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INTEREST RATES AND CONSUMPTION VOLATILITY: ANY IMPLICATIONS FOR CONSUMPTION SMOOTHING?

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Abstract

The roles of market interest rates in consumption smoothing have been fairly examined; their effects on consumption volatility however in various country groups have received limited attention. This study aims to estimate the effects of these rates on consumption volatility based on data from developed and developing country samples. The General Method of Moments (GMM) and the Two Stage Least Squares (2SLS) estimation techniques employed, due to the endogeneity property of the specified model, yield interesting results. Lending rates reduced consumption volatility in developed countries while saving rates did not worsen it. The rates had no effect in developing countries and mixed effects in the whole sample. The rates are relatively lower in developed countries and this partially explains why consumption volatility is lower in developed economies than in developing counterparts. As a result, the developing countries need to implement policies to reduce interest rates as a means of reducing consumption volatility and thus enhance consumption smoothing and maximise their welfare.

1. Introduction

Personal incomes as well as other macroeconomic variables often follow a stochastic trend (Chamberlain and Wilson, 2000); consumers thus often have to approximate their values when making decisions. As rational utility-maximising economic agents, consumers generally allocate all their lifetime incomes to consumption[1]. This assumption, and the assumption that consumers are constrained by playing ponzi game[2] not only results in Walrasian satisfaction of intertemporal budget constraint but also that consumption is planned on lifetime (expected or trend) income. Thus, consumption path may deviate from the actual income path, resulting in surplus and deficit at different points in time.

Efficient management of the surplus and financing of deficits depends on effectiveness of the financial sector. A perfectly competitive financial sector

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efficiently prices saving deposits in a way that reflects market conditions. The resulting rates on savings would be such that will not distort intertemporal consumption decisions. In the same vein, such a market would equally price deficit financing in such a way that lending rates would not be too high to discourage the consumer from borrowing when the actual income is below planned consumption.

However, in many countries the financial sector is not competitive as it is dominated by the banking industry. In this situation, consumers have limited financial options to manage or smooth their consumption. Poorly developed domestic financial markets that characterise developing economies may constrain domestic demand by restraining consumers from borrowing against their future incomes (Gourinchas and Jeane, 2011). Together with imposing lending constraint that distorts consumption decisions, poorly developed conditions of the financial sector also distort saving decisions (Chamon and Prasad, 2008; Mendoza, Quadrini and Rios-Rull, 2009) leading to sub-optimisation of intertemporal consumption path.

Also, consumers in developing economies face high bank lending rates, relative to those obtainable in developed countries. This imposes a cost on the consumption smoothing process and may force consumers to take a suboptimal consumption path dictated by their income, other than that desired. Bank lending rate is thus a form of transaction costs which Attanasio and Paiella (2007), Paiella (2006), Jorgensons (2002) and Luttmer (1999) identify as a factor that limits participation of consumers in a given financial market and discourage them from buying into credit arrangements with which they can maximise their utility.

On the other hand, saving rates on deposit in many developing countries tend to be strikingly low. The rates, relative to the consumer discount factor[3], determine whether or not consumers take advantage of the saving deposit in optimizing their consumption. If the rate is lower than the discount factor, consumers may reduce their savings as the optimal strategy in the short run; this however may not be optimal in the long run when considered in the light of 'non-ponzi game' condition[4] which is often seen as a constraint to consumers' choice.

These transaction costs limit consumer decisions, and this has though been established. However, the extent to which they affect the consumption smoothing process failed to be thoroughly analysed. While many previous studies have identified various causes for consumption volatility such as anticipated shocks to labour income or asset returns (Heathcote and Perri, 2015), partially or unsecured risks to labour income due to incomplete market (Challe and Ragot, 2015), liquidity constraints and financial development (Bhattacharya and Patnaik, 2015; Dogra and Gorbachev, 2015), limited attention has been paid to the effects of interest rates (the lending rate

and the saving rate) on liquidity constraints and consumption volatility. There is little evidence on how high lending rate in developing economies, relative to that in developed countries, may discourage borrowing and constitute or impose liquidity constraints.

This study thus contributes to the literature by estimating the independent effects of lending and saving rates on consumption volatility, using data on 117 countries. It also compares the nexus in developing countries with that in developed counterparts, using data from subsamples of 34 developed countries and 83 developing countries. It measured volatility as variances of consumption in a generalised autoregressive conditional heteroscedasticity (GARCH) model and associated high volatility (variances) with poor consumption smoothing. The study made use of the Two Stage Least Squares (2SLS) and General Methods of Moments (GMM) estimation techniques to analyse the nexus due to the inherent endogeneity in the relationship.

The study finds that saving rates have significantly reduced consumption volatility in contrast to lending rates in the whole sample. However, lending rates reduced consumption volatility in developed countries. This may be explained with the lending rates in these countries. Saving rates did not reduce the volatility in developed countries but had the potential of doing so. In developing countries however, neither lending rates nor saving rates did reduce consumption volatility, and this may be attributed to the high level of the rates in these countries. The developing countries thus need to implement policies to reduce interest rates as a means to reducing consumption volatility and maximising their welfare.

The rest of the paper is organised as follows. Section 2 reviews the relevant literature while section 3 presents the theoretical and empirical framework. This section also discusses the methodology employed. Section 4 discusses the findings and section 5 rounds off with concluding remarks.

