losses induced by macrovolatility should not be high in magnitude. The work is organised as follows: Section 2 briefly summarises the literature; Section 3 presents the empirical model; Section 4 shows the cross-country estimates; Section 5 concludes.

2 Why should we care about macro-volatility? A review of the literature

The phenomenon of macro fluctuation has been confined within standard cycle theory for a long time, and was mainly concerned with the decomposition of economic growth into cyclical and trend components. Thus, it has long been considered as a second-order issue in studies on developing countries - but of primary interest in industrial countries concerned with smoothing the fluctuations of their business cycles. Moreover, according to the influential Lucas (1987)'s study, the cost of fluctuations is supposed to be of little account in terms of welfare. The fraction of consumption forgone for a reduction in its variability is approximated by the reduction in the squared coefficient of variation multiplied by a half the coefficient of relative risk-aversion (see Appendix A) and so the value of so-called "economic stabilisation" policies have been supposed to be low. However, Lucas (1988) observed that, in the long term, fluctuations in rates of growth are likely to be more substantial in less developed countries, suggesting a link between a country's level of economic development and its volatility. Recent empirical evidence questions Lucas (1987)' results. While Lucas conveniently assumed consumption shocks to be serially uncorrelated, Reis (2009) points out that Lucas' estimates are downward-biased, since he belittled the role of "persistence" as a crucial determinant of the cost of fluctuation (see Appendix A).

This weakness is supposed to be more serious in the context of developing countries (Calderon and Fuentes, 2010). From the work of Ramey and Ramey (1995) onwards empirical cross-country studies have consistently found that volatility exerts a significant negative impact on long-run growth and welfare, especially in developing economies (Fatas, 2000; Pallage and Robe, 2003; Wolf, 2005; Aizenman and Pinto, 2005) and that consumption volatility increases with respect to income volatility (Kose et al., 2003). Among the most recent contributions, Malik and Temple (2009) argue that volatility should be assumed as "endemic" in the developing world. They show that the median standard deviation of annual growth rates in low-income countries has been more than three times that of OECD member countries over a period of 40 years (1960-99). The World Bank, in its volatility handbook, also claimed that, in the developing world, "good times do not offset the negative impact of bad times" and shocks tend to have permanent negative effects (Aizenman and Pinto, 2005). According to a number of scholars, such asymmetry is reinforced by internal factors such as incomplete markets, inefficient taxation, pro-cyclical fiscal policy, and especially weak financial market institutions (Easterly et al., 2001; Denizer et al., 2002; Ferreira da Silva, 2002; Bekaert et al., 2004). Other factors include political insecurity, macroeconomic instability and institutional weaknesses – all phenomena that largely affect developing countries (Alesina et al., 1999; Judson and Orphanides, 1999; Gavin and Hausmann, 1996; Raddatz 2006; Servén, 1997; Agénor et al., 2000; Fatás and Mihov 2005, Acemoglu et al., 2003, Rodrik, 1998 and 1999). Volatility, in this context, is seen as a proxy of "uncertainty", likely to lead firms either to under-invest or to invest in "wrong" projects (Caballero, 1991; Bertola and Caballero 1994; Serven, 1997; Aizenman and Marion, 1999) and households to abandon a smooth path of consumption. These behaviours are enhanced by conditions of risk aversion, incomplete markets, lumpiness, and the irreversibility associated with the investment process (Hnatkovska and Loyaza, 2005). More recently, the literature has also investigated the plausibility of an overall negative effect of cyclical fluctuations on long-term growth (Fatas, 2000; Blackburn and Pelloni, 2004 and 2005), overcoming the standard distinction between the two issues.

Loayza & al. (2007) highlight two main reasons why one should care about macroeconomic fluctuation: i) the substantial welfare loss of deviating from a smooth path of consumption; ii) the indirect welfare loss in terms of future consumption, in the case of a negative impact of volatility on growth. They also argue that these phenomena are emphasised in developing countries, which not only face more volatility than industrial countries but suffer larger volatility effects, because of the intrinsic instability of the developing process (mainly linked to the weakness of their financial systems and the main characteristics of their specialization process of production); the concrete risk of policy mismanagement (e.g., as in the case of pro-cyclical and/or erratic fiscal and monetary policies), and the presence of weaker mitigating and coping mechanisms.

To assess the cost of fluctuations on consumption behaviour the obvious theoretical reference is the theory of ”precautionary saving” (Caroll, 2001; Kimball, 1990; Caballero, 1990, Deaton, 1992). According to this strand of the literature, if the marginal utility of consumption function is convex the consumer follows a prudent behaviour.[5] This means, that an individual pays attention not only to the mean of the future income (as implicitly assumed by the standard permanent consumption model, see Appendix A) but also to its variability. While the qualitative and quantitative aspects of the theory of precautionary saving (whose basic intuition dates back to Keynes) are now well established, less agreement exists about the strength of the precautionary motive (Carroll and Kimball, 2008) and little attention has been devoted to its aggregated counterpart. Furthermore, the impact of the precautionary motive in developing contexts remains somehow ambiguous and calls for additional empirical investigation. Deaton (1992) - the first to provide evidence of the cost of precautionary saving on household welfare in developing contexts - highlights a positive effect of risk/uncertainty on saving and growth. Conversely, Hahn (1970), Dercon (2004), Elbers et al. (2009), Gunning (2010) show how the introduction of risky assets produces, under a series of specific circumstances, a negative effects of risk and uncertainty on saving decisions. Cross-country comparison could certainly help in assessing whether and to what extent, on average and *ceteris paribus*, the aggregate precautionary saving behaviour in developing countries is statistically different from that of the more developed contexts.

[5]Although often confused, precaution and risk aversion are not exactly the same thing (Carroll and Kimball, 2008). While prudence represents the “intensity” of the precautionary saving motive, risk aversion determines the price one is willing to pay to eliminate uncertainty if at all possible. Practically speaking, the degree of precaution is the degree of convexity of the marginal utility function, while risk aversion is controlled by the degree of concavity of the utility function. Hence, while precaution depends on the third derivative of the utility function, risk aversion depends on the second derivative and one can be inferred from the other only for very special functions, e.g. if utility is exponential, then absolute prudence coincides with absolute risk aversion (Kimball, 1990).

3 Macro-volatility and extra saving: the empirical model

As Caroll (2001) highlights, when there is meaningful uncertainty in future income, the optimal behaviour of moderately impatient consumers is much better described by the classic Friedman's (1957) permanent income consumption function than by the later explicit maximising version.[6] If liquidity constraints are not binding and agents follow rational expectations, then the Euler equation implies that consumption follows a martingale[7]. In this case, consumption follows a (non strict) random walk process, i.e. current consumption is the best predictor of future consumption. This result is known in the literature as the random walk hypothesis for consumption (Hall, 1978). Subsequent empirical analyses do not confirm the complete uncoupling of consumption and current income implied in Hall's hypothesis. Similarly, the so called "excess sensitivity hypothesis" (Flavin, 1981) has been challenged by subsequent econometric findings (Deaton, 1992). Furthermore, the "Deaton Paradox" (Deaton, 1987) casts doubts on the rational expectations hypothesis because of the "excess smoothness " of consumption with respect to income.[8] Hence, to provide an empirical version of the consumption function able to control for the main stylised facts on consumption behaviour and fit the empirical data we believe that the simplest Friedman's (1957) classical model can be assumed to be a reasonable and feasible tool. According to Friedman's (1957) classical model, actual consumption, C_t, and actual income, Y_t, contain both permanent and unanticipated transitory components of consumption and income, respectively. As standard in this literature we refer here only to labour income (i.e., excluding capital income). It lets us treat income as outside the agents' control and assess the consumption

[6]As highlighted by Deaton (1992) this approach coincides with the life-cycle model (Modigliani and Brumberg, 1954, 1980; Ando and Modigliani, 1963) only if permanent income is computed as the average of life-time income. Here, we follow Friedman's original statement and do not commit ourselves to this assumption, leaving demographic influences out of our analysis.

[7]A stochastic process in which the conditional expectations of a variable is its current value. Additional pre-requisites are needed for this result such as: preferences that are inter-temporally separable, quadratic felicity functions; constant real interest rate equal to the rate of time-preference (Deaton, 1992).

[8]According to the rational expectations hypothesis, if per capita real income is a random walk, income innovations are permanent and consumption should vary at least as much as income (Muellbauer and Lattimore, 1995).

consequences of unanticipated shocks (while capital income depends at least partially on assets and portfolio choices of households).

The Friedman (1957)'s model, in its simplest form[9], assumes the following identities:

$$C_t = C_t^P + C_t^T \tag{1}$$

$$Y_t = Y_t^P + Y_t^T \tag{2}$$

where C_t^P and Y_t^P are aggregate permanent consumption and income at time t, respectively, and C_t^T and Y_t^T are the transitory components. We assume permanent consumption to be proportional to permanent income (see Appendix A):

$$C_t^P = kY^P \tag{3}$$

where $k = \frac{\delta(1+r)}{(1+\delta)r}$; δ is the time preference and r is the interest rate. Permanent income is unknown. According to Friedman (1957), it is analogous to the expected or average income.[10] It is reasonable to assume it to be subject to an adaptive expectations process, such as:

$$Y_t^P = \lambda Y_t + (1-\lambda)Y_{t-1}^P \tag{4}$$

where λ is the coefficient of adaptive expectations. In practice, permanent income at time t is a weighted average of actual income at time t and permanent income at time $t-1$. It means, people make predictions on permanent income at time t by observing the difference between actual income at time t and the expected permanent income at time $t-1$.[11]

Hence, making reference to Eq.1 and Eq.4, we can re-write Eq.3 as follows:

$$C_t - C_t^T = k\lambda Y_t + k(1-\lambda)Y_{t-1}^P \tag{5}$$

[9] We give credit to Christopher Dougherty for this version of Friedman (1957)'s original model.

[10] If permanent income is taken to be the annuity value of lifetime resources, Friedman's theory is closely related to Modigliani and Brumberg's (1954, 1980) life-cycle hypothesis (Deaton, 1992)

[11] This assumption seems appropriate given the traditional aggregate decreasing forecasting power for more distant time horizons. Moreover, additional pieces of information become available as time passes, so there is no reason to commit future consumption any sooner than necessary (Deaton, 1992).

We obtain current consumption as a function of current income and permanent income lagged one period, as follows:

$$C_t = k\lambda Y_t + k(1-\lambda)Y_{t-1}^P + C_t^T \tag{6}$$

Recalling that $kY_{t-1}^P = C_{t-1}^P = C_{t-1} - C_{t-1}^T$ and substituting it to Eq.6, we can easily derive a reduced form of the permanent consumption equation, as follows:

$$C_t = \gamma Y_t + (1-\lambda)C_{t-1} + C_t^T - (1-\lambda)C_{t-1}^T \tag{7}$$

where $\gamma = k\lambda = \frac{\partial C_t}{\partial Y_t}$ is the short run marginal propensity to consume out of income; $k = \frac{\delta(1+r)}{(1+\delta)r}$ is the long run marginal and average propensity to consume and λ is the weight attached to the "non-permanent" component of actual income. It means, as λ approximates to zero, consumption approximates to permanent income.

Eq. (7) is compatible with a number of stylised facts on consumption:

- the short term marginal propensity of consumption is lower than its long term counterpart ($\gamma < k$ since $\lambda < 1$);
- marginal and average consumption are constant in the long run and equal to k;
- C_t fluctuates less than Y_t (since $\gamma < 1$), i.e., consumption smoothing hypothesis holds. Households tend to stabilise consumption during the business cycle;
- the intercept of the short term consumption function is linked to past experience (C_{t-1}). If income is increasing it shifts upwards and the actual long-run relationship between permanent consumption and income becomes steeper (being the slope γ).

Since C^T is not observable, Eq. (7) cannot be applied to fit empirical data. A workable solution is to take a log approximation of Eq. (7) as follows:[12]

[12] The log approximation of the consumption function is also convenient due to the presence of exponentially trendy macro data. Traditional models assume the log normality of consumption from the log normality of permanent income. Battistin, Blundell & Lewbel (2007) demonstrate empirically that the distribution of consumption expenditures across households is closer to log normal than is the distribution of income.

$$c_t = \hat{\beta}_1 y_t + \hat{\beta}_2 c_{t-1} + \hat{u}_t \quad (8)$$

where c_t and y_t are natural logs of real income and consumption.It means to assume that: $\hat{\beta}_1$ as the short-run marginal propensity to consume ($\hat{\beta}_1 = \gamma$); $\hat{\beta}_1/(1-\hat{\beta}_2)$ as the long-run marginal and average propensity $\hat{\beta}_1/(1-\hat{\beta}_2) = k$; $(1 - \hat{\beta}_2)$ as the adaptive expectation coefficient $(1 - \hat{\beta}_2) = \lambda$; $\hat{u}_t$ as the transitory component of consumption such as: $u_t = c_t^T - \hat{\beta}_2 c_{t-1}^T$.

However, the preference for constant consumption depicted by this theoretical model rests on the hypothesis of certainty equivalence (i.e., consumers make the same decision both under a certain and an uncertain scenario). It is not compatible though with the presence of a prudent behaviour (Deaton, 1992).[13] To assess the role of uncertainty, as already underlined, we should rely on the theory of "precautionary saving" (Caroll, 2001; Kimball, 1990; Caballero, 1990, Deaton, 1992). According to this strand of the literature, a prudent consumer pays attention not only to the mean of the future income but also to its variability, considered as a proxy of uncertainty.

[13]In the standard permanent income model, the optimal choice corresponds to the situation where the expectation of marginal utility equals the marginal utility of the expectation (hypothesis of linearity of the marginal utility of consumption). This means that the consumer only looks to the expected mean of future income, not to its variability. In this situation, increases in future uncertainty do not by themselves affect saving.

3.1 Assessing the impact of macro-fluctuations in consumption

An influential strand of the literature on precautionary saving asserts the need to look primarily at consumption variability rather than income (see, among others, Lucas, 1987; Dynan, 1993; Merrigan and Normandin, 1996; Lee and Sawada, 2010), because the consumption of an optimising household changes only in response to unanticipated innovations in income. This literature generally applies the following second-order Taylor approximation around the point C_t of the non-linear Euler equation (see Eq.(28) in Appendix [A]):

$$E_t\Delta c_{t+1} = \frac{1}{\theta}\left(\frac{r-\delta}{1+r}\right) + \frac{\rho}{2}E_t\Delta(c_{t+1})^2 \tag{9}$$

where $\theta = (-C_t\frac{U''}{U'})$ is the coefficient of Relative Risk Aversion ; $\rho = (-C_t\frac{U'''}{U''})$ is the coefficient of relative prudence;[14] Δ is the first difference operator; c_t is log of consumption at time t and $E_t\Delta(C_{t+1})^2$ measures uncertainty (i.e., under certainty, $E_t\Delta(c_{t+1})^2 = 0$). It is apparent that under a prudent behaviour (i.e., if $\rho > 0$, as is the case when an exponential utility function, $U(C) = -\frac{1}{\alpha}e^{-\rho C}$ is used), then higher expected squared consumption growth (here assumed as a proxy of uncertainty) is positively related to higher expected consumption growth, which implies higher expected saving and hence lower expected consumption. Thus, a negative correlation between current consumption and uncertainty is in place. This relation holds both for CRRA and CARA utility functions.[15] The estimation of Eq. (9) is widespread in practice. Scholars generally replace the expected variables involved in Eq. (9) by their sample means, leaving the error term to capture all the unanticipated components[16] as follows:

$$\Delta c_{t+1} = \beta_0 + \beta_1\Delta(c_{t+1})^2 + \epsilon_{t+1} \tag{10}$$

where $\beta_0 = \frac{1}{\sigma}\left(\frac{r-\delta}{1+r}\right)$ and $\beta_1 = \frac{\rho}{2}$ and ϵ_t is a normal distributed error term with a mean of zero.

