# THE INTERTEMPORAL APPROACH TO THE CURRENT ACCOUNT FOR SOUTH AFRICA

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## Overview

- Introduction
  - Aim of study
  - Literature overview
- Current account balance of South Africa
- Theoretical background
- Data and empirical results
- Concluding remarks



## Introduction

- Current Account (CA) based on 2 perspectives derived from accounting identities
  - Patterns of international trade and payments
  - National savings and investments
  - Open economies: capital mobility → CA imbalances
  - Small economy is expected to smooth consumption due to output shocks by borrowing/lending & thereby running a CAdeficit/surplus
  - Intertemporal approach based on latter and is defined as: the outcome of forward-looking rational consumption-saving and investment decisions of economic households



## Aim of study

- Construct a benchmark (optimal) CA series
  - Compare with actual CA given expectations of output shocks
  - Important to include households' knowledge about developments that might affect optimal choices
  - Campbell and Shiller (1987) argue that the CA captures information
- Thus; benchmark and actual CA series are identical, output shocks affect both
- Intertemporal model predict: CA operates as a buffer to smooth consumption when faced with economic shocks to national cash flow
- Standard models to test the consumption-smoothing theory derived from present-value models (Campbell, 1987 and Campbell & Shiller, 1987)



## Literature overview

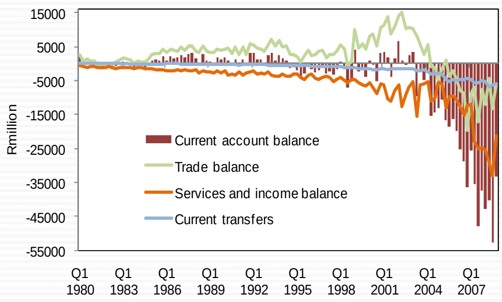
| Author(s) | Country | Validity of intertemporal model |
|---|---|---|
| Khundrakpam & Ranjan (2008) | India | Not rejected |
| Ghosh & Ostry (1995) | India | Not rejected |
| Sheffrin & Woo (1990) | Belgium | Not rejected |
| Campa & Gavilán (2006) | Belgium | Not rejected |
| Obstfeld & Rogoff (1994) | Sweden | Not rejected |
| Otto (2003) | Australia | Not rejected |
| Cashin & McDermott (2002) | Australia | Not rejected |
| Ghosh (1995) | Canada<br>Germany<br>Japan<br>UK<br>US | Not rejected<br>Not rejected<br>Not rejected<br>Not rejected<br>Not rejected |



## Literature overview *(continued...)*

| Author(s) | Country | Validity of intertemporal model |
|---|---|---|
| Milbourne & Otto (1992) | Australia | Not rejected |
| Guest & McDonald (1998) | Australia | Reject |
| Sheffrin & Woo (1990) | Canada<br>Denmark<br>UK | Reject<br>Reject<br>Reject |
| Saksonovs (2006) | Germany<br>South Africa<br>UK | Not rejected<br>Not rejected<br>Not rejected |
| | | |

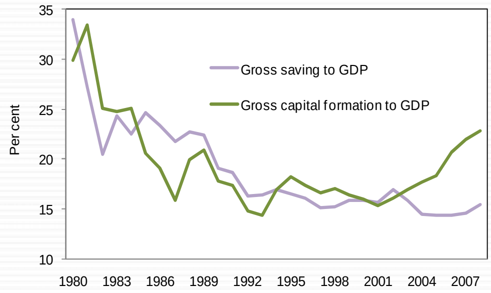
## Current account balance of South Africa




Source: SA Reserve Bank



## Current account balance of South Africa *(continued...)*




Source: SA Reserve Bank



## Theoretical background

- The present-value model is derived from the permanent-income theory of consumption to:
  - a small open economy;
  - an infinite time horizon;
  - single homogenous good;
  - free capital mobility

  - Permanent-income hypothesis (Friedman, 1957): consumption depends on what households expect to earn over a period of time
  - Households smooth out fluctuations in income to save during periods of high income and dis-save during periods of low income



## Theoretical background *(continued...)*

- Following Ghosh (1995), the economy is represented by a household who maximises lifetime utility from consumption:

$$u_t = \sum_{j=0}^{\infty} \beta^t E[u(c_t)] \qquad (1)$$

where $\beta$ is the subjective discount rate $(0<\beta<1)$ that reflects preference for current consumption over future consumption;

$u$ is the utility function such that $u'>0,\ u''<0$

$c_t$ is the consumption of a single good; and

$E$ is the expectations operator



## Theoretical background *(continued...)*

- Intertemporal budget constraint:

$$b_{t+1} = (1+r)b_t + q_t - c_t - i_t - g_t \qquad (2)$$

where $b$ denotes the level of foreign assets/bonds;

$q$ is the level of output or GDP;

$i$ is investment;

$g$ is government spending;