2. Literature Review

Consumption occupies a central role in the macroeconomy and that justifies why several studies and theories are devoted to understanding its behaviour (Romer, 2012). Consumption explains a substantial portion of the aggregate demand in any economy; hence any influence on consumption expenditure has significant effect on economic output. One of the earlier theories on consumption is the Keynesian fundamental psychological law of consumption that postulates consumption as linearly dependent on current income (Mankiw, 2002). The implication of this theory

is that consumption is limited to current disposable income (Attanasio and Webber, 2010) as described by the Keynesian consumption function in the equation (1) below:

$$C_t = c_o + c_1 Y_t^d \tag{1}$$

Where

C_t = consumption at time t; c_o = autonomous consumption

c_1 = marginal propensity to consume; Y_t^d = disposable income at time t

Equation (1) implies that income-consumption deficit may not arise until income is nil, the shape of consumption path is determined by income; thus, external financing options for consumption-smoothing is non-existent. These implications however, established in the post-Keynesian consumption literature are not realistic.

Several studies have shown that the Keynesian theory of consumption does not fully describe consumption behaviour because consumers dislike bulges in their marginal utility (Romer, 2012). They smooth their consumption path by relating consumption to expected long-term income. The average value of the present value of life-time income streams, which is consumed, is called the permanent income. This behaviour informs the postulation of life-cycle and permanent income models by Modigliani and Brumberg, (1954; 1980) and Friedman (1957) respectively. These models postulate that permanent income, other than current income, determines consumption in a way presented in equation (2) below (Attanasio and Webber, 2010; Romer, 2012; Obstfeld and Rogoff, 1996).

$$C_t = \frac{r}{1+r}\left(A_t + \sum_{k=0}^{\infty} \left\langle E(Y_{t+k} \,|\, I_t \right\rangle \right) \tag{2}$$

where

r = interest rate;

A_t = financial asset at time t;

I_t = information available at time t;

Others = as earlier defined.

Equation (2) shows that the consumer, in allocating resources across periods to maximise lifetime utility, consumes only a constant return on the present value of all

the lifetime resources comprising the initial assets and labour income (assumed invested on a financial market). The R.H.S of equation (2) shows that consumption is a constant fraction of lifetime resources, the permanent income for each period in the consumer's lifetime. This supports Hall's (1978) findings presented in equation (3) below:

$$\left\langle E(C_{t+1}\left|I_t\right.\right\rangle = C_t \tag{3}$$

which, under assumption of rational expectation becomes equation (4) below

$$C_{t+1} = C_t + \varepsilon_t \qquad \left\langle E(\varepsilon_t\left|I_t\right.\right\rangle = 0 \tag{4}$$

This implies that current income-consumption deficits and surpluses are bound to occur and the consumer only needs to save the surplus in financial assets or borrow against the future income to finance the deficit.

The propensity of a consumer to acquire financial assets in which to save the surplus and/or obtain finance as a means of smoothing his consumption path depends on the efficiency of the financial market as well as its depth. Where the market is dominated by the banking sector, consumption smoothing may depend on lending/credit facilities, interest rates (lending and saving rates) offered on banking products.

This is evident in equation (2) and its first difference (equation (5) below) consumption and its change is sensitive interest rates in the financial market.

$$\Delta C_{t+1} = \frac{r}{1+r}\sum_{k=0}^{\infty}\frac{r}{(1+r)^k}\times\left[\left\langle E(Y_{t+k+1}\left|I_{t+1}\right.\right\rangle - \left\langle E(Y_{t+k+1}\left|I_t\right.\right\rangle\right] \tag{5}$$

This sensitivity of consumption to interest rates and its variants (the saving rate and the lending rate) has received limited attention though, both in the theoretical and the empirical literature. Yet, the sensitivity of consumption to change in income has been largely considered. Diebold and Rudebusch (1991), using Autoregressive Fractionally Integrated Moving Average (ARFIMA) analysed the relationship between consumption volatility and income fluctuation. Consumption was found to be less volatile than income and this led to the conclusion, as earlier documented in the literature, that consumption is smoother than predicted by the Permanent Income

Hypothesis (PIH), which posits that consumption volatility (changes) would be larger than income volatility.

Heathcote and Perri (2015) consider a relationship between consumption and wealth (long term/accumulated income). Anticipated decline in the former (due to unfavourable macroeconomic climate, especially unemployment) is theoretically and empirically shown to increase precautionary saving and reduce consumption. The decline in consumption in response to declined wealth or asset value (prices) is shown to be larger for low-wealth households than high-wealth households. This is noted to suggest that consumption spending is sensitive to risk of decline in streams of consumption-financing resource (labour income/wealth). The authors did not however draw a line between the decline in aggregate prices that drive down households' wealth and interest rates. Decline in asset prices would naturally raise real interest rates and this may drive up the saving rates demanded by depositors and interest rate charged by banks on lending. The large borrowing costs may impose borrowing constraints on consumers, reinforce decline in consumption spending when asset prices fall (in addition to precautionary saving effects) and worsen consumption volatility.

Challe and Ragot (2015) underscore the role of incomplete markets and lack of complete insurance from unemployment risk in the consumption volatility. In response to uninsured employment risks, households raise precautionary wealth by cutting individual consumption more. The engendered precautionary saving increase consumption volatility as cut in consumption is larger than anticipated decline in income.

Bhattacharya and Patnaik (2015) identify that financial development following a reform worsens consumption volatility in emerging economies unlike its effects in developed economies. They argue that the development increases the share in the economy of Ricardian households which respond to shock to permanent (trend) productivity or expected income by varying consumption more than change in current income. The share in the economy of Ricardian households increases with rise in financial development as the financially constrained households get access to finance. While agreeing with Resend (2006) that consumption volatility is higher in emerging economies than developed counterparts, Bhattacharya and Patnaik (2015) emphasize that endogenous borrowing constraints may cause consumption volatility and its relaxation through improved access to finance (due to financial reform) may also exacerbate the volatility.