[14] More details about prudence and risk aversion definition are provided in footnote 5

[15] for additional details on the different characteristics of the two utility functions see footnotes 20 and 21

[16] A correlation between the error term and the average variance of consumption is generally acknowledged by this empirical exercise because of the presence of error terms associated with replacing expected values with observed means

Although Carroll (2001b) argued the near-impossibility of recovering a direct estimate of the exact values of the parameters for prudence and risk aversion from the above second order Taylor approximation, this does not invalidate the precautionary saving implications derived from the inter-temporal optimization of Eq.(25). Moreover, since measurement error should bias the estimate of the coefficient of relative risk aversion downward (see Carroll, 2001b), a GMM estimate is generally used as a rough lower bound on the coefficient of relative risk aversion (this is again consistent with the aim to provide conservative estimates of the phenomenon). Eq.(25), however, ignores the role of persistence in consumption fluctuation. While Lucas (1987) looked at the persistence phenomenon as a convenient way of enhancing the predictability of consumption and lowering the forecast error variance, Reis (2009) highlights the role of persistence as an additional cost of fluctuations induced by its long-lived impact. As a result, Reis (2009) estimates of the costs of consumption fluctuations in the USA are significantly larger than Lucas' (1987) calculations (approximately between 0.5 per cent and 5 per cent of per capita consumption). Given all this, we apply the following panel version of (Eq. 8) to test the impact of aggregate volatility on "extra saving":

$$c_{it} = \hat{\beta}_1 y_{it} + \hat{\beta}_2 c_{it-1} + \hat{\beta}_3 \sigma^2_{cid} + u_{it} + \hat{\varphi} u_{it-1} \tag{11}$$

where φ is the parameter of serial correlation across errors.[17] and σ^2_{cid} is the rolling volatility of consumption of length d (i.e., over d periods from t) for each country i. $\hat{\beta}_3$ is the parameter of interest. It provides a measure of the cost of consumption variability on current per capita consumption, based on the permanent income hypothesis. The expected sign of $\hat{\beta}_3$ is negative since consumption variability is supposed to be negatively correlated with current consumption, as implicitly assumed by the theory of precautionary saving (see Eq. [9]).

We perform our empirical exercise by applying a different set of measures for consumption volatility. As a baseline exercise, we test total observed volatility proxied by the standard deviation of the first differences of per capita consumption (Aizeman & Pinto, 2005, Wolf, 2005). Total observed volatility reflects both uncertainty and risk in consumption, which indeed are

[17]According to Eq.8, this parameter should be equal to $-\hat{\beta}_2$ (i.e., the theory predicts strong negative serial correlation across the unobservable errors, hence a cycle in the error structure).

separate concepts.[18] The issue of disentangling the "unpredictable component" (i.e., true uncertainty) and "pure risk" from sample variability is not trivial (Hnatkovska & Loayza, 2005; Wolf, 2005; Demir, 2009). Following Hnatkovska & Loayza (2005), we apply a workable method to test whether we can detect any difference in the impact of "'normal"' versus "extreme"' volatility, further disentangling the relative impacts of negative and positive fluctuations to verify the net effects on consumption of alternative periods of crisis and boom volatility. Furthermore, following the literature in the field (Carroll and Samwick, 1997; Hubbard et al., 1994; Gourinchas and Parker, 2002; Meghir and Pistaferri, 2004; Storesletten et al., 2004; Krebs, 2005) we also test the rolling standard deviation of life time consumption innovation for each country in the panel, derived from the residual of its consumption process.[19] Also for this measure, following Carroll and Samwick (1997), we provide a further distinction for each country i between innovations to permanent consumption and transitory shocks to consumption as follows:

$$s_{p_i}^2 = \upsilon_{i_d} - \upsilon_{i_{d-1}} \tag{13}$$

$$s_{e_i}^2 = \frac{\upsilon_{i_{d-1}} - (d-1)s_{p_i^2}}{2} \tag{14}$$

where υ_{i_d} is the variance of log difference of consumption of length d for each country in the sample.[20] We assume that $E(s_{p_i}^2) = \sigma_p^2$ and $E(s_{e_i}^2) = \sigma_\epsilon^2$ where σ_p^2 and σ_ϵ^2 are the variances of the permanent and transitory shocks to consumption, respectively. This variance decomposition method is robust to MA(1) serial correlation in the transitory shocks since we adopt $d \geq 1$ (additional details of both decomposition methods are provided in Appendix B).

[18]While risk is in fact the predictable component of consumption volatility (i.e., probabilities can be meaningfully defined in terms of relative frequencies), uncertainty is, by definition, its "unpredictable component" (Knight, 1921).

[19]Following Gosh and Ostry (1997), we apply the following univariate autoregression process of the first differences of observed per capita consumption time series:

$$\Delta c_t = \psi \Delta c_{t-1} + \varepsilon_t \tag{12}$$

[20]Please note that under the hypothesis of absence of unpredictable growth, the average log difference is zero. Hence, υ_{i_d} comes out to be equal to the log difference.

3.2 Assessing the impact of macro-fluctuations in income

Recalling Caroll (2001)'s concerns about the use of the standard log-linearised consumption Euler equations[21], we provide an additional test, by looking directly at income shocks. Here, however, a complication arises, since the adoption of the Constant Relative Risk Aversion (CRRA) isoelastic utility function - which is standard in models of precautionary saving (Carroll 1992, and 1998; Carroll and Samwick, 1997; Deaton 1992; Zeldes 1989, Skinner 1988) - and a stochastic income process do not allow a closed form solution.[22] To assess the cost of fluctuations in income, therefore, the only solution remaining is to apply a negative exponential utility function with Constant Absolute Risk Aversion (CARA), which allows for a closed form solution for the consumption function.[23] Unfortunately, the CARA application also has its drawbacks since it implies that the degree of risk aversion is constant (i.e., independent of the level of individual resources) and it does not rule out negative consumption, especially early in life if assets are low and income innovations are variable (Deaton, 1992).

Blanchard and Fischer (1989), Caballero (1990 and 1991), Weil (1990), Guiso et al., (1992), Lyhagen (2001), among others, assume that agents maximise the expected value of the following time-separable utility function over an infinite horizon:

$$\max -\frac{1}{\rho} E \sum_{i=0}^{x} \beta^i e^{-\rho c_{t+i}} \tag{15}$$

where β is the discount rate and ρ is the degree of absolute prudence.[24] Eq. (15) is subject to a standard budget constraint (such as $w_t = rw_{t-1} +$

[21] Caroll (2001b) convincingly shows that the above standard methods for estimating log-linearised consumption Euler equations cannot successfully uncover structural parameters like the coefficient of relative risk aversion from a dataset of simulated consumers behaving exactly according to the standard model.

[22] CRRA utility function is the following: $U = \frac{C^{1-\theta}-1}{1-\theta}$ where θ is the coefficient of relative risk aversion and it is assumed $\theta > 0$. It follows $\frac{d\alpha}{dA} > 0$ but $\frac{d(\alpha/A)}{dA} = 0$ where prudence is: $U''' = \theta^2 C^{-\theta} > 0$.

[23] CARA utility function is the following: $U(C) = -\frac{1}{\alpha} e^{-\alpha C}$ where α is the coefficient of absolute risk aversion ($\alpha = -\frac{U''}{U'}$) and $\alpha > 0$.

[24] Here the degree of absolute prudence is assumed to be equal to the degree of absolute risk aversion because of the use of exponential utility, see note 5.

$y_t - c_t$ where w_{t-1} is given) and a standard income stochastic process (such as $y_t = \lambda y_t + (1-\lambda)\widehat{y} + \varepsilon_t$ where $\varepsilon_t N(0, \sigma^2)$. It can be shown (see Appendix A) that in the simplified case where $\beta = r$ and if income shocks are normally distributed, the solution of the system is the following:

$$c_t = \frac{r-1}{r-\lambda}(y_t + \frac{1-\lambda}{r-1}\widehat{y} + w_t) - \frac{\frac{\rho r}{r-\lambda}\sigma^2}{r} \tag{16}$$

where the first term of the right hand side of Eq. (16) is certainty equivalent consumption, and its second term is precautionary saving. This latter term increases, as usual, with the variance of income shocks, σ^2, and the degree of prudence, ρ, as well as the degree of persistence of the innovations in income λ, (Reis, 2009). As suggested by Guiso et al., (1992) and Lyhagen (2001), we can thus test the impact of income volatility in deviating representative agents from the permanent consumption path using the familiar panel version of Eq.(11) in income fluctuations, as follows:

$$c_{it} = \hat{\beta}_1 y_{it} + \hat{\beta}_2 c_{it-1} + \hat{\beta}_3 \sigma^2_{yid} + u_{it} + \hat{\varphi} u_{it-1} \tag{17}$$

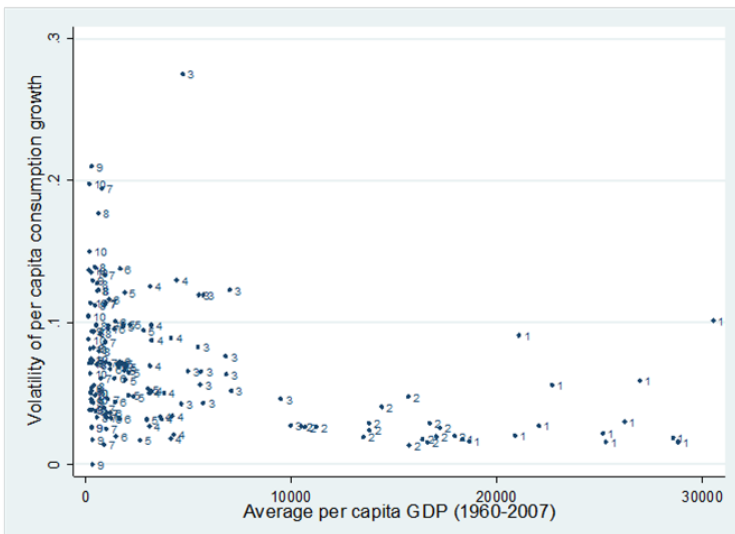
where σ^2_{yid} is now the rolling volatility of income of length d (i.e, over d periods from t) for each country i and φ is the parameter of serial correlation of the transitory component of consumption. $\hat{\beta}_3$ is again the parameter of interest whose expected sign is always negative. It provides a measure of the impact of income fluctuation on current per capita consumption, based on CARA and permanent income hypotheses. As in the case of consumption fluctuation, we provide separate estimates of total income volatility (as baseline scenario) together with measures of volatility of income life time innovations, as well as the differentiated impacts of various decomposition methods based on Hnatkovska & Loayza (2005) and Carroll and Samwick (1997) (see Appendix B).

4 Cross-country estimates

Fig. 1 provides a glance about the long run relationship between volatility of per capita consumption growth and per capita GDP across our sample of 147 countries (the full list of countries included in the sample is provided in Table 1 in Appendix C) in the period 1950-2009. It highlights the presence of strong heterogeneity in consumption volatility according to the income levels of the countries in the sample. More specifically, richer countries show a lower degree of consumption volatility, while poorer ones show higher degrees of consumption volatility and more mixed performances.This well known evidence leads us to investigate whether the existence of differences in countries' income levels actually produces diversified effects in their precautionary saving behaviour to aggregate volatility. Hence, to control specifically for this source of countries' heterogeneity, we estimate the model by income deciles too.[25]

Figure 1:

Volatility and per capita GDP in the long run



Deciles are calculated by decades according to the average per capita income of each country in each decade. We thus estimate both Eq. (11) and Eq. (17) for the entire period 1950-2009, and also by decades, using the following variables (data are from the latest PWT 7.0 database): the consumption share of real gross domestic product per capita (as a proxy for per capita consumption in real terms) and real GDP chain per worker (2005 Constant Prices) as a proxy for labour income in real terms.

[25]Additional sources of countries' heterogeneity are captured by controlling for countries' fixed effect in our panel estimates.

4.1 The dynamic panel model

Eq. (11) and (17) are two examples of reduced forms aimed at assessing the long term level of consumption according to both the theory of permanent consumption and the theory of precautionary saving. However, the presence of the lagged dependent variable requires to take care of the likely inconsistency of estimators induced by the fact that, by construction, unobserved panel-level fixed effects are correlated with the lagged dependent variable. To this end, and also to control for measurement errors in the analysis, we rely on consistent GMM estimators (Arellano and Bond, 1991)[26]. Furthermore, in Eq.(11) the error term is assumed to be correlated with average volatility, because of the use of observed variables in place of the expected ones (see subsection 3.1). To this end, in estimating Eq.(11) we allow the error term at time t to have some feedback on the subsequent realisations of volatility at time t.[27] Moreover, we should be wary of the moving-average correlation in the idiosyncratic errors, which is essential in order to capture the presence of heteroschedasticity due to persistence of the second moments of consumption (induced by its transitory component). This implies: firstly, only lags three or higher should be considered as valid instruments for the differenced composite error, since $\hat{u}_{t-2}$ is the farthest lag that appears in the differenced equation; second, lagged-levels are spurious instruments because of the persistent nature of the process. Hence, following Arellano and Bover (1995) and Blundell–Bond (1998), an additional moment condition has been applied to the level equation (constructed with the second lag of our dependent variable as an instrument).[28]

[26]Arellano & Bond (1991) build on Holtz-Eakin, Newey, and Rosen (1988) to identify how many lags of the dependent variable, the predetermined variables, and the endogenous variables are valid instruments and how to combine these lagged levels with first differences of the strictly exogenous variables into a potentially large instrument matrix. Using this instrument matrix, Arellano and Bond (1991) derive the corresponding one-step and two-step GMM estimators, as well as the robust VCE estimator for the one-step model

[27]More formally, it means assuming volatility as pre-determined variable, i.e., $E(vol_{is}\varepsilon_{it)=0}$ for $s \leq t$ and $E(vol_{is}\varepsilon_{it)\neq 0}$for $s > t$. Consequently, we can use lagged values of volatility as instrument only for the period where it is unrelated with the error term.

[28]Arellano and Bover(1995) and Blundell and Bond (1998)] propose to use additional moment conditions in which lagged differences of the dependent variable are orthogonal to levels of the disturbances. To get these additional moment conditions, they assumed that the panel-level effect is unrelated to the first observable first-difference of the dependent variable.

Heteroskedasticity consistent standard errors robust to the spatial dependence of panel data are provided as well.[29] It must be noted also that the first differentiation procedure removes any time invariant components of the model. However, although observed variables are in real terms, we control for the presence of time variant fixed effects, i.e. omitted country specific factors that change every year (other than consumption volatility). Like all GMM estimators, the consistency of these estimates depends strictly on the validity of the moment conditions used. Unfortunately, there is no method to test this validity. The Sargan test for over-identifying restrictions is not applicable in this case since the errors are not independently and identically distributed. However, the Arellano-Bond test for serial correlation in the first-differenced errors at order 2 confirms the hypothesis of no serial correlation in the first-differenced errors.[30]

As already underlined, the parameter of interest in each case is $\hat{\beta}_3$, whose expected sign is negative. Its empirical assessment provides a first empirical test, on average and *ceteris paribus*, worldwide and in the long-run, of consumption behaviour under risk.

Table 1 shows the outcomes for the baseline consumption model (Eq. [8]) of our cross-country empirical estimates. Outcomes are presented for the entire sample of countries and the entire period (1950-2009), by deciles and by decades. As is apparent from the table, our permanent consumption model fits well the empirical data. In all the empirical exercises the Arellano Bond test strongly supports the hypothesis of no serial correlation in the errors. All coefficients are significant and show the expected signs. The estimated long-run marginal and average propensity to consume is closer to one in all the proposed versions of the baseline model (recall that $k = \hat{\beta}_1/(1 - \hat{\beta}_2)$).

[29]The assumption that the disturbances of a panel model are cross-sectionally independent is often inappropriate (so called "pure heteroschedasticity"). Provided that the unobservable common factors are uncorrelated with the explanatory variables, the coefficient estimates from standard panel estimators are still consistent (but inefficient). However, standard error estimates of commonly applied covariance matrix estimation techniques are biased and hence statistical inference that is based on such standard errors is invalid (see Driscoll and Kraay, 1998; Hoechle, 2007).

[30]Please note that rejecting the null hypothesis of no serial correlation in the first-differenced errors at order zero does not imply model misspecification because the first-differenced errors are serially correlated if the idiosyncratic errors are independent and identically distributed. It is only rejection of the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one which implies model misspecification.

Looking at the estimates by deciles, developing countries show, as expected, the highest sensitivity of consumption to current income.