$r$ is the fixed world interest rate



## Theoretical background *(continued...)*

- Household maximises (1) subject to (2):

$$c_t^* = \frac{r}{\theta}\left\{b_t + \frac{1}{1+r}E_t\left[\sum_{j=0}^{\infty}\frac{1}{(1+r)^j}\Delta(zb_{t+j})\right]\right\} \qquad (3)$$

where $c_t^*$ denotes the optimal level of consumption

- Equation (3) decomposed into:
  - consumption-smoothing component and;
  - consumption-tilting component
  - The consumption-tilting parameter; $\theta$ is estimated as the coefficient of $c_t$ in the regression of national cash flow $z_t$ including interest payments, i.e. $zb_t = q_t + rB_t - i_t - g_t$ on $c_t$

## Theoretical background *(continued...)*

- If $\theta<1$ ⇒ consumption exceeds current permanent cash flow (tilt consumption towards present)
- If $\theta>1$ ⇒ tilt consumption towards future
- If $\theta=1$ ⇒ consumption = permanent cash flow
- The current account is defined as;

$$ca_t^* = y_t - i_t - g_t - \theta c_t^* \qquad (4)$$

where $y_t = q_t + rb_t$

- Consumption-smoothing behaviour:
  - current account surplus ⇒ country is lending when output increases relative to its permanent level
  - current account deficit ⇒ country is borrowing when output falls below its permanent level



## Theoretical background *(continued...)*

- By substituting equations (3) and (4):

Optimal current account is obtained as follows;

$$ca_t^* = zb_t - \frac{r}{\theta}\left\{b_t + (1+r)^{-1}E_t\sum_{j=0}^{\infty}(1+r)^{-j}(zb_{t+j})\right\} \qquad (5)$$

by assuming $\theta=1$, and simplifying, the following is obtained;

$$ca_t^* = -E_t\sum_{j=1}^{\infty}(1+r)^{-j}\,\Delta(zb_{t+j}) \qquad (6)$$

- (6) represents the optimal current account as the expected present discounted value of changes in national cash flow
- Expected transitory shocks affect current account balance
- Optimal level of cash flow ⇒ smooth consumption in presence of shocks to components of $zb_t$



## Data and empirical results

- The current account is defined as; $ca_t^* = y_t - i_t - g_t - \theta pc_t^*$

where *y* is gross national product (GNP);

*pc* is private consumption spending;

*i* is total investment;

*g* is government consumption at time *t*

$\theta$ is the estimated consumption-tilting parameter

- National cash flow inclusive of interest payments is represented by;

$zb_t = q_t + rb_t - i_t - g_t$

where *q* is real gross domestic production (GDP) and

*b* is net foreign assets



## Data and empirical results *(continued...)*

- Quarterly SA data from SARB and IMF (IFS)
- Full sample period: 1980Q1-2008Q4
- Sub-samples: 1980Q1-1994Q4 and 1995Q1-2008Q4 and 2001Q1-2008Q4
- Nominal values deflated by using CPI
- Per capita terms: divide data by level of total population
- World interest rate: 4%

(Sheffrin & Woo, 1990; Ghosh, 1995; Ghosh & Ostry, 1995, Cashin & McDermott, 1998 & 2002)

- Constant interest rate: small open economy not affect world interest rate



**Testable implications**

**Present-value model hypothesis**

- Stationary optimal *ca* series
- Long-run relationship between *zb* and *pc* as $ca_t = zb_t - \theta c_t$
- CA Granger-cause $\Delta zb$
- Coefficient on $\Delta zb$=0 and coefficient on *ca*=1

**Other implications (optimal vs actual ca)**

- Correlation coefficient
- Equality of variances (receive sufficient capital flows to ensure consumption-smoothing)



## Data and empirical results *(continued...)*

### *a) Unit root tests*

| | | Stationary | Non-stationary* |
|---|---|---|---|
| ADF-test | 1980-2008 | Δzb | ca pc zb |
| | 1980-1994 | ca zb Δzb | pc |
| | 1995-2008 | zb Δzb | ca pc |
| | 2001-2008 | ca pc zb Δzb | - |
| PP-test | 1980-2008 | ca zb Δzb | pc |
| | 1980-1994 | ca pc zb Δzb | - |
| | 1995-2008 | ca pc zb Δzb | - |
| | 2001-2008 | ca pc zb Δzb | - |

* Stationary after taking first differences

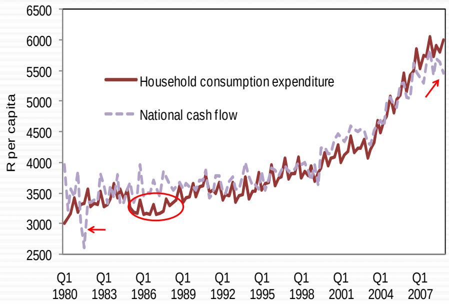
## Data and empirical results *(continued…)*

*b) Consumption tilting component (θ)*

- Determine $\theta$ to estimate optimal CA
- $\theta$ is cointegrating vector between *zb* and *pc*
- Cointegration is necessary as $ca_t = zb_t - \theta pc_t$
- ADF-test: *zb* and *pc* is non-stationary for 1980Q1-2008Q4
- Johansen cointegration test
- One cointegrating vector for full period and sub-periods