Dogra and Gorbachev (2015) however note that financial liberalisation in the United States did not increase the share of financially unconstrained households; rather the ratio of the financially constrained households to the financially

unconstrained ones slightly rose between 1980 and 2007. Consumption volatility also rose over this period. Their findings suggest that liquidity constraints determine consumption volatility in developed economies, as a higher probability of being denied credit (access to finance) has strong effects on consumption volatility than income volatility does. The engendered volatility is also established to bear grave implications for welfare.

Attanasio and Paiella (2011) noted that costs of creating and managing financial asset portfolio discourage consumers and undermine their ability to manage their income risk and optimise their utility. Guo and Stepanyan (2011) documented that while deposit rates and discount rates negatively affect credit growth (credit availability), domestic deposit growth and foreign deposit growth, lagged GDP growth and inflation positively affect credit growth. Georgievska et al. (2011) argue that the interest rate on lending is significantly affected by bank size and market shares and to a lower extent by deposit rate and non-performing loans. In addition, both domestic rate and foreign rates are also found to exert significant influence on the lending rate.

While most strands of the literature agree that liquidity constraints underlie consumption volatility, limited attention has been paid to the influence of interest rates (especially the lending rate) on liquidity constraints and consumption volatility. Little is known about how high the lending rate in developing economies, relative to that in developed countries, may discourage borrowing and constitute or impose liquidity constraints.

3. Theoretical and Empirical Framework

This section presents the theoretical framework within which the nexus between interest rates and consumption volatility is analysed. The empirical framework for estimating the nexus and the estimation techniques are also highlighted.

3.1. The model

The representative consumer solves the problem presented in equations (6) to (8) below:

$$Max \sum_{s=t}^{T-t} \beta^{s-t} u(C_s) \tag{6}$$

Subject to

$$W_{S+1} - D_{S+1} = W_S(1 + r_S^S) - D_S + \left[Y_S - (C_S + r_S^L D_S)\right] \tag{7}$$

$$W_T - D_T \geq 0 \tag{8}$$

C_s = consumption at time s, approximated by aggregate consumption per capita;

$u(\cdot)$ = instantaneous utility function;

β = discount factor;

Y_s = income at time s, approximated by gross domestic product (GDP)[5] per capita;

B_s = credit (borrowings) assessed from the bank at time, approximated by aggregate credit per capita;

r_s^S =saving rate on deposit;

r_s^L = lending rate at time s;

W_s = wealth at time s;

L_t = present value of financial liability created from borrowings;

D_s = total debt or borrowing at time s.

Equation (6) is the present value of utility function being maximised within the budget constraint presented in equation (7). Equation (7) is the budget constraint: it explains net wealth accumulation (difference between financial assets W and financial liabilities D in a period) in terms of existing net wealth and saving in the previous period. Net wealth in a period is the sum of the last period wealth and saving in the current period (the excess of income over consumption and interest payment on debt, $r_s^L \ D_s$). Equation (8) indicates that the consumer does not leave behind debt.

Expressing equation (7) in terms of consumption and substituting the result in equation (6) represents the problem in the unconstrained form below:

$$Max \sum_{s=t}^{T-t} \beta^{s-t} u(Y_s - r_s^L D_s + W_s(1 + r_s^S) - W_{s+1} + D_{s+1} - D_s) \tag{9}$$

The first order conditions for the maximisation problem with respect to W_{s+1} and D_{s+1} yield the following Euler equation that must hold for every $s \geq t$.

$$u'(C_s) = (1 + r_s^S)u'(C_{s+1}) \tag{10}$$

$$u'(C_s) = (1 + r_s^L)u'(C_{s+1}) \tag{11}$$

On rearrangement and imposition of the inanda conditions, equation (10) and (11) yield:

$$\frac{C_{s+1}}{C_s} = \beta(1 + r_s^S) \tag{12}$$

$$\frac{C_{s+1}}{C_s} = \beta(1 + r_s^L) \tag{13}$$

Equations (12) and (13) show that the higher the saving rates and lending rates, the higher the consumption growth. Higher saving rates induce consumers to delay present consumption; hence the future consumption is larger. This tends to widen consumption level at two different periods. On the other hand, higher lending rates discourage consumers to reallocate consumption from the future to the present through borrowing today and paying back tomorrow. Consumption levels at two different periods thus widen. This limits their ability to smooth their consumption path and maximise their welfare.

3.2. Empirical Framework

Consumption growth, or change in consumption levels of a consumer over time has been theoretically shown to be influenced by discount rates, saving rates, lending rates, and income (see equations 5, 12 and 13 above). Thus, we model change or growth in consumption in country *i* and year *s*, for estimation purpose, as follows:

$$\frac{C_{i,s+1}}{C_{i,s}} = f(r_{i,s}^S, r_{i,s}^L, GDPC_{i,s}) \tag{14}$$

where

$\frac{C_{i,s+1}}{C_{i,s}}$ = change or growth in consumption per capita in country *i* and year *s*;

$r_{i,s}^{S}$ = saving rate in country i and year s;

$r_{i,s}^{L}$ = lending rate in country i and year s;

$GDPC_{i,s}$ = income per capita in country i and year s;

Subscript i and s denotes the cross-section (country) and time period.

Similarly, consumption volatility, $\sigma_{i,s}^{c}$, which relates to changes or variation in consumption would be influenced by these determinants. The relationship is presented in equation (15) below:

$$\Rightarrow \sigma_{i,s}^{c} = f(r_{i,s}^{S}, r_{i,s}^{L}, GDPC_{i,s}) \tag{15}$$

where

$\sigma_{i,s}^{c}$ is measured as variance in the generalised autoregressive conditional heteroscedasticity (GARCH) model specified in (16) below.

$$\begin{aligned} \sigma_{i,s}^{c} &= \varphi + \phi u_{i,s-1}^{c} + \gamma \sigma_{i,s-1}^{c} \\ C_{i,s} &= \eta + \delta C_{i,s-1} + u_{i,s} \end{aligned} \tag{16}$$

where

$\varphi, \phi, \gamma \; and \; \delta > 0$ are parameters;

C = consumption per capita;

u = residuals in consumption autoregressive equation.