Table 1:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (baseline model)

Baseline	All	1960-69	1970-79	1980-89	1990-99	2000-09				
pc gdp worker (log)	0.240***	0.242***	0.238***	0.322***	0.442***	0.287***				
	(6.05)	(5.48)	(3.68)	(4.26)	(9.88)	(6.23)				
L. pc consumption (log)	0.756***	0.720***	0.722***	0.624***	0.484***	0.668***				
	(23.31)	(13.84)	(9.49)	(7.09)	(9.29)	(12.68)				
N	8005	1090	1409	1537	1745	1642				
ArellanoBond Test	0.628	1.938	-0.282	-1.317	1.101	1.037				
Prob$\geq$z	0.530	0.055	0.778	0.188	0.271	0.300				
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*				
Baseline	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
pc gdp worker (log)	0.201***	0.195***	0.270***	0.193***	0.158***	0.197***	0.215***	0.133***	0.141**	0.0284
	(6.09)	(4.63)	(7.99)	(4.03)	(4.96)	(5.38)	(3.32)	(5.10)	(2.64)	(1.40)
L. pc consumption (log)	0.762***	0.775***	0.675***	0.775***	0.817***	0.772***	0.752***	0.847***	0.842***	0.971***
	(18.02)	(15.57)	(15.62)	(13.71)	(21.12)	(18.25)	(9.98)	(27.93)	(13.85)	(43.63)
N	769	803	778	740	749	738	696	764	827	559
ArellanoBond Test	0.602	-0.755	-0.317	-1.246	1.146	1.169	0.761	-0.811	0.960	-0.676
Prob $\geq$z	0.547	0.450	0.751	0.213	0.252	0.242	0.447	0.417	0.337	0.499
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

Table 2 reports the estimates for our various proxies of aggregate consumption and income volatility (again for the entire sample of countries and the entire period, by decades and by deciles). For brevity, the parameters for the baseline consumption regression of the volatility exercises are not reported in the table (they do not show significant changes across the various volatility models) and only outcomes for volatility of lengths 5 and 10 are reported. According to the outcomes of Table 2, cross-country and in the long-run, the coefficients of all the reported measures of consumption volatility show, on average and *ceteris paribus*, a robust negative relationship with current per capita consumption. Hence, they suggest that the standard permanent consumption model actually suffers for omitted variables bias if one does not control for consumption volatility, highlighting the presence of a significant amount of extra saving. If we break down our panel by decades (going backwards from the last available observation)[31] we noticed this negative relationship holds only from the nineties onwards (hence, it seems to be a very recent phenomenon). If we look at the estimates by deciles (i.e., controlling for income heterogeneity) we notice that the phenomenon is ro-

[31]We set up the following decades: decade 1 (1960-1969); decade 2 (1970-1979); decade 3 (1980-1989); decade 4 (1990-1999); decade 5 (2000-2009). Results for decade 1950-1959 are not available since we cannot observe consumption volatility for d periods ahead.

bust across deciles (with the exception of deciles 2 and 4), highlighting the presence of extra-saving in the poorest countries also.

Table 2:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (proxies for consumption volatility)

Proxies of consumption volatility (*)	All	1960-69	1970-79	1980-89	1990-99	2000-09
pc cons_vol_d5	-0.337***	-0.523**	-0.539**	-0.278	-0.379**	-0.352**
	(-5.11)	(-2.59)	(-2.78)	(-0.91)	(-2.80)	(-2.60)
pc cons_vol_d10	-0.457***	-0.306	-0.423	-0.636	-0.862***	-0.583**
	(-4.38)	(-0.69)	(-1.30)	(-0.74)	(-4.75)	(-2.83)
pc consinn_vol_d5	-0.326***	-0.165	-0.514*	-0.303	-0.461**	-0.311*
	(-4.60)	(-0.82)	(-2.47)	(-0.92)	(-3.09)	(-2.52)
pc consinn_vol_d10	-0.523***	0.0330	-0.442	-0.856	-0.952***	-0.619***
	(-5.25)	(0.07)	(-1.03)	(-1.21)	(-5.38)	(-3.35)
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Proxies of consumption volatility (*)	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
pc cons_vol_d5	-0.136*	0.0855	-0.249*	-0.0212	-0.579	-0.473**	-0.426*	-0.232	0.0712	-0.0878***
	(-2.22)	(0.72)	(-2.56)	(-0.24)	(-1.71)	(-3.13)	(-2.18)	(-1.69)	(0.57)	(-4.53)
pc cons_vol_d10	0.157	-0.218	-0.380**	0.118	-0.795*	-0.473	-0.838**	-0.204	-0.737***	-0.175***
	(0.90)	(-1.25)	(-2.63)	(0.71)	(-2.23)	(-1.92)	(-2.67)	(-1.64)	(-5.39)	(-3.84)
pc consinn_vol_d5	-0.170*	0.0796	-0.238	-0.0437	-0.583	-0.448**	-0.391*	-0.187	-0.213*	-0.105***
	(-2.13)	(0.64)	(-1.96)	(-0.62)	(-1.71)	(-2.78)	(-2.15)	(-1.32)	(-2.43)	(-5.55)
pc consinn_vol_d10	0.158	-0.194	-0.376*	0.100	-0.923**	-0.458	-0.785**	-0.223	-0.683***	-0.283***
	(0.99)	(-1.08)	(-2.20)	(0.58)	(-2.62)	(-1.74)	(-3.26)	(-1.69)	(-4.30)	(-6.65)
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

The same negative relationship holds, cross-country on average and *ceteris paribus*, between per capita consumption and our various proxies of income volatility Table 3. However, this relationship turns out to be significant, overall, for larger d and less spread out across income deciles (it is significant in deciles 4, 5, 7, 8 and 9). Finally, consistent with the estimates on consumption volatility, estimates by decades confirm this relationship to be a very recent phenomenon.

Tables 4 and 5 provide estimates for the various sub-components of consumption and income volatility (see Appendix C). The first four rows of both tables show the coefficients for both permanent and transitory shocks. It is worth noting that they are not significant if we look at the entire sample and period of observation. However, they turn out to be significant by income deciles, even if positively correlated with consumption in the lowest deciles. Furthermore, our estimates consistently highlight that permanent shocks are significant larger in magnitude than transitory ones. The decomposition between normal and extreme volatility of consumption is significant too (see from the 5th to the 8th rows). Its significance holds for the en-

Table 3:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (proxies for income volatility)

Proxies of income volatility (*)	All	1960-69	1970-79	1980-89	1990-99	2000-09				
pc gdp_vol_d5	-0.193	-0.200	-0.224	0.130	-0.274	-0.872***				
	(-1.24)	(-0.69)	(-1.16)	(0.54)	(-0.60)	(-4.05)				
pc gdp_vol_d10	-0.312*	0.161	-0.366	0.516	-0.503	-1.291***				
	(-2.41)	(0.26)	(-0.97)	(1.18)	(-0.98)	(-3.51)				
pc gdpinn_vol_d5	-0.217	0.0826	-0.437	0.0661	-0.248	-0.718***				
	(-1.28)	(0.31)	(-1.67)	(0.32)	(-0.49)	(-4.08)				
pc gdpinn_vol_d10	-0.403*	0.631	-0.384	-0.0350	-0.533	-1.482***				
	(-2.41)	(0.78)	(-0.94)	(-0.12)	(-1.00)	(-3.35)				
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*				
Proxies of income volatility (*)	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
pc gdp_vol_d5	-0.140	0.103	-0.521***	-0.344	-0.266	-0.452	-0.370	-0.185**	0.233***	0.0102
	(-0.94)	(1.01)	(-4.21)	(-1.41)	(-1.32)	(-1.59)	(-1.91)	(-2.76)	(4.94)	(0.02)
pc gdp_vol_d10	0.250*	-0.0149	-0.969***	-0.156	-0.613***	-0.784	-1.384*	-0.327**	-0.340*	0.307*
	(2.17)	(-0.12)	(-5.33)	(-0.63)	(-7.22)	(-1.60)	(-2.23)	(-2.75)	(-2.23)	(2.35)
pc gdpinn_vol_d5	-0.176	0.0819	-0.527***	-0.226	-0.214	-0.496	-0.522*	-0.164**	-0.0517	-0.285
	(-1.00)	(0.63)	(-3.67)	(-1.14)	(-1.06)	(-1.50)	(-2.10)	(-2.70)	(-1.15)	(-1.50)
pc gdpinn_vol_d10	0.215	-0.0525	-1.078***	-0.231	-0.708***	-1.061	-1.385*	-0.352**	-0.256	-0.181
	(1.69)	(-0.31)	(-4.89)	(-0.90)	(-7.64)	(-1.85)	(-2.03)	(-2.70)	(-1.58)	(-1.02)
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

tire sample and is widespread across deciles. The decomposition of extreme volatility between crisis and boom volatility (respectively, the extreme fluctuations above and below a specified band, see Appendix B) is significant too. Also in this case, in the lowest decile, normal volatility is positively correlated with consumption, while extreme, and especially crisis volatility, are negatively correlated. It must be noted as well that all the above decompositions are more significant from the nineties onwards. Estimates on income volatility are consistent with those of consumption volatility even if, as usual, slightly less significant (Table 5). However, a significant and positive correlation between permanent and transitory innovation of income is not only confirmed for the lowest income decile but becomes the net effect for the entire sample. In the lowest income deciles crisis volatility is confirmed to be an issue in the case of income volatility also.

To summarise, our long-run cross-country empirical exercise reports substantial evidence of a robust negative relation between observed per capita consumption and macro-volatility (especially in consumption and to a lesser extent in income), on average and *ceteris paribus*, for long panel data and a large sample of "representative agents" in different countries (147 countries). It suggests the need to be aware of a likely omitted variable bias in

Table 4:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (consumption volatility decomposition))

consumption vol decomposition (*)	All	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10	1960-69	1970-79	1980-89	1990-99	2000-09
pc cons_varperm_d5	-0.0787	5.032***	-0.876	-2.536**	4.727	-4.522	-0.504	-2.958	-2.845*	0.406	-1.913	5.287	-1.116	-3.943	2.510	2.058
	(-0.05)	(14.75)	(-0.25)	(-2.91)	(1.76)	(-0.85)	(-0.41)	(-0.94)	(-2.54)	(0.15)	(-0.92)	(1.15)	(-0.81)	(-1.38)	(0.96)	(1.61)
pc cons_vartrans_d5	0.131	2.161***	-0.519	-1.045**	2.215	-1.272	0.0853	-0.899	-1.386**	-0.369	-0.918	1.842	-0.422	-1.676	1.255	1.100*
	(0.19)	(11.96)	(-0.32)	(-3.09)	(1.77)	(-0.61)	(0.15)	(-0.73)	(-2.75)	(-0.38)	(-1.06)	(0.91)	(-0.69)	(-1.39)	(1.02)	(2.02)
pc cons_varperm_d10	1.873	9.425***	-4.816	-6.748***	-3.524	-2.453	-8.902*	1.401	-0.221	-4.414	-4.045	1.745	1.252	-7.163***	6.621	2.572*
	(0.83)	(12.16)	(-0.74)	(-4.15)	(-0.93)	(-0.67)	(-2.21)	(0.29)	(-0.12)	(-1.67)	(-1.85)	(0.77)	(0.10)	(-4.30)	(1.82)	(1.98)
pc cons_vartrans_d10	0.560	2.206***	-0.845	-1.298***	-0.405	0.00680	-1.692	0.168	-0.147	-0.758	-0.670	0.512	0.217	-1.490***	1.440	0.829**
	(1.10)	(13.48)	(-0.58)	(-4.01)	(-0.45)	(0.01)	(-1.92)	(0.16)	(-0.47)	(-1.41)	(-1.39)	(1.00)	(0.08)	(-4.36)	(1.80)	(2.99)
pc cons_normvol_d5	-1.180**	-7.413	-3.025	-1.290	2.334	4.739**	-5.223***	0.475	-1.473	15.25*	3.812	1.311	4.297	-0.770	-1.787	-2.913
	(-2.82)	(-1.41)	(-1.24)	(-0.84)	(1.39)	(3.22)	(-14.02)	(0.23)	(-0.60)	(2.12)	(1.48)	(0.83)	(1.18)	(-0.34)	(-1.15)	(-1.81)
pc cons_extvol_d5	-0.518*	0.842	1.444	0.0872	-0.854	-3.331	-0.398***	-1.231***	-0.470	0.142**	-0.197	-2.758	-2.379	-0.667	-0.476	-0.650**
	(-2.47)	(0.58)	(1.59)	(0.11)	(-1.48)	(-1.58)	(-3.85)	(-3.73)	(-1.67)	(2.71)	(-1.77)	(-1.67)	(-1.81)	(-1.35)	(-0.87)	(-3.17)
pc cons_normvol_d10	0.601	14.94*	-15.63***	3.048	1.602	-5.321*	1.021	-3.633	-1.935	-16.05	2.168	-5.197	-5.180	-11.05*	3.430	-0.498
	(0.23)	(2.43)	(-3.44)	(0.94)	(0.36)	(-2.36)	(1.46)	(-0.50)	(-1.80)	(-1.11)	(0.89)	(-0.38)	(-1.27)	(-2.35)	(0.50)	(-0.27)
pc cons_extvol_d10	-0.950***	-2.346*	2.382	-1.274*	0.223	-1.747	-0.873**	-1.533*	-0.174	-3.996	-0.476***	-0.810	-1.251	0.280	-2.302*	-0.974*
	(-3.37)	(-2.06)	(1.74)	(-2.45)	(0.26)	(-1.87)	(-2.91)	(-2.03)	(-0.51)	(-1.33)	(-36.27)	(-0.18)	(-1.49)	(0.15)	(-2.44)	(-2.34)
pc cons_boomvol_d5	-0.227	1.316	1.681	0.144	0.000749	-3.191***	-2.007***	-0.983*	0.0489	-5.995***	-0.0186	-7.583**	-8.334**	-0.935	0.561	-1.178***
	(-0.60)	(0.82)	(1.32)	(0.18)	(0.00)	(-4.37)	(-16.34)	(-2.15)	(0.07)	(-7.12)	(-0.03)	(-3.02)	(-2.66)	(-0.48)	(0.95)	(-4.29)
pc cons_crisvol_d5	-0.873**	-0.115	0.950	-0.00612	-2.286	-3.507	1.346***	-1.727	-0.932	5.898***	-0.452	1.281	3.207	-0.470	-2.677*	0.0420
	(-2.90)	(-0.07)	(0.52)	(-0.01)	(-1.88)	(-0.76)	(5.20)	(-1.52)	(-1.48)	(7.44)	(-0.55)	(0.49)	(0.94)	(-0.53)	(-2.04)	(0.10)
pc cons_boomvol_d10	-0.669	0.425	2.333	-2.055*	0.139	-0.708	-3.225***	1.764	-0.514**	-5.033	-0.904***	2.421	-8.550*	-2.192	-0.237	-2.197*
	(-1.25)	(0.39)	(1.38)	(-2.09)	(0.14)	(-1.11)	(-5.97)	(0.92)	(-2.60)	(-0.69)	(-3.34)	(0.26)	(-1.96)	(-0.60)	(-0.16)	(-2.26)
pc cons_crisvol_d10	-1.812**	-5.651*	2.605	-0.431	0.334	-4.223	0.854	-5.148**	0.0832	-3.295	0.199	-4.236	2.899	2.040	-6.296**	-0.203
	(-3.19)	(-2.49)	(0.65)	(-0.37)	(0.17)	(-1.07)	(1.11)	(-2.80)	(0.13)	(-1.83)	(0.53)	(-0.40)	(1.65)	(1.28)	(-2.96)	(-0.22)
FE year	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