The saving rate is determined through the interaction of demand for saving deposit and its supply. Therefore, the saving rate can be written as a function of its determinants.

$$r_{i,s}^{S} = f(DD_{i,s}, SD_{i,s}) \tag{17}$$

where

$r_{i,s}^{S}$ = saving rate;

$DD_{i,s}$ = credit, proxying (indirect) demand for saving deposit;

$SD_{i,s}$ = saving deposit, proxying supply of saving deposit;

The lending rate too is influenced by the demand for saving deposit and its supply.

$$r_s^L = f(DD_s, SD_s) \tag{18}$$

where

$r_{i,s}^{L}$ = lending rate in country;

others = as earlier defined.

Internalising equations (17) and (18) in a linear representation of equation (15) gives equation (19) below:

$$\sigma_{i,s} = \alpha_0 + \alpha_1 \ln r_{i,s}^{S} + \alpha_2 \ln r_{i,s}^{L} + \alpha_3 GDPC_{i,s-1} + \alpha_4 \ln DDC_{i,s} + \alpha_5 \ln SDC_{i,s} + \varepsilon_{i,s} \tag{19}$$

where

$DDC_{i,s}$ = credit per capita;

$SDC_{i,s}$ = saving deposit per capita.

The effects of lending and saving rates on consumption volatility are examined by estimating equation (19) for the whole sample of 117 countries. The equation is also estimated for developed and developing countries subsamples for reason of comparing the nexus in the broad categories of countries.

3.3. Estimation techniques

A number of explanatory variables in Equation (19) are endogenous. Estimating the equation with Ordinary Least Squares (OLS) would yield biased and, in many cases, inconsistent estimators. The endogeneity problem is circumvented with use of system General Method of Moments (GMM) and two stage Least Squares (2SLS).

4. Data and Preliminary Analysis

Consumption per capita (*CONSC*) is measured as the ratio of household final consumption expenditures to population, volatility of consumption per capita, σ, is measured as GARCH variances of *CONSC*; income per capita (*GDPC*) as ratio of Gross Domestic Product per capita to population, lending rate (*LENDRATE*) as interest rate charged on loans or credit by commercial banks, saving rate (*SAVRATE*) as rate on saving deposit, credit per capita (*CREDITC*) as ratio of credit granted by the banking sector to population, saving per capita (*SAVC*) as ratio of gross domestic saving top population. Data on the underlying variables are collected from the World Bank's Global Development Finance database while those on population are obtained from IMF's World Economic Outlook.

4.1. Descriptive analysis and statistics

Table 1 below presents the descriptive statistics of the data in the whole sample and the subsamples of developing and developed countries. The data show wide range (difference between maximum values and the minimum values) reflecting heterogeneity of the sample. The variations justify the use of panel data estimation techniques (Mobolaji, 2008) as they allow for more efficient estimation of parameters (Baltagi, 2008).

Table 1

Descriptive statistics

Whole sample of 117 countries							
	σ (CONSC)	CONSC	LENDRATE	SAVRATE	CREDITC	SAVC	GDPC
Mean	1175009.	4173.263	17.17667	13.99088	1428511.	2384.121	18493.77
Median	53953.30	937.1780	11.00000	5.000000	98.96910	301.6020	941.8910
Maximum	3.00E+08	47381.30	824.56000	682.3000	1.80E+08	204075.0	59018.70
Minimum	0.164800	71.22000	0.500000	0.010000	1.016700	1.18530	79.72770
Std. Dev.	6402873.	6726.490	90.31039	275.8075	11952194	8801.389	153696.4
Skewness	30.85439	2.285473	40.17997	61.43198	12.01239	14.44550	11.77940
Kurtosis	1289.365	8.479139	1988.047	3833.243	151.1499	268.6157	144.0742
Jarque-Bera	2.74E+08	8417.867	6.53E+08	2.43E+09	3724231.	11802551	3382214.

Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4.66E+09	16559509	68157.01	55515.81	5.67E+09	9460193.	73383267
Sum Sq. Dev.	1.63E+17	1.79E+11	32354721	3.02E+08	5.67E+17	3.07E+11	9.37E+13
Observations	968	3968	3968	3968	3968	3968	3968
Subsample of 34 developed countries							
	σ (CONSC)	CONSC	LENDRATE	SAVRATE	CREDITC	SAVC	GDPC
Mean	3235766.	11049.42	12.56449	7.154668	4910076.	5066.401	58404.84
Median	1800000.	9511.105	7.464850	3.564600	902529.5	3507.945	12463.90
Maximum	3.00E+08	47381.30	91.84000	88.29400	1.80E+08	57707.60	2300000.
Minimum	60.84220	1174.5800	0.500000	0.010000	22058.80	97.96630	1473.040
Std. Dev.	10475352	8647.957	45.07737	27.22479	21800509	6285.205	281288.2
Skewness	21.08449	0.869108	14.13647	17.87773	6.342142	3.966152	6.196752
Kurtosis	568.0700	3.490764	230.5241	392.0749	42.88926	26.62982	40.64857
Jarque-Bera	15411954	156.5879	2523195.	7327572.	84098.12	29821.92	75408.67
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	3.73E+09	12728928	14474.29	8242.178	5.66E+09	5836494.	67282373
Sum Sq. Dev.	1.26E+17	8.61E+10	2338796.	853108.6	5.47E+17	4.55E+10	9.11E+13
Observations	1152	1152	1152	1152	1152	1152	1152
Subsample of 83 developing countries							
	σ (CONSC)	CONSC	LENDRATE	SAVRATE	CREDITC	SAVC	GDPC
Mean	331971.8	1360.291	19.06347	16.78751	4234.809	1286.825	2166.511
Median	14340.35	471.4670	13.00000	5.643850	39.28610	74.58620	584.4295
Maximum	2.00E+08	47381.30	824.56000	682.3000	759644.0	204075.0	59018.70
Minimum	0.164800	71.22000	4.730800	0.281700	1.016700	1.18530	79.72770
Std. Dev.	3233812.	2432.665	103.2017	326.9102	30196.43	9426.800	4399.995
Skewness	37.05225	4.080079	37.42033	51.96193	15.50616	16.27482	5.122847
Kurtosis	1647.356	25.37114	1636.999	2735.406	311.0264	292.3875	40.87322
Jarque-Bera	3.18E+08	66534.57	3.14E+08	8.77E+08	1817107.	9950408.	180617.7
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	9.35E+08	3830581.	53682.72	47273.63	9.46E+13	3623699.	6100894.
Sum Sq. Dev.	2.94E+16	1.67E+10	29981394	3.01E+08	8.95E+25	2.50E+11	5.45E+10
Observations	2816	2816	2816	2816	2816	2816	2816

Source: *Author's computation*

All the variables are positively skewed in all the samples; however skewness is largest in the developing countries subsample, followed by the whole sample, and then the developed countries subsample. This suggests that developing countries

subsample is least balanced in terms of composition: a few countries in the subsample are so large that the mean of the variables are far greater than their median values, when compared to the other subsample. This reflects in the kurtosis of the variables in the sample and the subsamples: the variables in developing countries are more lepto-kurtic than the samples which are even more leptokurtic than the developed countries counterparts.

The mean of the variables, with exception of lending rates and saving rates, are the largest in developed countries, followed by the whole sample and the developing countries subsamples. This shows that developed countries are economically larger, on average, than developing counterparts. The lending rates and saving rates are however the least in developed countries subsample than the other subsample. This is not surprising as the rates are outcomes of the interaction between supply of funds or savings (SAVC) and its demand or credit (CREDITC). Supply of funds (SAVC), on average, is the largest in developed countries and this explains why the average saving rates is the lowest. The saving rates are proportional to the saving of funds supply in the subsample; and this extends to the lending rate as saving rates inform lending rates.

4.2. Unit roots analysis and statistics

The unit roots property of the data employed is highlighted in table 2 below. The table presents the statistics from various unit roots tests. Some of the tests assume common unit root across the cross-sections while others assume individual unit roots. Those assuming common unit roots include the Lin, Levin and Chu (LLC) panel unit root test and the Breutang (BRE) panel unit root test. Those that assume individual unit roots include Ims, Pesharan and Shin (IPS), Augmented Dickey-Fuller (ADF) and Philips and Perron (PP) tests. Most of the tests show that variance of consumption, lending rates and saving rates are I(0) while CREDITC, SAVC and GDPC are I(1) in the whole sample and the subsamples.

Table 2

Unit roots statistics

Whole sample of 117 countries										
	common unit root process assumed				Individual unit root process assumed					
	LLC		BRE		IPS		ADF		PP	
Series	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.
σ (CONSC)	-12.4**	-24.4**	-12.6**	-7.28**	-15.3**	-42.3**	919**	2023**	2457**	18256**
LENDRATE	-12.8**	-23.1**	-1.04	-15.3**	-4.20**	-15.4**	330**	828**	251	2072**
SAVRATE	-7.85**	-17.3**	-4.11**	-13.1**	-6.13**	-17.9**	416**	809**	302**	1513**
CREDITC	14.5	-18.5**	13.5	11.2	7.27	-9.22**	129	679**	122	2832**
SAVC	-2.10*	-21.0**	3.03	-2.23*	-2.60**	-29.4**	336**	1257**	461**	6808**
GDPC	1.36	-24.7**	3.51	-15.2**	4.59	-23.5**	154	959**	134	2158
Subsample of 34 developed countries										
	common unit root process assumed				Individual unit root process assumed					
	LLC		BRE		IPS		ADF		PP	
Series	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.
σ (CONSC)	-17.5**	-9.56**	13.8**	-1.57	-14.3**	-20.9**	302**	448**	1180**	4886**
LENDRATE	-4.41**	-12.4**	-1.40**	-8.93**	-2.48**	-10.6**	105**	250**	79.3	612**
SAVRATE	2.73**	-8.70**	2.99**	-5.59**	2.60**	-7.80**	113**	199**	78.6	377**
CREDITC	6.53	-17.5**	7.14	-13.8**	-3.58	-14.3**	345	301**	206	1180**
SAVC	1.19	-9.97**	4.20	3.12	0.71	-14.5**	85.7	364**	93.5	1964**
GDPC	1.74	-17.2**	2.52	-5.79**	4.70	-12.6**	26.7	267**	19.8	569**
Subsample of 83 developing countries										
	common unit root process assumed				Individual unit root process assumed					
	LLC		BRE		IPS		ADF		PP	
Series	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.	Level	1st diff.
σ (CONSC)	-11.2**	-22.5**	12.4**	-7.65**	-13.4**	-36.9**	734**	1576**	1653**	13370**
LENDRATE	-12.7**	-20.5**	-0.37	-12.5**	-3.44**	-13.0**	225**	578**	172	1460**
SAVRATE	-7.13**	-14.3**	-2.99**	-11.9**	-5.56**	-16.3**	303**	610**	223**	1140**
CREDITC	19.8	-9.37**	14.8	13.5	5.73	-1.97*	106	377**	82.9	1651**
SAVC	-3.14**	-18.6**	0.93	-6.01**	-3.58	-25.5**	250**	894**	368	4843**
GDPC	0.63	-19.0**	2.75	-14.3**	2.47	-19.8**	127	692**	115	1589**

**, ** indicate 5% and 1% degree of statistical significance*

Source: *Author's computation.*

The outcomes of the tests necessitate further diagnostic tests: cointegration analysis. There is need to find if there exists a long run relationship between the variables. If the variables are cointegrated, the relationship between the variables may be analysed with appropriate regression techniques.