Table 5:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (income volatility decomposition))

income vol decomposition (*)	All	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10	1960-69	1970-79	1980-89	1990-99	2000-09
pc gdp_varperm_d5	0.624	3.869***	-1.382	-8.191***	-4.801*	-6.809	-7.452***	0.721	0.234	0.395	10.56	0.999	-3.250	0.481	2.679	1.535
	(0.43)	(13.67)	(-0.33)	(-3.98)	(-2.53)	(-1.26)	(-4.60)	(0.98)	(0.20)	(0.17)	(1.64)	(0.21)	(-1.08)	(0.17)	(1.57)	(1.77)
pc gdp_vartrans_d5	0.355	1.637***	-0.213	-2.830***	-2.226*	-2.558	-2.788***	0.538	-0.0244	0.152	3.995	-0.0467	-0.804	0.274	1.221	0.718*
	(0.59)	(10.55)	(-0.13)	(-3.36)	(-2.27)	(-1.17)	(-4.52)	(1.41)	(-0.04)	(0.15)	(1.63)	(-0.02)	(-0.68)	(0.24)	(1.56)	(2.12)
pc gdp_varperm_d10	4.573**	7.193***	-10.38	-4.800	1.539	2.376	-5.153	0.478	-3.533	-7.994**	-8.411	4.573**	-23.64	-16.57*	12.28	6.180
	(3.05)	(4.81)	(-0.81)	(-0.66)	(0.18)	(0.26)	(-1.51)	(0.07)	(-0.64)	(-2.85)	(-1.70)	(3.05)	(-1.80)	(-2.49)	(1.61)	(1.36)
pc gdp_vartrans_d10	1.207**	1.746***	-2.190	-1.332	0.661	0.894	-1.260	0.00127	-0.662	-1.571**	-1.695	1.207**	-5.321*	-3.578**	2.914	1.627
	(3.15)	(4.76)	(-0.81)	(-0.85)	(0.35)	(0.43)	(-1.75)	(0.00)	(-0.64)	(-2.84)	(-1.69)	(3.15)	(-1.97)	(-2.65)	(1.77)	(1.73)
pc gdp_normvol_d5	-3.717**	-4.223**	4.354***	-7.407***	-8.187*	-6.096***	-3.298	3.267	-6.283***	15.70***	-32.90	-2.316	6.974	3.050	-3.549*	-12.00*
	(-3.14)	(-2.77)	(3.95)	(-4.87)	(-2.04)	(-6.37)	(-0.57)	(0.50)	(-4.34)	(8.08)	(-1.52)	(-0.45)	(1.82)	(0.56)	(-2.17)	(-2.32)
pc gdp_extvol_d5	-0.0312	-0.246	-0.656	-0.325	-1.275	1.465*	-1.412	-2.882	0.175**	0.00106	9.618	-0.579	-1.023	0.0555	0.936	-1.693
	(-0.07)	(-0.62)	(-0.95)	(-0.64)	(-1.10)	(1.97)	(-0.86)	(-1.12)	(2.77)	(0.03)	(0.78)	(-0.34)	(-1.31)	(0.16)	(0.61)	(-1.76)
pc gdp_normvol_d10	-1.522	0.897	-0.0706	-14.28*	7.133*	-0.945	-5.046	9.412	-3.706*	-0.338	80.97***	-8.511	-1.565	8.961	-10.17	7.527
	(-0.64)	(0.29)	(-0.02)	(-2.15)	(2.22)	(-0.13)	(-1.22)	(0.82)	(-2.55)	(-0.06)	(7.49)	(-0.82)	(-0.29)	(0.89)	(-1.28)	(1.20)
pc gdp_extvol_d10	-0.582	0.774	0.367	-1.787	-3.608*	-1.721*	-5.405	-8.532**	-0.149	-3.310	-9.982*	3.326	-1.696	1.680	0.773	-6.777***
	(-0.98)	(1.02)	(0.33)	(-1.33)	(-2.16)	(-2.06)	(-1.14)	(-3.00)	(-1.22)	(-1.16)	(-2.06)	(0.67)	(-0.60)	(0.98)	(0.97)	(-3.92)
pc gdp_boomvol_d5	-2.089*	1.139*	0.704	-1.032	-0.0491	-6.376***	-0.378	-9.094	-0.555	-6.039*	17.50	-9.220**	-12.82***	-4.103	-2.523	-1.351
	(-2.51)	(2.33)	(0.53)	(-0.88)	(-0.02)	(-8.64)	(-0.15)	(-1.58)	(-1.48)	(-2.18)	(0.97)	(-2.71)	(-3.54)	(-1.38)	(-1.93)	(-1.21)
pc gdp_crisvol_d5	1.167	-1.987*	-2.398	0.744	-2.654	5.586***	-1.855	0.918	0.553**	3.878*	-0.716	3.647	5.170*	1.837	3.696	-2.246
	(1.11)	(-2.30)	(-1.92)	(0.52)	(-1.35)	(4.68)	(-1.12)	(0.46)	(2.91)	(2.20)	(-0.14)	(1.26)	(2.37)	(1.14)	(1.52)	(-1.49)
pc gdp_boomvol_d10	-0.495	4.287**	2.855	-1.775	-0.143	-13.32***	-10.98	-7.233*	4.226***	-5.613	-19.35***	0.0132	-4.455	4.699	0.811	-5.104*
	(-0.28)	(3.02)	(1.59)	(-0.75)	(-0.17)	(-3.30)	(-1.53)	(-2.31)	(3.36)	(-1.65)	(-3.74)	(0.00)	(-1.18)	(1.06)	(0.24)	(-2.48)
pc gdp_crisvol_d10	-0.629	-4.476***	-2.422	-1.809	-6.554**	4.014*	-1.979	-11.76*	-2.009***	-0.938	-3.051	5.711	0.529	0.682	0.749	-8.620**
	(-0.61)	(-4.32)	(-1.40)	(-0.61)	(-3.18)	(2.29)	(-0.45)	(-2.23)	(-4.10)	(-0.38)	(-0.32)	(0.83)	(0.14)	(0.33)	(0.29)	(-3.27)
FE year	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

performing analysis on permanent consumption without controlling for risk. However, the analysis of standardised coefficients[32], reported in Table 6 for all the sample and last decade of the analysis, demonstrates that the relative impact of observed volatility on consumption is low. Hence, even if our results are consistent with the previous empirical literature on the issue and with the theory of precautionary saving, we cannot support empirically the hypothesis made by Loayza et al., (2007) of a substantial welfare loss if deviating from a smooth path of consumption. Nevertheless, our analysis suggests that countries in the lower deciles of the distribution register in the long-run, on average and ceteris paribus, also lower current consumption (i.e., "extra savings") because of aggregate volatility, especially crisis volatility. This evidence holds across decades but has become more significant in recent years.

4.2 An Autoregressive Distributed Lags (ARDL) version of the consumption model

According to the permanent income hypothesis, consumption should track income over the life-cycle and predictable life-cycle changes in income help predict consumption changes. This is assumed in an aggregate framework thanks to the turnover of generations which transmits income growth into consumption growth (Deaton, 1992). However, in the short-run, data show excess sensitivity of current consumption to current income (i.e., a relative higher sensibility of consumption to its transitory component, which is likely linked to imperfect information and the correlated small individual mistakes in consumption choices). As detected in Table 2, this issue is particular evident, on average and ceteris paribus, for the poorest countries in the sample. It means technically that, according to the permanent income hypothesis, consumption and total income are co-integrated (consumers take some time to adjust their consumption towards the long run equilibrium). In this respect, even if consistent with the theory of permanent consumption and precautionary saving, the above estimates need improvements. The GMM Arellano and Bond estimates focus only on the long-term relation between consumption

[32]standardised coefficients are the estimates resulting from an analysis carried out on standardised variables. This is usually done to address the issue of which independent variable has a greater effect on the dependent variable in a multiple regression analysis, when the variables are measured in different units of measurement.

Table 6:

Dynamic Panel Estimates with MA(1) specification - dep.var: log of pc consumption (standardised coefficients for all countries)

1960-2009	Baseline	Proxies of consumption volatility (*)				Proxies of income volatility (*)			
pc gdp worker (log)	0.257***	0.260***	0.327***	0.266***	0.329***	0.226***	0.275***	0.232***	0.282***
	(6.25)	(7.09)	(8.14)	(7.21)	(8.37)	(7.06)	(9.37)	(7.49)	(9.90)
L. pc consumption (log)	0.758***	0.748***	0.684***	0.744***	0.686***	0.766***	0.709***	0.760***	0.709***
	(23.70)	(25.60)	(20.45)	(25.00)	(21.11)	(22.56)	(21.92)	(22.99)	(21.85)
pc cons_vol_d5		-0.0122***							
		(-3.38)							
pc cons_vol_d10			-0.0189***						
			(-3.54)						
pc consinn_vol_d5				-0.0116**					
				(-3.20)					
pc consinn_vol_d10					-0.0187***				
					(-3.67)				
pc gdp_vol_d5						-0.007			
						(-1.24)			
pc gdp_vol_d10							-0.011*		
							(-2.41)		
pc gdpinn_vol_d5								-0.008	
								(-1.28)	
pc gdpinn_vol_d10									-0.014*
									(-2.41)
N	8005	7144	6270	6973	6089	7075	6167	6893	5986
ArellanoBond Test	0.680	0.704	0.750	0.569	0.686	0.781	0.845	0.678	0.934
P≥z	0.496	0.481	0.453	0.569	0.492	0.434	0.398	0.497	0.350
FE year	*yes*		*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*

2000-2009	Baseline	Proxies of consumption volatility (*)				Proxies of income volatility (*)			
pc gdp worker (log)	0.396***	0.260***	0.448***	0.420***	0.461***	0.409***	0.449***	0.403***	0.469***
	(5.80)	(7.09)	(5.50)	(6.02)	(5.52)	(6.67)	(7.60)	(5.99)	(7.71)
L. pc consumption (log)	0.651***	0.748***	0.586***	0.617***	0.577***	0.633***	0.589***	0.640***	0.572***
	(12.34)	(25.60)	(8.24)	(10.50)	(7.89)	(12.90)	(11.56)	(11.81)	(10.52)
pc cons_vol_d5		-0.0122***							
		(-3.38)							
pc cons_vol_d10			-0.0258**						
			(-2.59)						
pc consinn_vol_d5				-0.0136*					
				(-2.07)					
pc consinn_vol_d10					-0.0264**				
					(-2.94)				
pc gdp_vol_d5						-0.0273**			
						(-3.18)			
pc gdp_vol_d10							-0.0385**		
							(-3.02)		
pc gdpinn_vol_d5								-0.0210**	
								(-3.00)	
pc gdpinn_vol_d10									-0.0433**
									(-2.87)
N	1642	1636	1573	1634	1550	1634	1566	1631	1542
ArellanoBond Test	1.062	1.120	0.882	0.971	0.777	1.146	0.965	0.942	0.849
P≥z	0.288	0.263	0.378	0.331	0.437	0.252	0.335	0.346	0.396
FE year	*yes*		*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*

(*) reported standard errors below the corresponding coefficients are robust to heteroskedasticity and income (although the moment conditions use first-differenced errors, the Arellano-Bond procedure estimates the coefficients of the level model), taking account of the role of cyclical movements via the autocorrelation component of the errors. It does not provide a full account of the separate (short term and long term) components of consumption function as well as the adjustment mechanism that links short term and long term consumption-income equilibria. Moreover, Fisher-type tests suggest "unit-root" problems even when cross-sectional averages and linear time trends are taken explicitly into account.[33] A suitable way to provide more robust empirical estimates of the above link is to apply an Autoregressive Distributed Lags (ARDL) consumption function. By applying an Error Correction Model (ECM), this framework is able to link both the short term and long term components of consumption function in a way which is consistent with the standard stylised facts on consumption (i.e., consumption proportional to permanent income in the long-run and to current income in the short-run, see section 3).[34]

The generic form of the Autoregressive Distributed Lags-ARDL (p,q) process applied to consumption function is the following:

$$C_t = \beta_0 + \beta_1 Y_t + \beta_2 Y_{t-1} + ... + \beta_p Y_{t-p} + \gamma_1 C_{t-1} + \gamma_q C_{t-q} + u_t$$

The aim is to reach a version of this ARDL process with errors white noise and the minimum amount of lags. To this end, we start applying the following ARDL (1,1) process:

$$C_t = \beta_0 + \beta_1 Y_t + \beta_2 Y_{t-1} + \beta_3 C_{t-1} + u_t \tag{18}$$

[33] Following up Im–Pesaran–Shin (IPS) approach, Fisher test performs a unit-root test on each panel's series separately, then combine the p-values to obtain an overall test of whether the panel series contains a unit root. The starting point for the test is a set of Dickey–Fuller regressions of the form: $\Delta Y_{it} = \phi_i Y_{it-1} + Z_{it}\gamma_i + \varepsilon_{it}$ where ϕ_i is panel-specific. The null hypothesis is $H_0 : \phi_i = 0$ for all i versus the alternative $H_a : \phi_i < 0$. $Z_{it}\gamma_i$ represent panel-specific means (fixed effects) and linear time trends that describes the process by which the series is generated. Our test uses Newey–West (1987) standard errors (i.e., based on heteroskedasticity- and autocorrelation-consistent covariance matrix estimator) to account for serial correlation.

[34] An ECM is commonly used when both short-run dynamics and long-run economic relationship among the variables need to be considered. A formal explanation of the dependent variable variations is attempted in terms of the function of the explanatory variable variations, and the delayed deviation in the theoretical relationship. Also, the ECM specification allows all the available information to be extracted from the data without infringing, a priori, the classical hypotheses and, if the equilibrium relation has been correctly specified, the long-run deviation series will be stationary (Engle and Granger, 1987).

Eq.(18) can be transformed as follows:

$$C_t - C_{t-1} = \Delta C_t = \beta_0 + \beta_1 \Delta Y_t + (\beta_2 + \beta_1) Y_{t-1} + (\beta_3 - 1) C_{t-1} + u_t \quad (19)$$

From Eq.(18) we can derive also the steady state equation as follows[35]:

$$C^* = \frac{\beta_0}{(1-\beta_3)} + \frac{\beta_1 + \beta_2}{(1-\beta_3)} Y^* \quad (20)$$

where $\frac{\beta_1+\beta_2}{(1-\beta_3)}$ is the long term propensity of consumption β. Hence $\beta_2 = \beta(1-\beta_3) - \beta_1$. Thus, if one takes into account the steady state (long term) equilibrium in Eq.(19), it can be transformed as follows:

$$\Delta C_t = \beta_0 + \beta_1 \Delta Y_t + (1-\beta_3)[C_{t-1} - \beta Y_{t-1}] + u_t \quad (21)$$

where $[C_{t-1} - \beta Y_{t-1}]$ is the error correction mechanism (Hendry, 1995; Hamilton, 1994); β is the long term parameter; β_1 is the short term parameter (it is attached to variables in differences) and $(1-\beta_3)$ is the speed of the adjustment process from short term to long term equilibrium (the EC term).

Eq. (21) can be estimated without constraints as follows:

$$\Delta Ct = \beta_0 + \beta_1 \Delta Y_t - (1-\beta_3) C_{t-1} - \beta(1-\beta_3) Y_{t-1} + u_t \quad (22)$$

Hence, the following empirical model can be derived:

$$\Delta Ct = \delta_0 + \delta_1 \Delta Y_t + \delta_2 C_{t-1} + \delta_3 Y_{t-1} + u_t \quad (23)$$

where:
$\delta_0 = \beta_0$ [the constant]
$\delta_1 = \beta_1 = c$ [the short run propensity of consumption]
$\delta_2 = -(1-\beta_3) =$ [i.e. the EC term]
$\delta_3 = \beta(1-\beta_3)$ [where β is the long term propensity of consumption]

The consistency of this model with permanent consumption theory is generally acknowledged by the following empirical condition $-\delta_2 = \delta_3$ (i.e.,

[35] It is worth recalling here that in steady state variables are supposed to be in equilibrium at a constant level as follows:
$C_t = C_{t-1} = C^*$ and $Y_t = Y_{t-1} = Y^*$

$\beta = 1$). Since in equilibrium, $\sigma^2_{id} = 0$ by definition, we can test the role of macro-volatility (as a proxy of uncertainty) similarly to what already done in Eq. (11) and Eq.(17), as follows:

$$\Delta c_{it} = \delta_0 + \delta_1 \Delta y_{it} + \delta_2 c_{it-1} + \delta_3 y_{it-1} + \delta_4 \sigma^2_{id} + u_{it} \tag{24}$$

where c_{it} and y_{it} are natural logs of real per capita income and consumption for each country i; σ^2_{id} is, as usual, the rolling volatility of consumption/income income over length d, proxied, as usual, by the standard deviation of the first differences of per capita consumption/income (Aizeman & Pinto, 2005, Wolf, 2005) together with measures of volatility of /consumption/income life time innovations, as well as the differentiated impacts of various decomposition methods based on Hnatkovska & Loayza (2005) and (Carroll and Samwick, 1997) (see Appendix B). δ_4 is now the parameter of interest, whose expected sign cannot however be determined *a priori*. According to Eq. (16), for a representative consumer, it should be positive since an increase in uncertainty is supposed to be associated with higher consumption growth (which is assumed to reflect higher saving). As Guiso et al. (1992) and Carroll and Samwick (1995) suggest, however, uncertainty is not supposed to depress consumption forever. Holding more wealth is the appropriate response. To this end, while a consumer facing higher uncertainty will initially have to depress consumption more in order to build up larger stock of wealth, in the steady state of a buffer-stock saving model there should be no apparent relation between uncertainty and current consumption across consumers already holding the optimal buffer stock (Hubbard et al., 1994). As a result, since our estimates cannot control for household wealth, we cannot determine the sign of δ_4 *a priori*

To estimate the unconstrained Eq. (24) and to control also for possible measurement errors in the data, we rely again on the consistent GMM estimator (Arellano and Bond, 1991). Unlike the previous estimates, Eq. (24) now takes explicitly into account the impact of the short term fluctuations of income on consumption other than their long term relationship, as well as the speed of adjustment of consumption to its long term level. Hence, the residuals of our ARDL specification are not expected to show any systematic component.[36] Furthermore, Fisher type tests now confirm the absence of a

[36] According to Engle and Granger (1987)'s contribution, if a long term relationship of two (or more than two) non stationary variables exists, there is also a cointegration relationship (i.e., a stationary linear combination) between them.