4.3. Cointegration analysis and statistics

The existence of long run relationships between the variables is tested by using three cointegration tests: Johansen-Fisher test, Pedroni test and Kao tests. All the tests affirm that long run or cointegrating relationships exist between the variables in the whole sample and the subsamples. Table 3 below presents the statistics from the three tests under different assumptions.

Table 3

Cointegration statistics

Whole sample of 117 countries

Variables in cointegration vector	**Johansen-Fisher**					**Pedroni**				**Kao**
		No Intercept, no trend in CE & VAR		Intercept & trend in CE & VAR						
	H_0:r	λ_{trace}	$\lambda_{\max-eigen}$	λ_{trace}	$\lambda_{\max-eigen}$	stat	Intercept	Intercept & trend	None	
σ (CONSC)	$r = 0$	1735**	1080**	1543**	2592**	Panel-v	-4.67**	-8.58**	-6.96**	-2.05*
LENDRATE	$r \leq 1$	1133**	769**	1147**	3200**	Panel-rho	-4.05**	-1.26	-4.92**	
SAVRATE	$r \leq 2$	704**	503**	743**	599**	Panel-PP	-30.9**	-36.5**	-19.3**	
CREDITC	$r \leq 3$	398**	298**	621**	473**	Panel-ADF	-7.92**	-8.02**	-4.32**	
SAVC	$r \leq 4$	232**	206**	381**	298**	Group-rho	3.87**	6.27**	2.99*	
GDPC	$r \leq 5$	150**	151**	367**	367**	Group-PP	-33.6**	-38.3**	-23.8**	
						Group-ADF	-7.02**	-5.75**	-4.82**	

Subsample of 34 developed countries										
	Johansen-Fisher					**Pedroni**				**Kao**
Variables in cointegration vector		No Intercept, no trend in CE & VAR		Intercept & trend in CE & VAR						
	H_0:r	λ_{trace}	$\lambda_{\max-eigen}$	λ_{trace}	$\lambda_{\max-eigen}$	stat	Intercept	Intercept & trend	None	
σ (CONSC)	$r = 0$	332**	698**	223**	418**	Panel-v	-3.39**	-5.25**	-5.61**	-2.23*
LENDRATE	$r \leq 1$	332**	150**	178**	884**	Panel-rho	-1.03	0.46	-1.35	
SAVRATE	$r \leq 2$	210**	912**	262**	201**	Panel-PP	-20.2**	-25.2**	-6.87**	
CREDITC	$r \leq 3$	77.7**	173**	225**	165**	Panel-ADF	-3.59**	-3.26**	0.12	
SAVC	$r \leq 4$	38.9**	89.7**	113**	72.8**	Group-rho	2.20*	3.72**	1.51	
GDPC	$r \leq 5$	25.4**	56.0**	101**	101**	Group-PP	-14.5**	-17.1**	-6.78**	
						Group - ADF	-2.40*	-1.91*	-0.84	

Subsample of 83 developing countries										
	Johansen-Fisher					**Pedroni**				**Kao**
Variables in cointegration vector		No Intercept, no trend in CE & VAR		Intercept & trend in CE & VAR						
	H_0:r	λ_{trace}	$\lambda_{\max-eigen}$	λ_{trace}	$\lambda_{\max-eigen}$	stat	Intercept	Intercept & trend	None	
σ (CONSC)	$r = 0$	1403**	875**	1320**	2174**	Panel-v	-0.15	-3.49**	-0.60	-2.62**
LENDRATE	$r \leq 1$	801**	552**	952**	2053**	Panel-rho	-5.15**	-2.87**	-5.82**	
SAVRATE	$r \leq 2$	493**	332**	499**	398**	Panel-PP	-22.8**	-25.7**	-19.2**	
CREDITC	$r \leq 3$	320**	234**	396**	307**	Panel-ADF	-7.17**	-7.49**	-5.88**	
SAVC	$r \leq 4$	193**	169**	268**	225**	Group-rho	1.93*	3.82**	1.69*	
GDPC	$r \leq 5$	125	125	266**	266**	Group-PP	-20.9**	-21.7**	-16.5**	
						Group - ADF	-6.65**	-5.48**	-4.97**	

**, ** indicate 5% and 1% degree of statistical significance*
***Source:** Author's computation.*

Both the trace test and the eigen-value statistics of Johansen-Fisher test under the assumption that the long run relationship is devoid of intercept and trend show that that there is at least five cointegrating relationship between the variables. The statistics under the alternative assumption that the cointegrating relationship has both intercept and trend also established no less than five cointegrating relationships. Most of the Pedroni test statistics under the three different assumptions (i. that the cointegrating relationships have intercept but no trend, ii. that they have both intercept and trend, iii. that they neither have intercept nor trend) are significant at 5% or less because they are larger than the critical (absolute) value of 1.64 (Asteriou and Hall, 2007), and thus affirm cointegration between the variables. Kao cointegration test does not disagree with other tests.

5. Empirical evidence

This section discusses the results from the empirical analysis of the effects of lending rates and saving rates on consumption volatility. It also analyses their implication for consumption smoothing and intertemporal utility maximisation. The nexus is examined in a sample of 117 countries and 2 subsamples: one with 34 developed countries and the other with 83 developing countries.

5.1. Consumption Volatility and Interest Rates

The effects interest rates on consumption volatility in the sample of 117 countries are presented in table 4 below. The table also highlights the effects of credit, saving and income (GDP) on consumption volatility. Both the 2SLS and GMM models perform satisfactorily in explaining consumption volatility as the Wald statistics are statistically significant. Other statistics for the GMM model also indicate satisfactory performance: the Sargan test statistic did not reject the null that over-identifying restrictions are valid while the absence of second order autocorrelation shows that the GMM estimators are consistent (Arellano and Bond, 1991; Baltagi, 2005).

Lending rate did not reduce consumption volatility and neither does evidence show that it worsens it. Both 2SLS and GMM models report statistically insignificant negative effects of the rates on consumption volatility. This suggests that consumers are not encouraged by lending rate to borrow to smooth their consumption and shield it from income volatility; hence, the rate did not significantly mitigate consumption volatility. However, there is potential for the rate to reduce the volatility as evidence shows that the rate did not worsen the volatility at all: only that the consumption-

smoothing effects of the rate are statistically insignificant. One reason for this result is that lending rate is generally high: the mean and the median lending rate in the 117 countries sampled are 17.2% and 11.0% respectively (see table 1 above). The double digit median rate can discourage consumption borrowing because repayment will reduce the future income and consumption[6].

Saving rates significantly reduced consumption volatility. The 2SLS and GMM estimators are negative and statistically significant. These results suggest that consumers are responsive, and not averse, to saving rates in smoothing their consumption path. The rates are not too low to discourage saving in a period of income surplus. The mean and median saving rates in the sampled countries, as shown in table 1 above, are 13% and 5.0% respectively. Neither are they too high to encourage savings that would cause fluctuations of marginal utility of consumption.

Saving however did worsen consumption volatility and this result suggests that saving had not created enough buffers by which the consumption may be smoothed. On the other hand, evidence from the 2SLS model shows that credits obtained from banks reduced consumption volatility at 10% level of statistical significance while the estimates from the GMM model only indicate that credit only had the potential to smooth consumption and reduce its volatility.

Table 4

Consumption volatility and Interest (all the countries)

Dependent Variable: Consumption volatility		
	2SLS	Sys. GMM
Explanatory Variables		
Volatility in the previous period		0.116*** (0.000)
GDP	0.030 (0.390)	-0.077*** (0.000)
Lending rate	-0.101 (0.209)	0.073 (0.486)
Saving rate	-0.140*** (0.007)	-0.0158** (0.039)
Credit	-0.032* (0.064)	-0.011 (0.345)
Saving	0.062*** (0.000)	0.082*** (0.000)

Constant	11.23 (0.000)	-0.0081 (0.373)
Estimation Statistics		
Wald χ^2 statistics	77.39*** (0.000)	185.2*** (0.000)
Sargan test Stat.		69.39 (0.167)
Autocorr. test (1st order)		-5.084 (0.000)
Autocorr. test (2nd order)		1.421 (0.1553)
No of countries	116	116

All variables in natural logarithms, and in per capita except the interest rates
, ** and * indicate 10%, 5% and 1% degree of statistical significance*
Source: *Author's computation.*

The GMM model shows that higher income is conducive to consumption smoothing as GDP reduced consumption volatility significantly. The model also shows that consumption volatility is persistent: volatility in one period induced consumption to be volatile in the subsequent period. The result suggests that it would take consumers some time to attain their optimal inter-temporal consumption path once consumption is perturbed.

5.2. Consumption volatility and interest rates in developed countries

Table 5 shows that lending rates reduced consumption volatility in developed countries unlike in the whole sample. This result is not surprising because the mean and median lending rates in developed countries of 12.6% and 7.5% respectively are much lower than those of the whole sample of 17.2% and 11.0% respectively (see table 1 above). The low lending rates in the developed countries did not discourage borrowing for income smoothing. Results from the 2SLS and GMM confirm this as they show that lending rates significantly reduced consumption volatility at 10% and 1% respectively.

Saving rates did not however reduce volatility of consumption spending and neither did they worsen it. That the rates did not reduce consumption volatility may not be unconnected to its low values, relative to those in whole sample of countries: the mean and the median saving rates in developed countries are 7.2% and 3.6% respectively while those of the whole sample 13% and 5% respectively. Consumers in the developed countries may not thus be encouraged to save enough in periods of income surplus due to lower rates; hence the rates did not conduce to lowering consumption volatility.

Evidence from the GMM supports that saving in developed countries reduced consumption volatility and is thus conducive to consumption smoothing and inter-temporal utility maximisation. This effect of saving on consumption volatility is statistically significant at 5%. The 2SLS model however suggests otherwise and this contradictory result is only significant at 10%. Also, both the 2SLS and GMM estimators did not report credit or bank lending to consumers as worsening volatility.

Table 5

Consumption volatility and interest rates in developed countries

Dependent Variable: Consumption volatility		
	2SLS	Sys. GMM
Explanatory Variables		
Volatility in the previous period		-0.113*** (0.000)
GDP	-0.125* (0.064)	-0.102*** (0.000)
Lending rate	-0.212* (0.065)	0.425*** (0.001)
Saving rate	-0.049 (0.480)	0.095 (0.252)
Credit	0.243 (0.558)	-0.003 (0.573)
Saving	0.085* (0.052)	-0.025** (0.012)
Constant	11.23 (0.000)	-0.0081 (0.373)
Estimation Statistics		
Wald χ^2 statistics	86.76*** (0.000)	9205.4*** (0.000)
Sargan test Stat.		27.64 (1.000)
Autocorr. test (1st order)		-2.208** (0.038)
Autocorr. test (2nd order)		1.098 (0.272)
No of countries	34	34

All variables in natural logarithms, and in per capita except the interest rates
, ** and * indicate 10%, 5% and 1% degree of statistical significance*
Source: *Author's computation.*

As in the whole sample, income mitigates consumption volatility in developed countries: results from both the 2SLS and GMM show statistically significant evidence for the inverse relationship between income and consumption volatility. These results indicate that higher income is conducive to consumption smoothing as GDP reduced consumption volatility significantly; they agree with the Keynesian theory that average propensity to consume (APC) declines with income. The lower the APC, the lower the consumption-income affinity and the lower the chances that income volatility drives consumption volatility. The effect of income on consumption smoothing is much stronger in developed countries than the whole sample. In addition, consumption volatility in one period did not worsen volatility in the subsequent periods.