"unit-root" problem. However, here we assume again volatility as a predetermined variable to control for the likely correlation between volatility and errors determined by replacing expected values with observed means. We thus apply four lags to be considered as valid instruments. Furthermore, as in the level equation, an additional moment condition has been applied constructed as the third lag of the dependent variable. It should be noted that in this case also the first differentiation procedure removes any time invariant components of the model. To address the issue of time-varying unobserved heterogeneity we control however for time variant fixed effects. Finally, we control for heteroskedasticity for the spatial dependence of panel data.

Tab.7 shows the outcomes for our ARDL baseline model. The ARDL estimates are consistent with the permanent theory of consumption too. All coefficients are significant and show the right signs. Again, the consumption smoothing hypothesis holds across countries (this is now demonstrated by the condition: $-\delta_3 = \delta_4$) while the Arellano-Bond test shows high significance for absence of serial correlation in the errors. The significant lower speed of adjustment to the long-term equilibrium of the poorest and richest countries in the sample should be noted as well (see the dynamic across deciles of the parameter δ_2).

From Table 8 the negative incidence of volatility in depressing current consumption is confirmed in the poorest countries in the sample (they show a significant and positive impact of 10 year consumption volatility on consumption growth). This coupled with a slow pace of adjustment to the long-term equilibrium can produce in the medium-term a negative incidence of volatility in consumption perspectives for these countries. Conversely for some of the other countries gathered in different deciles - and for the overall sample - a significant negative relationship between volatility and consumption growth is apparent from our estimates. This empirical evidence is apparently at odds with what is expected by the theory of precautionary saving. However, as underlined above, since we cannot control for household stock of wealth we cannot actually have a clear expectation about the sign of the volatility/consumption relationship in our empirical exercise. Furthermore, empirical cross-country studies have consistently found that macro-volatility exerts a significant negative impact on long-run growth (see, among others, Loayza et al., 2007). The most common explanation is that the negative income growth volatility nexus in a long run perspective has indirect welfare cost by hampering future consumption possibilities. Other possible explanations are the presence of risky assets (Dercon, 2004; Elbers et al., 2009;

Table 7:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (baseline model)

Baseline	All	1960-69	1970-79	1980-89	1990-99	2000-09
diff pc gdp worker (log)	0.661***	0.534***	0.579***	0.618***	0.842***	0.770***
	(12.84)	(4.42)	(6.56)	(10.83)	(10.91)	(5.23)
L. pc consumption (log)	-0.131***	-0.242***	-0.153***	-0.238***	-0.296***	-0.253***
	(-6.53)	(-4.18)	(-3.42)	(-5.30)	(-4.22)	(-6.84)
L. pc gdp worker (log)	0.114***	0.219***	0.118**	0.189***	0.291***	0.268***
	(5.43)	(4.03)	(3.23)	(3.76)	(3.74)	(6.08)
cons	0.0301	-0.107	0.116	0.126	-0.354	-0.459**
	(0.36)	(-0.71)	(0.55)	(0.52)	(-1.61)	(-3.06)
N	7990	1089	1406	1531	1743	1640
ArellanoBond Test	0.888	1.776	-0.168	-0.319	0.941	1.162
Prob ≥z	0.482	0.077	0.866	0.749	0.347	0.245
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Baseline	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
diff pc gdp worker (log)	0.740***	0.589***	0.817***	0.674***	0.616***	0.877***	0.897***	0.575***	0.684***	0.736**
	(6.56)	(4.34)	(9.06)	(4.27)	(11.75)	(5.94)	(3.98)	(4.47)	(4.95)	(3.07)
L. pc consumption (log)	-0.0947***	-0.130***	-0.153***	-0.169***	-0.119*	-0.108***	-0.197***	-0.110***	-0.0504***	-0.0308***
	(-3.54)	(-4.81)	(-3.53)	(-4.79)	(-2.22)	(-3.73)	(-4.31)	(-8.01)	(-6.13)	(-5.48)
L. pc gdp worker (log)	0.0484*	0.131***	0.123*	0.179***	0.120	0.120***	0.210***	0.112***	0.0583***	0.0176
	(2.22)	(4.49)	(2.48)	(5.32)	(1.92)	(3.94)	(3.84)	(5.62)	(5.85)	(0.90)
cons	0.231	-0.148	0.0429	-0.301	-0.165	-0.258**	-0.400	-0.178	-0.141*	0.116
	(1.65)	(-1.34)	(0.18)	(-1.82)	(-0.65)	(-2.94)	(-1.64)	(-1.08)	(-2.04)	(0.51)
N	769	803	777	738	745	735	695	763	827	557
ArellanoBond Test	-0.462	0.781	0.497	-0.908	1.281	1.062	0.767	1.165	0.371	0.00819
Prob ≥z	0.644	0.435	0.619	0.364	0.200	0.288	0.443	0.244	0.710	0.993
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

Gunning, 2010) as well as likely transfers of wealth from poorer to richer households, the latter characterised by lower marginal propensity to consume. Hence, if these arguments hold, a negative sign for the coefficient δ_4 is plausible too. Results for consumption volatility are confirmed by Table 9with respect to income volatility (i.e., a significant and positive sign of 10 year income volatility in the case of decile 1 and a significant and negative sign overall and for some countries gathered in different deciles). Finally, the analysis by decades in both our empirical exercises (on consumption and income volatility) confirm that the significance of the relationship between volatility and consumption is a recent phenomenon.

Likewise, consistent with the previous estimates, Table 10 and Table 11 confirm that permanent shocks are much larger than transitory ones, while a negative and robust relationship between consumption growth and extreme (and crisis volatility) holds, especially in the poorest countries (deciles 1 and 2. Finally, the usual breakdown of panel data by decades confirms the increased significance of the phenomenon in the last decade.

Last but not least, Tab.12 confirm (for brevity only outcomes for the entire sample and last decade of the analysis are reported), a low relative

Table 8:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (proxies of consumption volatility)

Proxies of consumption volatility (*)	All	1960-69	1970-79	1980-89	1990-99	2000-09
pc cons_vol_d5	-0.159***	-0.409*	-0.279*	-0.229	-0.245*	-0.218*
	(-3.37)	(-2.16)	(-2.01)	(-0.91)	(-2.48)	(-2.08)
pc cons_vol_d10	-0.313**	-0.287	0.000959	-0.496	-0.613**	-0.426*
	(-2.58)	(-0.77)	(0.00)	(-0.85)	(-2.61)	(-2.37)
pc consinn_vol_d5	-0.235*	0.0739	-0.0124	-0.197	-0.396**	-0.411**
	(-2.44)	(0.40)	(-0.08)	(-0.62)	(-2.97)	(-2.61)
pc consinn_vol_d10	-0.326**	-0.388	0.264	-0.271	-0.630**	-0.463**
	(-2.75)	(-0.66)	(0.82)	(-0.46)	(-2.80)	(-2.62)
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Proxies of consumption volatility (*)	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
pc cons_vol_d5	-0.125	0.0673	-0.298***	0.0772	-0.330	-0.290*	-0.400*	-0.0952	0.00941	-0.0207
	(-1.95)	(0.72)	(-3.80)	(0.80)	(-1.51)	(-2.38)	(-2.20)	(-1.32)	(0.16)	(-0.57)
pc cons_vol_d10	0.205***	-0.0530	-0.242**	-0.00485	-0.341	-0.407	-0.797*	-0.141	-0.669	-0.0416
	(4.25)	(-0.35)	(-2.83)	(-0.03)	(-1.77)	(-1.39)	(-2.09)	(-1.38)	(-1.93)	(-0.39)
pc consinn_vol_d5	0.0140	0.0481	-0.240**	-0.123	-0.162	-0.379	-0.410*	-0.0706	-0.00535	-0.00601
	(0.34)	(0.48)	(-3.29)	(-1.28)	(-0.52)	(-1.96)	(-2.10)	(-1.21)	(-0.06)	(-0.12)
pc consinn_vol_d10	0.214***	-0.0199	-0.219*	-0.0430	-0.385*	-0.425	-0.690**	-0.141	-0.648	-0.185***
	(4.71)	(-0.12)	(-2.26)	(-0.23)	(-2.06)	(-1.42)	(-2.66)	(-1.17)	(-1.83)	(-4.60)
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

Table 9:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (proxies of income volatility))

Proxies of income volatility (*)	All	1960-69	1970-79	1980-89	1990-99	2000-09
pc gdp_vol_d5	-0.165**	0.158	0.0410	0.160	-0.0196	-0.741**
	(-2.86)	(0.59)	(0.30)	(0.75)	(-0.08)	(-2.69)
pc gdp_vol_d10	-0.244*	0.0353	-0.00866	0.380	-0.397	-0.758*
	(-2.47)	(0.08)	(-0.03)	(0.75)	(-1.33)	(-2.16)
pc gdpinn_vol_d5	-0.195**	0.399	-0.0412	0.0856	0.0386	-0.648*
	(-2.89)	(1.17)	(-0.24)	(0.44)	(0.16)	(-2.29)
pc gdpinn_vol_d10	-0.267*	0.104	-0.0172	0.400	-0.402	-0.799*
	(-2.47)	(0.17)	(-0.05)	(0.63)	(-1.24)	(-2.07)
FE year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Proxies of income volatility (*)	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
pc gdp_vol_d5	-0.0520	0.130	-0.472***	-0.248	-0.191	-0.353	-0.335	-0.129	0.165	0.0955
	(-0.87)	(1.72)	(-4.61)	(-0.92)	(-1.65)	(-1.24)	(-1.76)	(-1.35)	(1.03)	(0.29)
pc gdp_vol_d10	0.177*	0.0772	-0.689***	-0.231	-0.516***	-0.538	-1.208	-0.140	-0.249***	0.362
	(2.40)	(0.85)	(-3.71)	(-0.73)	(-5.41)	(-1.01)	(-1.68)	(-1.64)	(-5.32)	(1.70)
pc gdpinn_vol_d5	-0.0514	0.184	-0.455***	-0.215	-0.128	-0.390	-0.390	-0.137	0.129	-0.172
	(-0.71)	(1.95)	(-4.39)	(-0.86)	(-0.95)	(-1.09)	(-1.74)	(-1.36)	(0.98)	(-1.24)
pc gdpinn_vol_d10	0.157*	0.133	-0.716**	-0.348	-0.546***	-0.690	-0.910	-0.146	-0.217***	-0.125
	(2.02)	(1.05)	(-3.21)	(-1.05)	(-6.77)	(-1.16)	(-1.38)	(-1.54)	(-3.31)	(-0.53)
FE year	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

Table 10:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (consumption volatility decomposition)

consumption vol decomposition (*)	All	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10	1960-69	1970-79	1980-89	1990-99	2000-09
pc cons_varperm_d5	0.197	3.351***	0.378	-1.449**	3.933	-1.600	0.719	0.151	-2.369	1.130	-0.751	3.610	-1.665*	-2.074	-0.443	3.198***
	(0.18)	(5.35)	(0.11)	(-2.90)	(1.93)	(-0.41)	(0.74)	(0.06)	(-1.47)	(0.60)	(-0.45)	(0.72)	(-2.28)	(-0.84)	(-0.19)	(3.65)
pc cons_vartrans_d5	0.192	1.496***	0.272	-0.681**	1.910*	-0.219	0.793	0.406	-1.200*	-0.383	-0.456	1.343	-0.706*	-0.828	-0.242	1.519***
	(0.42)	(4.45)	(0.18)	(-2.59)	(2.13)	(-0.14)	(1.66)	(0.44)	(-1.97)	(-0.65)	(-0.67)	(0.65)	(-2.07)	(-0.77)	(-0.24)	(3.57)
pc cons_varperm_d10	2.142	7.591***	-0.677	-3.680***	-7.573	3.660	-8.447*	-4.046	-0.516	2.761	-3.453**	2.142	1.040	-6.502***	3.983	6.510**
	(1.09)	(8.90)	(-0.16)	(-4.41)	(-0.90)	(1.60)	(-2.26)	(-0.52)	(-0.46)	(1.33)	(-2.80)	(1.09)	(0.09)	(-3.74)	(1.51)	(2.70)
pc cons_vartrans_d10	0.564	1.658***	-0.0205	-0.651***	-1.185	0.979*	-1.555*	-0.777	-0.176	0.740	-0.490	0.564	0.221	-1.359***	0.816	1.568**
	(1.32)	(9.67)	(-0.02)	(-3.63)	(-0.61)	(2.12)	(-2.05)	(-0.44)	(-1.02)	(1.65)	(-1.96)	(1.32)	(0.09)	(-3.60)	(1.45)	(3.09)
pc cons_normvol_d5	-0.839*	-6.520*	-2.623	0.665	3.533*	2.346*	-4.874***	-0.211	-1.608	7.024*	6.050**	-1.424	1.892	-1.122	-2.246*	-3.125*
	(-2.30)	(-2.56)	(-1.37)	(0.92)	(2.12)	(2.07)	(-6.32)	(-0.18)	(-1.21)	(2.11)	(2.74)	(-1.03)	(0.89)	(-0.77)	(-2.11)	(-2.06)
pc cons_extvol_d5	-0.346*	1.313	0.802	-0.978**	-1.302	-1.322	-0.374***	-1.144	-0.146	0.0182	-0.111	-0.345	-0.792	-0.422	-0.349	-0.605**
	(-2.45)	(1.66)	(0.93)	(-2.72)	(-1.81)	(-0.67)	(-3.77)	(-1.70)	(-0.74)	(0.07)	(-1.57)	(-0.30)	(-1.71)	(-0.87)	(-0.93)	(-2.71)
pc cons_normvol_d10	-1.498	8.414***	-11.47***	-1.228	0.423	-13.04**	-0.000268	-2.692	-1.906	-13.63	4.384	-15.53	-0.0202	-11.79**	-2.265	-3.048**
	(-0.74)	(3.58)	(-3.84)	(-0.75)	(0.12)	(-3.08)	(-0.00)	(-0.24)	(-1.27)	(-1.35)	(0.71)	(-1.70)	(-0.00)	(-2.94)	(-0.32)	(-2.70)
pc cons_extvol_d10	-0.502*	-1.059	1.926	-0.542	-0.00935	2.735*	-0.660	-1.831	-0.114	-3.359	-0.222*	0.921	-0.720	0.403	-1.216	-0.749*
	(-2.14)	(-1.55)	(1.83)	(-1.61)	(-0.01)	(2.26)	(-1.48)	(-1.43)	(-0.72)	(-0.82)	(-2.42)	(0.24)	(-1.60)	(0.40)	(-0.89)	(-1.97)
pc cons_boomvol_d5	-0.252	0.511	-0.708	-0.716**	-0.885	-0.00342	-1.442***	-0.746*	0.724	-4.736**	-1.357	-3.259	-2.085**	-0.102	0.00348	-1.266***
	(-1.09)	(0.80)	(-0.88)	(-2.61)	(-1.60)	(-0.00)	(-7.58)	(-2.20)	(1.47)	(-2.77)	(-1.00)	(-1.41)	(-3.20)	(-0.14)	(0.01)	(-3.93)
pc cons_crisvol_d5	-0.565	0.478	2.176	-1.272*	-1.582	1.489	0.813*	-1.890	-0.947**	3.002**	1.657	1.829	0.840	-0.658	-1.348	0.303
	(-1.70)	(1.12)	(1.57)	(-2.49)	(-1.93)	(0.84)	(2.27)	(-1.13)	(-2.80)	(2.74)	(1.00)	(0.96)	(0.72)	(-1.17)	(-1.03)	(0.64)
pc cons_boomvol_d10	-0.521	-0.292	1.017	-3.027*	-0.932	3.886**	-3.162***	1.067	-0.536	-3.807	-1.724***	-0.113	-10.94***	-0.302	-1.035	-1.870**
	(-1.40)	(-0.41)	(0.96)	(-2.49)	(-1.14)	(3.06)	(-9.40)	(0.39)	(-0.88)	(-0.43)	(-3.43)	(-0.02)	(-3.51)	(-0.17)	(-0.49)	(-2.68)
pc cons_crisvol_d10	-0.813*	-1.974	5.671	1.956	1.145	0.142	1.279	-5.115**	0.204	-3.030	2.164**	2.042	4.921**	0.899	-1.809	0.645
	(-2.07)	(-1.60)	(1.77)	(1.77)	(0.65)	(0.06)	(1.57)	(-2.66)	(0.29)	(-1.01)	(2.80)	(0.29)	(3.10)	(0.78)	(-1.20)	(0.80)
FE year	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

Table 11:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (income volatility decomposition)

income vol decomposition (*)	All	dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10	1960-69	1970-79	1980-89	1990-99	2000-09
pc gdp_varperm_d5	1.068	2.137***	-0.708	-4.840*	-4.977	-5.623	-3.557*	1.922*	1.336	2.004	9.654**	2.961	-2.591	3.925	-0.924	2.739**
	(1.44)	(5.73)	(-0.25)	(-2.28)	(-1.66)	(-1.24)	(-2.17)	(2.56)	(1.72)	(0.84)	(2.60)	(0.67)	(-0.96)	(1.21)	(-0.38)	(3.19)
pc gdp_vartrans_d5	0.467	0.983***	0.210	-1.180	-2.062	-2.232	-1.039	0.863**	0.435	0.685	2.907**	0.861	-0.649	1.651	-0.458	1.203**
	(1.48)	(4.63)	(0.21)	(-1.38)	(-1.48)	(-1.21)	(-1.16)	(2.96)	(1.24)	(0.66)	(2.69)	(0.48)	(-0.66)	(1.22)	(-0.42)	(3.28)
pc gdp_varperm_d10	4.566***	5.773***	-7.559	-11.36	8.917	9.070	-3.897	-4.843	0.705	-1.732	-11.77	4.566***	-15.83	-12.97*	5.223	8.184
	(3.39)	(7.64)	(-0.85)	(-1.43)	(0.87)	(0.95)	(-1.17)	(-0.79)	(0.14)	(-1.24)	(-1.89)	(3.39)	(-1.40)	(-2.44)	(0.71)	(1.93)
pc gdp_vartrans_d10	1.138***	1.323***	-1.583	-2.212	2.169	2.321	-0.799	-1.011	0.247	-0.285	-2.328	1.138***	-3.630	-2.668*	1.420	1.906*
	(3.53)	(7.98)	(-0.86)	(-1.40)	(0.99)	(1.07)	(-1.23)	(-0.73)	(0.26)	(-1.01)	(-1.80)	(3.53)	(-1.55)	(-2.47)	(0.92)	(2.17)
pc gdp_normvol_d5	-1.661	-1.062	5.555***	-0.238	-10.51**	-3.884***	0.202	0.843	-3.304	6.361**	-31.07	2.433	0.636	2.529	-1.526	-9.661**
	(-1.53)	(-0.78)	(4.50)	(-0.07)	(-3.04)	(-6.97)	(0.04)	(0.12)	(-1.92)	(3.08)	(-1.55)	(0.97)	(0.17)	(0.59)	(-1.35)	(-2.95)
pc gdp_extvol_d5	-0.0623	-0.139	-1.424*	-2.041*	-0.293	0.900**	-2.111	-2.592	-0.140	0.0509	11.80	-0.719	0.00317	-0.145	0.751	-1.805*
	(-0.28)	(-0.46)	(-2.06)	(-2.00)	(-0.16)	(2.76)	(-1.46)	(-1.07)	(-0.63)	(0.19)	(1.20)	(-0.48)	(0.01)	(-0.59)	(0.88)	(-1.96)
pc gdp_normvol_d10	-0.165	-1.069	1.453	-4.981	10.34***	-5.951	-13.52*	19.21*	-1.801	-7.292	31.03***	-1.993	-4.066	10.62	-6.612	7.456
	(-0.08)	(-0.47)	(0.47)	(-0.81)	(3.36)	(-1.10)	(-2.32)	(2.02)	(-1.33)	(-1.30)	(3.99)	(-0.27)	(-0.86)	(0.78)	(-1.53)	(1.38)
pc gdp_extvol_d10	-0.719	0.869	0.0107	-2.935*	-5.137**	-1.067	-1.815	-10.45***	-0.115	-0.440	2.833	0.834	-0.151	0.606	-0.0822	-5.052**
	(-1.30)	(1.55)	(0.01)	(-2.31)	(-2.64)	(-1.66)	(-0.44)	(-3.70)	(-1.17)	(-0.29)	(0.57)	(0.23)	(-0.06)	(0.47)	(-0.15)	(-2.72)
pc gdp_boomvol_d5	-1.193	0.524	-0.486	-2.282	1.231	-6.778***	2.698	-9.206	0.683	-0.423	17.35	-5.020	-2.233	1.294	-2.792	-0.138
	(-1.36)	(1.11)	(-0.40)	(-1.32)	(0.44)	(-7.93)	(1.91)	(-1.71)	(0.50)	(-0.21)	(1.20)	(-1.65)	(-1.02)	(0.34)	(-1.94)	(-0.12)
pc gdp_crisvol_d5	0.607	-1.079**	-2.600*	-1.677	-1.971	5.089***	-4.305**	1.715	-0.570	0.356	4.091	1.428	1.315	-0.764	3.614**	-4.350**
	(0.76)	(-2.87)	(-2.08)	(-1.81)	(-1.42)	(6.28)	(-2.79)	(1.33)	(-1.09)	(0.24)	(1.03)	(0.61)	(0.99)	(-0.42)	(2.82)	(-3.04)
pc gdp_boomvol_d10	-0.565	2.599***	2.127	-5.724***	0.451	-12.51***	-2.979	-9.326**	2.020	-1.485	-5.772	-9.504	-2.174	0.660	-1.235	-1.431
	(-0.41)	(3.87)	(1.50)	(-5.32)	(0.48)	(-5.32)	(-0.69)	(-3.09)	(1.56)	(-0.60)	(-1.07)	(-1.05)	(-0.53)	(0.21)	(-0.60)	(-0.70)
pc gdp_crisvol_d10	-0.801	-1.655*	-2.512*	1.855	-10.24***	4.881**	-1.085	-13.28**	-1.007	0.528	9.219	7.768	1.204	0.587	0.656	-8.985***
	(-1.24)	(-2.05)	(-1.99)	(0.89)	(-4.93)	(3.06)	(-0.20)	(-2.59)	(-1.59)	(0.70)	(0.78)	(1.63)	(0.38)	(0.39)	(0.88)	(-4.15)
FE year	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

(*) variables tested in different models; reported standard errors below the corresponding coefficients are robust to heteroskedasticity

impact of observed volatility on consumption growth as is apparent from the reported standardised beta coefficients.

5 Conclusion

In contrast to previous works on the issue, we perform an empirical strategy grounded on a consumption model based on the permanent income hypothesis and take explicitly into account the role of persistence in consumption and income volatility. Our empirical model confirms that macro-volatility plays, in the long-run (1950-2009), on average and *ceteris paribus*, a significant role in deviating consumption from its smoothing path and in reducing future consumption perspectives. This empirical evidence holds across deciles and decades, including the poorest ones, and is becoming more significant in recent years.

This work confirms, on one hand, the results made by previous empirical literature and suggests the need to be aware of a likely omitted variable bias in performing analysis on permanent consumption without controlling for precautionary saving. On the other hand, it supports the Lucas(1987)' view that the cost of fluctuations should be perceived to be low in terms of welfare implications. It is worth noting, however, that in the poorest countries in the sample the reduction of current consumption induced by macrovolatility is coupled with a low speed of adjustment to the long-term equilibrium, with negative welfare implications in the medium-run.

Our empirical evidence provides new insights into the long standing debate about the costs of fluctuations. First, it shows that the poorest countries hold a significant amount of "extra saving", in a long-run perspective, because of economic fluctuations. Second, it underlies that, on average, uncertainty affects not only the volatility of consumption around its mean but the mean itself (Elbers and Gunning, 2003) thus hampering future consumption prospects.

Table 12:

ARDL Panel Estimates, dependent variable: log difference of pc consumption (standardised coefficients for all countries)

1960-2009	Baseline	Proxies of consumption volatility (*)				Proxies of income volatility (*)			
diff pc gdp worker (log)	0.520***	0.528***	0.537***	0.508***	0.543***	0.507***	0.532***	0.503***	0.532***
	(12.84)	(11.64)	(11.81)	(11.46)	(11.94)	(11.37)	(12.01)	(11.37)	(12.23)
L. pc consumption (log)	-1.646***	-1.648***	-2.298***	-2.014***	-2.347***	-1.664***	-2.033***	-1.844***	-2.110***
	(-6.53)	(-5.59)	(-5.69)	(-6.79)	(-6.95)	(-5.90)	(-6.84)	(-7.26)	(-9.12)
L. pc gdp worker (log)	1.522***	1.657***	2.099***	1.800***	2.131***	1.472***	1.860***	1.660***	1.956***
	(5.43)	(5.05)	(5.35)	(6.24)	(6.85)	(4.87)	(5.96)	(6.27)	(8.46)
cons	0.389**	0.0282	-0.0988	-0.0340	-0.0590	-0.0814	-0.0642	-0.0133	-0.0133
	(3.29)	(0.41)	(-1.55)	(-0.54)	(-0.85)	(-1.21)	(-1.06)	(-0.21)	(-0.21)
pc cons_vol_d5		-0.107***							
		(-3.37)							
pc cons_vol_d10			-0.202**						
			(-2.58)						
pc consinn_vol_d5				-0.151*					
				(-2.44)					
pc consinn_vol_d10					-0.202**				
					(-2.75)				
pc gdp_vol_d5						-0.0633			
						(-1.55)			
pc gdp_vol_d10							-0.101		
							(-1.92)		
pc gdpinn_vol_d5								-0.0621	
								(-1.46)	
pc gdpinn_vol_d10									-0.0850
									(-1.49)
N	7990	7131	6268	6960	6087	7075	6167	6893	5986
ArellanoBond Test	1687	1674	1681	1719	1669	1726	1681	1719	1669
P≥z	-5.473	-5.575	-5.391	-5.628	-5.266	-5.359	-4.998	-5.272	-4.862
FE year	0.374	0.328	0.375	0.393	0.427	0.300	0.321	0.351	0.308
2000-2009	Baseline	Proxies of consumption volatility (*)				Proxies of income volatility (*)			
diff pc gdp worker (log)	0.606***	0.632***	0.589***	0.603***	0.589***	0.562***	0.583***	0.583***	0.587***
	(5.23)	(5.86)	(5.37)	(5.97)	(5.36)	(5.74)	(5.42)	(5.81)	(5.46)
L. pc consumption (log)	-3.186***	-3.764***	-3.576***	-3.557***	-3.764***	-3.225***	-3.275***	-3.113***	-3.439***
	(-6.84)	(-6.15)	(-4.51)	(-5.45)	(-3.68)	(-4.97)	(-4.55)	(-4.96)	(-4.70)
L. pc gdp worker (log)	3.578***	3.938***	3.198***	3.211***	3.056***	2.862***	2.884***	2.835***	2.742***
	(6.08)	(5.82)	(4.65)	(5.13)	(3.88)	(4.69)	(4.79)	(4.58)	(5.10)
cons	-0.0397	0.136	0.157	0.231*	0.216	0.0961	0.128	0.182*	0.0712
	(-0.30)	(1.46)	(1.27)	(2.31)	(1.52)	(1.00)	(1.15)	(2.10)	(0.59)
pc cons_vol_d5		-0.155*							
		(-2.18)							
pc cons_vol_d10			-0.274*						
			(-2.37)						
pc consinn_vol_d5				-0.195*					
				(-2.17)					
pc consinn_vol_d10					-0.381**				
					(-3.00)				
pc gdp_vol_d5						-0.345**			
						(-2.71)			
pc gdp_vol_d10							-0.357*		
							(-2.20)		
pc gdpinn_vol_d5								-0.306*	
								(-2.33)	
pc gdpinn_vol_d10									-0.346*
									(-2.03)
N	1640	1635	1572	1633	1549	1634	1566	1631	1542
ArellanoBond Test	1.162	1.260	1.036	1.116	0.927	1.278	1.123	1.080	1.013
P≥z	0.245	0.207	0.300	0.264	0.354	0.201	0.261	0.280	0.311
FE year	*yes*		*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*

(*) reported standard errors below the corresponding coefficients are robust to heteroskedasticity

References

[1] Ando, A. and Modigliani, F. (1963). The life cycle hypothesis of savings: Aggregate implications and tests. *American Economic Review*, 53, 55-84.

[2] Acemoglu, D., S., Johnson, J., Robinson, & Y., Thaicharoen (2003). Institutional causes, macroeconomic symptoms: volatility, crises and growth.*Journal of Monetary Economics*, 5(1), 49-123.

[3] Agenor, P., R., C., J., McDermott, & E., S., Prasad (2000). Macroeconomic fluctuations in developing countries: some stylized facts. *World Bank Economic Review*, 14(2), 251-285

[4] Aizenman, J., & N., Marion (1999). Volatility and Investment: Interpreting Evidence from Developing Countries. *Economica*, 66, 157-79

[5] Aizenman, J., & B. Pinto (eds) (2005). *Managing economic volatility and crises: a practitioner's guide*. Cambridge: Cambridge University Press.

[6] Alesina A., R., Hausmann, R., & Hommes, E., Stein (1999). Budget institutions and fiscal performance in Latin America. *Journal of Development Economics*, 59, 253–273.

[7] Arellano, M., and S. Bond. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies* 58: 277–297.

[8] Arellano, M., and O., Bover (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics* 68: 29–51.

[9] Asdrubali P., and Kim, S. (2008). Incomplete Intertemporal Consumption Smoothing and Incomplete Risk Sharing. *Journal of Money, Credit and Banking*, 40:7.

[10] Battistin, E., R., Blundell & A., Lewbel (2007). *Why is Consumption More Log Normal Than Income? Gibrat's Law Revisited*, mimeo.

[11] Bekaert, G., C., R., Harvey & C., Lundblad (2004). *Growth volatility and financial liberalization*. mimeo, Duke University.

[12] Bernanke, B., (2005). *The Global Saving Glut and the U.S. Current Account Deficit*. Remarks at the Sandrige Lecture, Virginia Association of Economics, Richmond: Virginia, March, 10.

[13] Bertola, G., & R., J., Caballero (1994). Irreversibility and Aggregate Investment. *The Review of Economic Studies*, 61(2), 223-246.

[14] Blackburn, K., & A., Pelloni (2004). On the relationship between growth and volatility. *Economics Letters*, 83, 123–127.

[15] Blackburn K. and A. Pelloni (2005). Growth, cycles, and stabilization policy. *Oxford Economic Papers*, 57, 262–282.

[16] Blundell, R., and S., Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87: 115–143.

[17] Bordo M., D. (2005). Historical Perspective on Global Imbalances. NBER Working Paper Series, No. 11383, Cambridge MA: National Bureau of Economic Research.

[18] Broner, F. and Ventura, J.(2011). Globalization and risk sharing. *Review of Economic Studies* 78(1), 49-82.

[19] Caballero R., J., (1990), Consumption Puzzles and Precautionary Savings, *Journal of Monetary Economics* 25, 113-136.

[20] Caballero R., J., (1991), On the Sign of the Investment-Uncertainty Relationship. *The American Economic Review*, 81(1), 279-288.

[21] Caballero R., J., & A., Krishnamurthy (2009). Global Imbalances and Financial Fragility. NBER Working Paper Series, No. 14688. Cambridge MA: National Bureau of Economic Research.

[22] Caldern, C. and R., Fuentes (2010). *Characterizing the Business Cycles of Emerging Economies*. Policy Research Working Paper, 5343, The World Bank, DC, June.

[23] Campbell, J., (1987). Does Saving Anticipate Declining Labor Income? An Alternative Test of the Permanent Income Hypothesis. *Econometrica*, 55, 1249-73.

[24] Carroll, C.D., (1992). The buffer-stock theory of saving: some macroeconomic evidence. *Brookings Papers on Economic Activity* 1992 (2), 61–156.

[25] Carroll, C., D. (1998). How Important Is Precautionary Saving?, *Review of Economics and Statistics*, 80(3), 410-419.