5.3. Consumption volatility and interest rates in developing countries

Neither lending rates nor saving rates reduced consumption volatility in developing countries. Lending rates are high, with mean and median rates being 19.1% and 13.0% respectively. The high lending rates may discourage borrowing for consumption smoothing and hence worsen volatility. The saving rates too are relatively high and may have so distorted consumption-saving relationship that they no longer mitigate consumption volatility.

Saving and credits did not reduce consumption volatility in developing countries. Results from both the 2SLS and GMM estimations showed that saving increased consumption volatility at 10% significance while the 2SLS estimation provides the evidence the credit worsened the volatility at 1% level of statistical significance. These results may not be unconnected with the effects of lending and saving rates on consumption volatility.

Gross domestic product (GDP) did not reduce consumption volatility; rather, it worsens it. The 2SLS estimation shows that it increased the volatility at 1% significance. This may not be unconnected to the fact that incomes in developing economies are low, relative to the developed counterparts: the mean and median income per capita in developing countries are $2,167 and $584 respectively while those in developed countries are $58,404 and $12,464 respectively. The proportion of the income spent on consumption in developing economies may thus be so high that consumption may fluctuate significantly when income changes.

Table 6

Consumption volatility and interest rates in developing countries

Dependent Variables: Consumption volatility		
	2SLS	Sys. GMM
Explanatory Variables		
Volatility in the previous period		-0.160*** (0.003)
GDP	0.463*** (0.000)	-0.016 (0.669)
Lending rate	-0.015 (0.884)	-0.179 (0.498)
Saving rate	-0.010 (0.892)	0.085 (0.713)
Credit	0.100*** (0.000)	0.009 (0.630)
Saving	0.036* (0.071)	0.064* (0.097)
Constant	6.978*** (0.000)	8.789*** (0.000)
Estimation Statistics		
Wald χ^2 statistics	76.83*** (0.000)	27.08*** (0.000)
Sargan test Stat.		59.41 (0.461)
Autocorr. test (1st order)		-4.526** (0.000)
Autocorr. test (2nd order)		0.759 (0.448)
No of countries	83	83

All variables in natural logarithms, and in per capita except the interest rates
*, ** and *** indicate 10%, 5% and 1% degree of statistical significance
Source: *Author's computation.*

6. Concluding remarks

The stochastic nature of earned income often leads to divergence of consumption (driven by total income) from its optimal path. To maximise utility,

consumers save and borrow at prevailing saving rates and lending rates respectively; and this enables them to smooth their consumption path and minimise utility-reducing fluctuations in consumption. Saving rates and lending rates may however influence saving and borrowing decisions, and their effects on consumption volatility.

This study examined the extent to which lending and saving rates conduce to consumption smoothing and, in extension, inter-temporal utility maximisation by analysing the effects of the rates on consumption volatility in a large sample of 117 countries, as well as subsamples of 34 developed countries and 83 developing countries. The inter-temporal utility maximisation framework was employed and both the 2SLS and GMM estimation techniques were used to analyse the nexus due to endogeneity.

Saving rates significantly affected intertemporal consumption of consumers in most economies. The potential of the rate to reduce consumption volatility in developed countries is however higher than in developing countries. By reducing the consumption fluctuations, the rates enhanced the ability of households to maximise their utility via consumption smoothing.

Lending rates did not significantly reduce consumption volatility in many economies. They however did in developed economies. The effect of lending rates on consumption volatility in developed economies may be due to the fact that the rates tend to be relatively lower in developed economies.

Governments of developing economies should thus implement policies that would reduce lending rates for consumers in such a way that the rates do not discourage borrowing. This would go way to reduce consumption volatility and maximise consumers' welfare.

End Notes

1 This assumption embeds a situation where consumption includes bequest as a good from which the consumers derive utility assumption. It relies on local non-satiation condition for consumption goods, with more preferred to less as marginal utility of consumption is assumed to remain positive for all values, therefore justifying exhaustion of life time incomes.
2 The consumer is often constrained by socio-institutional arrangements from leaving behind debt; and this is manifested in the limit of credit he/she can obtain, conditional on his/her life-time wealth. The budget constraints must be satisfied and the consumer cannot consume more than his wealth. This is described as the 'non-ponzi game' situation.

3 Romer (2006) shows that in equilibrium, $\frac{C_{t+1}}{C_t} = \left(\frac{1+r}{1+\beta}\right)^{1/\theta}$ with *C, r B*, and θ being consumption, interest (saving) rate, discount factor and elasticity of intertemporally substituting consumption in one period for another or allocating resources to consumption in different period. The higher the saving rate above the discount factor, the higher the saving rate as the consumption in today would be less than tomorrow.

4 The consumer is often constrained by institutional/economic from leaving behind debt; and this is manifested in the limit of credit he/she can obtain, conditional on his/her life-time wealth. The budget constraints must be satisfied and the consumer cannot consume more than his/her wealth. This is described as the 'non-ponzi game' situation.

5 Use of GDP per capita and aggregate consumption capita to represent income and consumption of representative consumers respectively follows Challe and Ragot (2013).

6 Consumption borrowings are assumed not to be invested. Thus there are no proceeds from any investment to finance interest (and principal) repayment. Thus, repayment only comes from future income and the latter is reduced by the former.

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