[26] Carroll, C., D. (2000). Requiem for the Representative Consumer? Aggregate Implications of Microeconomic Consumption Behaviour. *The American Economic Review*. 90(2), 110-115.

[27] Carroll, C., D. (2001a). A theory of the consumption function with and without liquidity constraints. *The Journal of Economic Perspectives*, 15(3), 23-45.

[28] Carroll, C., D. (2001b). *Death to the Log-Linearized Consumption Euler Equation! (And Very Poor Health to the Second-Order Approximation)*, Advances in Macroeconomics: Vol. 1: No. 1, Article 6.

[29] Carroll, C., D., & A., A., Samwick (1997), The nature of precautionary wealth, *Journal of Monetary Economics* 40 (1997) 41-71

[30] Carroll, C., D., & O., Jeanne (2009). *A Tractable Model of Precautionary Reserves, Net Foreign Assets, or Sovereign Wealth Funds*. mimeo;

[31] Carroll, C., D., & M., S., Kimball (2008). "Precautionary saving and precautionary wealth." in Durlauf, S., N., & L., E., Blume (Eds.). *The New Palgrave Dictionary of Economics*. Second Edition. Palgrave Macmillan.

[32] Claessens, S., S., Evenett, & B., Hoekman (2010). *Rebalancing the Global Economy: A Primer for Policymaking*. London: VoxEU.org publication.

[33] Constantinides, G., & D., Duffie (1996). Asset Pricing with Heterogeneous Consumers. *Journal of Political Economy*, 104(2), 219-40.

[34] Crucini, M., J. and Hess, G., D. (2000). *International and Intranational risk sharing*. in Hess, G., D. and Van Wincoop, E., Intranational macroeconomics, Cambridge University Press, Cambridge, UK.

[35] Deaton, A. (1987). Life-Cycle Models of Consumption: Is the Evidence Consistent with the Theory? In Truman F., B. (eds) *Advances*

in Econometrics, Fifth World Congress, Vol.2, Cambridge University Press, Cambridge and New York.

[36] Deaton, A. (1992). *Understanding consumption*. Clarendon, Oxford

[37] Dercon S., (2003) (ed). *Insurance Against Poverty*. Oxford University Press.

[38] Demir, F. (2009). Financial liberalization, private investment and portfolio choice: Financialization of real sectors in emerging markets. *Journal of Development Economics*, 88, 314-324.

[39] Denizer, C., M., P., Iyigun, & A., L., Owen (2002). Finance and macroeconomic volatility. *Contributions to Macroeconomics*, 2(1).

[40] Dewatripont, M., X., Freixas & R., Portes (eds) (2009). *Macroeconomic Stability and Financial Regulation: Key Issues for the G20*. Centre for Economic Policy Research (CEPR).

[41] Dynan, K. E., (1993), How prudent are consumers? *Journal of Political Economy*, 101(6), 1104-1113.

[42] Driscoll, J., and A., C., Kraay (1998). Consistent covariance matrix estimation with spatially dependent data. *Review of Economics and Statistics*, 80: 549-56.

[43] Easterly, W.R., R., Islam, & J.E., Stiglitz (2001). *Shaken and Stirred: Explaining Growth Volatility*. In Pleskovic B. & N., Stern (eds) Annual Bank Conference on Development Economics 2000, Washington, DC: World Bank, 191-211.

[44] Elbers, C., & J., W., Gunning (2003). *Vulnerability in a stochastic dynamic model*. Tinbergen Institute Discussion Paper, 070/2, Amsterdam (NL): Department of Economics, Tinbergen Institute.

[45] Elbers, C., J., W., Gunning & L. Pan (2009). Growing out of Poverty under Risk: Evidence from Rural Ethiopia. mimeo. Department of Economics: University of Amsterdam.

[46] Engle, R. and Granger, C. (1987) Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica* 55,251-276.

[47] Fatás, A. (2000) Do business cycles cast long shadows? short-run persistence and economic growth. *Journal of Economic Growth*, 5, 147–162.

[48] Fatás, A., & I., Mihov (2005). *Policy Volatility, Institutions and Economic Growth*. CEPR Discussion Paper No 5388.

[49] Ferreira da Silva, G. (2002). The impact of financial system development on business cycles volatility: cross-country evidence. *Journal of Macroeconomics*, 24, 233-253.

[50] Flavin, M. (1981). The adjustment of consumption to changing expectations about future income. *Journal of Political Economy*, 89, 974-1009.

[51] Friedman, M. (1957). *A theory of the consumption function*. Princeton: Princeton University Press.

[52] Furth S. B., (2010). *Terms of Trade Volatility and Precautionary Savings in Developing Economies*. mimeo.

[53] Gavin, M., & R., Hausmann (1996). *Sources of Macroeconomic Volatility in Developing Economies*. mimeo, Inter-American Development Bank: Washington DC.

[54] Ghosh, A., R., & J., D., Ostry (1995). The Current Account in Developing Countries: A Perspective from the Consumption-Smoothing Approach. *The World Bank Economic Review*, 9(2), 305-333.

[55] Ghosh, A., R., & J., D., Ostry (1997). Macroeconomic Uncertainty, Precautionary Saving, and the Current Account. *Journal of Monetary Economics*, 40, 121-139.

[56] Giles, J., & K., Yoo (2007). Precautionary Behavior, Migrant Networks, and Household Consumption Decisions: An Empirical Analysis Using Household Panel Data from Rural China. *The Review of Economics and Statistics*, 89(3), 534–551.

[57] Gourinchas, P. (2000). *Precautionary Savings, the Life Cycle, and Macroeconomics*. Unpublished manuscript, Princeton University.

[58] Guiso, L., Jappelli, T., Terlizzese, D., (1992). Earnings uncertainty and precautionary saving. *Journal of Monetary Economics* 30, 307-337.

[59] Gunning J., W., (2010). Risk and savings: A taxonomy. *Economics Letters*, 107, 39–41.

[60] Hall, R., E. (1978). Stochastic implications of the life cycle-permanent income hypothesis: theory and evidence. *Journal of Political Economy*, 96, 971-87.

[61] Hamilton, J., D. (1994), *Time Series Analysis*, Princeton University Press.

[62] Heaton, J., & D., Lucas (1996). Evaluating the Effects of Incomplete Markets on Risk Sharing and Asset Pricing. *Journal of Political Economy*, 104(3), 443-87.

[63] Hnatkovska, V., & N., Loayza (2005). Volatility and growth. In Aizenman, J. and B. Pinto (eds), *Managing volatility and economic crises: a practitioner's guide*. New York: Cambridge University Press.

[64] Hoechle, D., (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal*, 7(3), 281-312

[65] Holtz-Eakin, D., W. Newey, and H. S. Rosen. 1988. Estimating vector autoregressions with panel data. *Econometrica*, 56: 1371–1395.

[66] Hubbard, R., G., Skinner, J., S. and Zeldes, S., P. (1994). *The importance of precautionary motives for explaining individual and aggregate saving*. In: Meltzer, A.H., Plosser, C.I., (Eds.), Carnegie- Rochester Conference Series on Public Policy, Vol. 40, 59 126.

[67] Judson, R., & A., Orphanides (1999). Inflation,Volatility and Growth. *International Finance*, 2(1), 117–138.

[68] Kimball, M., S. (1990). Precautionary saving in the small and in the large. *Econometrica*, 58, 53–73.

[69] Knight, F., H. (1921). *Risk, Uncertainty, and Profit.*

[70] Kose, M. A., Prasad E., S. & Terrones, M., E. (2003). *Financial integration and macroeconomic volatility*. IMF Staff Papers, 50, Special Issue, International Monetary Fund.

[71] Kose, M. A., Prasad E., S. & Terrones, M., E. (2007). *How does financial globalization affect risk sharing? patterns and channels*. IMF Working Papers, 07-238, International Monetary Fund.

[72] Kose, M. A., Prasad E., S. & Terrones, M., E. (2009). Does financial globalization promote risk sharing? *Journal of Development Economics*, 89(2), 258-270.

[73] Kose, M. A., Prasad E., S. & Taylor, A., D. (2011). Thresholds in the process of in- ternational financial integration. *Journal of International Money and Finance*, 30(1), 147-179.

[74] Krusell, P., & A., Smith. (1998). Income and Wealth Heterogeneity in the Macroeconomy. *Journal of Political Economy*, 106 (5), 867-96.

[75] Lane, P., R., & G., M., Milesi-Ferretti (2007). The External Wealth of Nation Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities. *Journal of International Economics*, 73(2), 223-250.

[76] Lee, J. J., & Y. Sawada (2010). Precautionary saving under liquidity constraints: evidence from rural Pakistan. *Journal of Development Economics*, 91, 77–86.

[77] Lyhagen , J., (2001). The effect of precautionary saving on consumption in Sweden, *Applied Economics*, 33:5, 673-681.

[78] Loayza, N., V, R., Rancière, L., Servén & J., Ventura (2007). Macroeconomic volatility and welfare in developing countries: An introduction. *The World Bank Economic Review*, 21(3), 343-357.

[79] Lucas, R., E., Jr. (1987), *Models of Business Cycles,* New York, Basil Blackwell.

[80] Lucas, R., E., Jr. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22 (1), 3-42.

[81] Madsen, J., B. & Mcaleer, M. (2000). Direct Tests of the Permanent Income Hypothesis under Uncertainty, Inflationary Expectations and Liquidity Constraints. *Journal of Macroeconomics*, 22(2), 229-252.

[82] Malik, A., & J.R.W., Temple (2009). The geography of output volatility. *Journal of Development Economics*, 90 (2), 163-178.

[83] Merrigan, P., Normandin, M., 1996. Precautionary saving motives: an assessment from UK time series of cross-sections. *Economic Journal* 106, 1193–1208.

[84] Modigliani, F. and Brumberg, R. (1954), *Utility analysis and the consumption function: An interpretation of cross-section data*. In Kurihara. K. (ed.). Post-Keynesian Economics, New Brunswick, NJ: Rutgers University Press.

[85] Modigliani, F. and Brumberg, R. (1980). *Utility analysis and aggregate consumption functions: An attempt at integration*, in Abel, A. (ed.), Collected Papers of Franco Modigliani, Vol. 2, MIT Press, Cambridge.

[86] Morduch, J. (1994). Poverty and vulnerability. *The American Economic Review*, 84, 221-25.

[87] Montalbano, P., (2011). Trade Openness and Developing Countries' Vulnerability: Concepts, Misconceptions and Directions for Research. *World Development* 39(9), 1489-1502.

[88] Muellbauer, J. and Lattimore, R. (1995). The Consumption Function: A Theoretical and Empirical Overview. In Pesaran, M., H., and Wickens, M., R., *Handbook of Applied Econometrics, Macroeconomics*. Blackwell Publishers, Oxford (UK) and Cambridge (USA).

[89] Obstfeld, M. and Rogoff, K. (1996). Foundations of International Macroeconomics, The MIT Press, Cambridge (MA).

[90] Pallage, S., & M. A., Robe (2003) On the welfare cost of economic fluctuations in developing countries. *International Economic Review*, 44(2), 2003.

[91] Parker J., A. & B., Preston (2005). Precautionary Saving and Consumption Fluctuations. *American Economic Review*, 95(4), 1119-1143.

[92] Pierucci, E. and Ventura, L. (2012). *International risk sharing and globalization*, MPRA Paper No. 35869, online at http://mpra.ub.uni-muenchen.de/35869/.

[93] Raddatz, C., (2006), Are external shocks responsible for the instability of output in low-income countries? *Journal of Development Economics*.

[94] Ramey, G., & V., Ramey (1995). Cross-country evidence on the link between volatility and growth. *American Economic Review*, 85(5), 1138-51.

[95] Reis, R. (2009). The Time-Series Properties of Aggregate Consumption: Implications for the Costs of Fluctuations. *Journal of the European Economic Association*, 7(4), 722-753.

[96] Rodrik, D. (1998). Why do more open economies have bigger governments? *Journal of Political Economy*, 106(5), 997-1032.

[97] Rodrik, D. (1999). Where did all the growth go? External shocks, social conflict, and growth collapses. *Journal of Economic Growth*, 4(4), 385-412.

[98] Rosenzweig, M., & K., Wolpin (1993).Credit market constraints, consumption smoothing, and the accumulation of durable production assets in low-income countries: investments in bullocks in India. *Journal of Political Economy*, 101, 223-244

[99] Servén, L. (1997). Irreversibility, Uncertainty and Private Investment: Analytical Issues and Some Lessons for Africa. *Journal of African Economies*, 6 (3), 229–68

[100] Skinner. J. (1988), Risky income, life-cycle consumption and precautionary saving. *Journal of Monetary Economics,* 22, 237-255.

[101] Stiglitz J.E. (2004), The Roaring Nineties: A New History Of The World's Most Prosperous Decade, W W Norton & Co Inc.

[102] Townsend, R. (1994). Risk and insurance in village india. *Econometrica*, 62(3), 539-91.

[103] Townsend, R. (1995). Consumption insurance: an evaluation of risk-bearing systems in low-income economies. *The Journal of Economic Perspectives*, 9(3), 83-102.

[104] Weil. P.. (1990). Precautionary savings and the permanent income hypotheses. Mimeo. Harvard University. Cambridge. (MA).

[105] Wolf, H. (2005). Volatility: definitions and consequences. In Aizenman, J., and B., Pinto (eds), *Managing volatility and economic crises: a practitioner's guide*. New York: Cambridge University Press.

[106] Zeldes, S., P. (1989). Consumption and liquidity constraints: an empirical investigation. *Journal of Political Economy*, 97, 305–346.

[107] Zimmerman, F. J., M.R., Carter (2003). Asset smoothing, consumption smoothing and the reproduction of inequality under risk and subsistence constraints. *Journal of Development Economics*, 71(2), 233-60.

A The permanent consumption model and the cost of fluctuations

Starting from the basic intuition that households wish to smooth consumption and prevent it fluctuating with short run fluctuations in income, Friedman (1957) models consumption under the Permanent Income Hypothesis (PIH).

Friedman's (1957) model starts solving the following intertemporal choice problem:

$$\begin{cases} \max_{C_t} \sum_{t=0}^{\infty} \frac{u(C_t)}{(1+\delta)^t} \\ s.t. \sum_{t=0}^{\infty} \frac{C_t}{(1+r)^t} = \sum_{t=0}^{\infty} \frac{Y_t}{(1+r)^t} \end{cases} \tag{25}$$

where $u(C_t)$ is the "felicity function", r is the interest rate, δ is the so-called "time preference" (i.e. a subjective discount rate of consumption) and the constraint is simply the intertemporal budget constraint (i.e. the present value of consumption should be equal to the present value of income). The hypothesis of infinite time horizon is standard in macroeconomics and reasonable when the focus is on households and not on individuals.

To derive the Euler condition, it is sufficient to apply the following Lagrangian function:

$$\Lambda(C_t, \lambda) = \sum_{t=0}^{\infty} \frac{u(C_t)}{(1+\delta)^t} + \lambda\left(\sum_{t=0}^{\infty} \frac{Y_t}{(1+r)^t} - \sum_{t=0}^{\infty} \frac{C_t}{(1+r)^t}\right) \tag{26}$$

and derive the first order conditions:

$$\begin{cases} \frac{\partial \Lambda}{\partial C_t} = \frac{u'(C_t)}{(1+\delta)^t} - \frac{\lambda}{(1+r)^t} = 0 \\ \frac{\partial \Lambda}{\partial \lambda} = \sum\limits_{t=0}^{\infty} \frac{Y_t}{(1+r)^t} - \sum\limits_{t=0}^{\infty} \frac{C_t}{(1+r)^t} = 0 \end{cases} \tag{27}$$

where the second function is the intertemporal budget constraint. Denoting C_0 as current income, from the first condition, when $t = 0$, we can derive $u'(C_0) = \lambda$. Substituting it we obtain the Euler condition:

$$\frac{u'(C_t)}{(1+\delta)^t} = \frac{u'(C_0)}{(1+r)^t} \tag{28}$$

If we make the hypothesis of a logarithmic felicity function $U(C) = \ln C$, since $u'(C) = \frac{1}{C}$, the Euler Condition becomes[37]:

$$C_t = (\frac{1+r}{1+\delta})^t C_0 \tag{29a}$$

Substituting Eq. (29a) in Eq. (25), the intertemporal budget constraint can be expressed as follows:

$$C_0 \sum_{t=0}^{\infty} \frac{1}{(1+\delta)^t} = Y_0 + \sum_{t=1}^{\infty} \frac{1}{(1+r)^t} Y_t \tag{30}$$

If one makes the hypothesis of future incomes to be constant ($Y_t = Y_F \forall t \geq 1$) and since $\sum\limits_{t=0}^{\infty} \frac{1}{(1+\delta)^t} = \frac{1+\delta}{\delta}$Eq. (30) becomes:

$$C_0 = \frac{\delta}{1+\delta}(Y_0 + \sum_{t=1}^{\infty} \frac{1}{(1+r)^t} Y_F) \tag{31}$$

since $\sum\limits_{t=1}^{\infty} \frac{1}{(1+r)^t} = \frac{1}{r}$, we finally get:

$$C_0 = \frac{\delta}{1+\delta}(Y_0 + \frac{1}{r} Y_F) \tag{32}$$

[37]This is a special case of the CRRA specification of the felicity function, since $\lim_{\theta \longrightarrow 1} \frac{C^{1-\theta}}{1-\theta} = \ln(C)$ where $\theta = 1$.

Permanent income (Y_P) can be defined as the constant income level that has the same net present value as the actual income stream. Hence, it can be expressed as follows:

$$Y_0 + \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} Y_F = \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} Y_P \tag{33}$$

Eq. (31) can thus be rewritten as follows:

$$C_0 = \frac{\delta}{1+\delta}(Y_0 + \frac{1}{r} Y_F) = \frac{\delta(1+r)}{(1+\Delta)r} Y_P \tag{34}$$

where $c = \frac{\delta}{1+\delta}$ (short run consumption propensity on current income) and $k = \frac{\delta(1+r)}{(1+\delta)r}$ (long run consumption -marginal and average - propensity on future income)[38]

Eq. (34) highlights that long term marginal and average propensity of consumption depends on δ (time preference) and r (interest rate). It should be noted that when $\delta = r$; $k = 1$. It means consumption is equal to permanent income in each period (i.e. consumption smoothing hypothesis).Conversely, when $\delta > r$ the consumer is impatient ($C_t < C_0$), while if $\delta < r$ the consumer is assumed to be patient enough to postpone consumption to the future ($C_t > C_0$).

This theoretical background lasts on the hypothesis of certainty equivalence (it does not depend on the presence of a certain or an uncertain scenario). In this framework, households look only at the expected mean of future consumption not at its variability. Starting from this framework, it is possible to assess the cost of fluctuations, by quantifying people preference for stability. To this end, Lucas (1987) suggested measuring the fraction of annual consumption that society would be willing to pay to eliminate fluctuations and get the value of the compensation parameter λ as a solution of the following equation:

$$E[\sum_{t=0}^{\infty} e^{-\delta t} U(C_t^{vol})] = \sum_{t=0}^{\infty} e^{-\delta t} U(C_t^{cert}) \tag{35}$$

[38]It is worth noting here that $\frac{\partial C_0}{\partial Y_F} = \frac{\bar{C}}{Y_F} = k$ (i.e. marginal propensity and average propensity to consumption are equal and constant. They are both k)

where, as usual, $E[.]$ is the expectation operator; δ is the time preference and e is the exponential function. In other words, λ represents the percentage of steady-state consumption process that agents would pay for, in every period and state, to move from a stochastic economy to a deterministic economy.

Assuming Constant Relative Risk Aversion (CRRA): $U(C_t) = \frac{C_t^{1-\theta}-1}{1-\theta}$ Eq.(35) becomes:

$$E[\sum_{t=0}^{\infty} e^{-\delta t}[\frac{C_t(1+\lambda))^{1-\theta}-1}{1-\theta}] = \sum_{t=0}^{\infty} e^{-\delta t}\frac{\bar{C}_t^{1-\theta}-1}{1-\theta} \tag{36}$$

where θ is the risk aversion parameter[39]. From Eq. (36) Lucas derives the following (approximate) closed form solution for the cost of fluctuations:

$$\lambda = \frac{1}{2}\sigma^2\theta \tag{37}$$

where: λ is the compensation parameter; σ^2 is the volatility of consumption (empirically observable) and θ is the degree of risk aversion (not observable).

A special case of the above formula occurs if utility is logarithmic, $u(ct) = ln(ct)$, where the above simplifies to $\lambda = \frac{1}{2}\sigma^2$ [40] (i.e. with log utility, the cost of fluctuations is equal to one half the variance of the natural logarithm of consumption). Hence, Lucas (1987) comes up with the conclusion that the cost of fluctuations accounts very little in terms of welfare. This result contributed to diverting much of the previous attention from this issue, especially in terms of policy goals, by favouring policies that support long term growth instead of economic stabilization ones.

However, Lucas (1987)'s results are not compatible with a number of stylised facts, in particular the so called "equity premium puzzle" (Mehra and Prescott, 1985).[41] But the most persuasive critique of Lucas' calculations comes from Reis (2009). He asserts that Lucas actually underestimates the

[39] It can be derived as $-Cu''/u'$

[40] It corresponds to the case of $\theta = 1$, since $\lim_{\theta \longrightarrow 1} \frac{C^{1-\theta}}{1-\theta} = \ln(C)$

[41] The "Equity Premium Puzzle", highlighted by Mehra and Prescott (1985) comes from the observation of higher return on equity stocks compared to government bonds. This highlight the presence of a sort of "risk premium" on equity stocks versus government bonds, i.e. individuals manifest clear risk aversion which is not compatible with standard economic models.

role of the "persistence" of consumption and its negative effect on welfare, by demonstrating that the more persistent the fluctuation, the larger the cost. According to Reis (2009) starting, as usual, from the following special case of CRRA: $U(C_t) = \ln(C_t) = \theta = 1$, Eq. (36) becomes:

$$\ln(1+\lambda) + (1-e^{-\delta})E[\sum_{t=0}^{\infty} e^{-\delta t} E(c_t] = (1-e^{-\delta})E[\sum_{t=0}^{\infty} e^{-\delta t} E(c_t] + \frac{1}{2} Var(c_t) \tag{38}$$

where $c_t = \ln(C_t)$. It follows:

$$\ln(1+\lambda) = \frac{1}{2}(1-e^{-\delta}) \sum_{t=0}^{\infty} e^{-\delta t} Var(c_t) \tag{39}$$

To estimate the cost of fluctuations it is thus necessary to forecast the variance of consumption at different time horizons. Starting from the simplest form of consumption dynamic:

$$c_t = \eta c_{t-1} + \varepsilon_t \tag{40}$$

and assuming a stationary environment it follows: $Var(c_t) = \sigma^2 \frac{(1-\eta^{2t})}{(1-\eta^2)}$.Hence, Eq. (39) becomes:

$$\ln(1+\lambda) = \frac{\frac{1}{2}\sigma^2}{e^{\delta} - \eta^2} \tag{41}$$

where η is the coefficient of lagged consumption (i.e. persistence of consumption). It simplifies to:

$$\ln(\lambda) \cong \frac{\frac{1}{2}\sigma^2}{\delta + 1} - \eta^2 \tag{42}$$

by using the following approximations: $e^{\delta} - 1 \cong \delta$ and $ln(1+\lambda) \cong \lambda$

It is apparent from Eq. (42) that λ increases with both variability and persistence of consumption, being equal the time preference δ. Hence, to get a full understanding of the impact of fluctuations on permanent consumption we need to take into account both variance and persistence. According to Reis (2009), Lucas' calculations are actually the "extreme case" (when $\eta = 0$) of the Eq. (41).

B Decomposition methods for observed volatility

Hnatkovska & Loayza (2005)'s decomposition method of volatility splits the variance of the n rates of change of per capita consumption for a given country (Δx_i) into three separate components (boom, normal and crisis) as follows:

$$\sigma^2 = \sum_{t=1}^{n} \frac{(\Delta x_i - \overline{\Delta x})^2}{n} = \sum_{t=1}^{n} \frac{(\Delta x_i^{boom} - \overline{\Delta x})^2}{n} + \sum_{t=1}^{n} \frac{(\Delta x_i^{normal} - \overline{\Delta x})^2}{n} + \sum_{t=1}^{n} \frac{(\Delta x_i^{crisis} - \overline{\Delta x})^2}{n} = \tag{43}$$

$$\sigma^2_{boom} + \sigma^2_{normal} + \sigma^2_{crisis} = a\sigma^2 + b\sigma^2 + c\sigma^2 \tag{44}$$

where:
$a + b + c = 1$

$$\Delta x_i^{boom} = \begin{cases} \Delta x_{i..} if..\Delta x_i > \overline{\Delta x} + \delta \\ 0.......otherwise \end{cases}$$

$$\Delta x_i^{crisis} = \begin{cases} \Delta x_i..if..\Delta x_i < \overline{\Delta x} - \delta \\ 0.......otherwise \end{cases}$$

$$\Delta x_i^{normal} = \begin{cases} \Delta x_i..if..\overline{\Delta x} - \delta < \Delta x_i > \overline{\Delta x} + \delta \\ 0.......otherwise \end{cases}$$

Hence, our volatility measure is the following:

$$\sigma = \sqrt{\sigma^2 =} \sqrt{\sigma^2_{boom} + \sigma^2_{normal} + \sigma^2_{crisis}} = \sqrt{a\sigma^2 + b\sigma^2 + c\sigma^2} \tag{45}$$

where, to simplify the computation, the share of variance is assigned to each component of volatility: $\sigma_{boom} = a'\sigma$

$\sigma_{normal} = b'\sigma$

$\sigma_{crisis} = c'\sigma$

Extreme volatility is the sum of the boom and crisis components of total observed volatility. It must be noted that unlike the original computation of Hnatkovska & Loayza (2005) we applied country specific decompositions. This has important implications for the estimates since it means adopting a set of different country specific thresholds calculated as $\pm\delta$ from the average standard deviation of observed rate of change of consumption for each country.

Carroll and Samwick (1997) provide a simple method for decomposing innovations into a transitory and permanent component. Assuming the following process for the log of permanent income:

$$p_t = p_{t-1} + \eta_t \tag{46}$$

where η_t is a shock to permanent income

Assuming that the log of current income is given by the log of permanent income plus a transitory error term, as follows:

$$y_t = p_t + \epsilon_t \tag{47}$$

Finally, assuming that both η_t and ϵ_t are white noise and uncorrelated with each other and at all leads and lags, we can derive the income difference of length d as follows:

$$r_{dy} = y_{t+d} - y_t = p_{t+d} + \epsilon_{t+d} - p_t - \epsilon_t \tag{48}$$

Substituting Eq. (46) into Eq. (48) recursively yields:

$$r_{dy} = \eta_{t+1} + \eta_{t+2} + ... + \eta_{t+d} + \epsilon_{t+d} - \epsilon_t \tag{49}$$

Hence, the second moment is

$$var(r_{dy}) = \upsilon_{y_d} = d\sigma_\eta^2 + 2\sigma_\epsilon^2 \tag{50}$$

where σ_η^2 and σ_ϵ^2 are, respectively, the variances of the permanent and transitory shocks to income.

To apply this decomposition method to our analysis we thus compute υ_{i_d} as follows:

$$\upsilon_{i_d} = r_{dyi}^2 \tag{51}$$

since we assume $\overline{r}_{dyi} = 0$ (no unpredictable growth trend).

We then use two υ_{i_d} of different lengths to solve for σ_η^2 and σ_ϵ^2 as follows:

$$s_{\eta_i}^2 = \upsilon_{i_d} - \upsilon_{i_{d-1}} \tag{52}$$

$$s_{\epsilon_i}^2 = \frac{\upsilon_{i_{d-1}} - (d-1)s_{\eta_i^2}}{2} \tag{53}$$

and assume that $E(s_{\eta_i}^2) = \sigma_\eta^2$ and $E(s_{\epsilon_i}^2) = \sigma_\epsilon^2$

C Tables

Table 13:

List of countries by deciles (decade 1960-69)

Decade 1960_1969									
dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
Zimbabwe	Equatorial Guinea	Niger	Comoros	Malaysia	Dominican Republic	El Salvador	Iran	Barbados	New Zealand
Burundi	Nepal	Chad	Congo, Dem. Rep.	Haiti	Colombia	Chile	Jamaica	Finland	Canada
Guinea-Bissau	Ghana	Madagascar	Kenya	Tunisia	Panama	Seychelles	Gabon	Italy	Sweden
China Version 1	Indonesia	Mauritania	Papua New Guinea	Syria	Ecuador	Cyprus	Argentina	France	United States
Mozambique	Uganda	Sri Lanka	Morocco	Paraguay	Bolivia	South Africa	Venezuela	Belgium	Luxembourg
Malawi	Botswana	Pakistan	Egypt	Fiji	Namibia	Peru	Puerto Rico	Austria	Switzerland
Ethiopia	China Version 2	Gambia, The	Cote d'Ivoire	Zambia	Brazil	Uruguay	Trinidad &Tobago	Iceland	
Mali	Rwanda	Congo, Republic of	Thailand	Korea, Republic of	Jordan	Singapore	Ireland	United Kingdom	
Lesotho	India	Guinea	Cameroon	Romania	Nicaragua	Hong Kong	Greece	Norway	
Burkina Faso	Bangladesh	Cape Verde	Nigeria	Mauritius	Guatemala	Portugal	Japan	Denmark	
Tanzania	Sierra Leone	Togo	Senegal	Honduras	Algeria	Mexico	Spain	Netherlands	
	Benin	Central African Republic	Philippines	Taiwan	Turkey	Costa Rica	Israel	Australia	

Table 14:

List of countries by deciles (decade 2000-09)

Decade 2000-2009									
dec1	dec2	dec3	dec4	dec5	dec6	dec7	dec8	dec9	dec10
Zimbabwe	Tanzania	Tajikistan	Angola	Albania	South Africa	Cuba	Slovak Republic	Taiwan	United States
Congo, Dem. Rep.	Comoros	Nigeria	Honduras	Dominica	Thailand	Argentina	Hungary	Spain	Singapore
Burundi	Uganda	Cameroon	Swaziland	China Version 1	Tonga	Costa Rica	Libya	Italy	Bermuda
Liberia	Ghana	Uzbekistan	Sri Lanka	China Version 2	Marshall Islands	Lebanon	Cyprus	France	Kuwait
Somalia	Gambia, The	Sudan	Indonesia	Turkmenistan	Brazil	Gabon	Saudi Arabia	Japan	United Arab Emirates
Niger	Chad	Laos	Micronesia, Fed. Sts.	Tunisia	Panama	Malaysia	Oman	Finland	Norway
Ethiopia	Nepal	Kyrgyzstan	Bolivia	Azerbaijan	Serbia	Chile	Czech Republic	Germany	Brunei
Malawi	Timor-Leste	Djibouti	Paraguay	Vanuatu	Dominican Republic	Mexico	Portugal	Hong Kong	Luxembourg
Central African Republic	Kenya	Pakistan	Guyana	St.Vincent & Grenadines	Mauritius	St. Lucia	Malta	United Kingdom	Qatar
Mozambique	Bangladesh	Nicaragua	Bhutan	Bosnia and Herzegovina	Venezuela	Latvia	Seychelles	Belgium	
Guinea-Bissau	Benin	Moldova	Kiribati	Ecuador	Suriname	Russia	Trinidad &Tobago	Sweden	
Afghanistan	Lesotho	Congo, Republic of	Syria	Algeria	Kazakhstan	Grenada	Korea, Republic of	Denmark	
Eritrea	Zambia	Vietnam	Georgia	Ukraine	Belize	St. Kitts & Nevis	Bahrain	Ireland	
Sierra Leone	Sao Tome and Principe	Papua New Guinea	Iraq	Guatemala	Bulgaria	Lithuania	Slovenia	Canada	
Madagascar	Cote d'Ivoire	Yemen	Maldives	Peru	Uruguay	Croatia	Barbados	Austria	
Togo	Haiti	India	Namibia	El Salvador	Jamaica	Poland	Israel	Netherlands	
Rwanda	Senegal	Philippines	Jordan	Montenegro	Iran	Palau	Greece	Macao	
Guinea	Mauritania	Mongolia	Armenia	Samoa	Botswana	Equatorial Guinea	Puerto Rico	Australia	
Burkina Faso	Solomon Islands	Cape Verde	Egypt	Colombia	Belarus	Estonia	New Zealand	Iceland	
Mali	Cambodia	Morocco	Fiji	Macedonia	Turkey	Antigua and Barbuda	Bahamas	Switzerland	