## Plot of national cash flow and household consumption
(1980Q1-2008Q4)






## Data and empirical results *(continued…)*

*b) Consumption tilting component*

- Long-run coefficient ($\theta$) between $zb_t$ and $pc_t$ is
- 0.827 ⇨ 1980Q1-2008Q4
- Consumption tilted towards current period

- 1.048 ⇨ 1980Q1-1994Q4
- Consumption tilted towards future

- 0.450 ⇨ 1995Q1-2008Q4
- 0.689 ⇨ 2002Q4-2008Q4



## Data and empirical results *(continued…)*

*b) Consumption tilting component*

- Nigeria: 0.85 (Adedeji, 2001)
- Ghana: 1.92 (Opoku-Afari, 2007)
- Turkey: 0.93 (Ogus & Sohrabji, 2006)
- India 0.93 (Khundrakpam & Ranjan, 2008)
- Ghosh & Ostry (1995) between 0.90 and 0.98 for:

  Ghana, Tunisia, India, Malaysia, Philippines, Thailand, Argentina, Brazil, Colombia, Guatemala, Mexico, Peru & Uruguay
- Ghosh & Ostry : most developing countries tilt consumption to present



## Actual and optimal current account

- Unrestricted VAR (Campbell & Shiller, 1987)
- *ca* and $\Delta zb$ is stationary during all periods
- Lag length of 5 periods (SC)
- Quarterly centered seasonal dummy variables



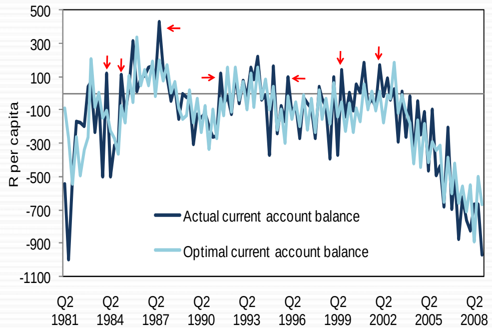
## Actual and optimal current account *(continued…)*

1980Q1-2008Q4

1) -0.236 [F-stat: 2.825 (p-value: 0.028)]
2) Reject hypothesis that *ca* does not GC $\Delta zb$ [F-stat: 2.252 (p-value 0.054)]
3) Optimal CA is stationary [PP-test]
4) Coefficient on
   a) $\Delta zb=0$ [F-stat: 1.887 (p-value: 0.103)]
   b) $ca=1$ [F-stat: 686.751 (p-value: 0.000)]

- CA helps predict future changes in *zb*
- Capital flows reflect consumption-smoothing behaviour
- Private consumption in SA was optimal
- Results (except 4b) in favour of present-value model

## Actual and optimal current account 1980Q1-2008Q4






## Actual and optimal current account *(continued...)*

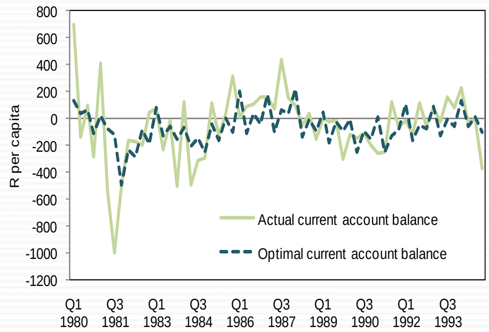
1980Q1-1994Q4

1) -0.435 [F-stat: 9.880 (p-value: 0.002)]
2) Reject hypothesis that ca does not GC $\Delta zb$ [F-stat: 14.116 (p-value 0.000)]
3) Optimal CA is stationary [PP-test]
4) Coefficient on
   a) $\Delta zb=0$ [F-stat: 3.093 (p-value: 0.084)]
   b) $ca=1$ [F-stat: 107.383 (p-value: 0.000)]

- CA helps predict future changes in *zb*
- Capital flows reflect consumption-smoothing behaviour
- Private consumption in SA was optimal before 1994
- Results (except 4) in favour of present-value model



## Actual and optimal current account 1980Q1-1994Q4






## Actual and optimal current account *(continued...)*

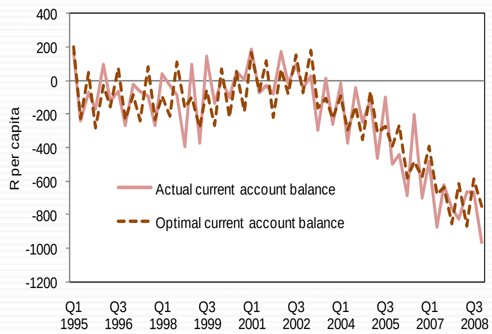
1995Q1-2008Q4

1) -0.093 [F-stat: 1.201 (p-value: 0.278)]
2) Fail to reject hypothesis that *ca* does not GC $\Delta zb$ [F-stat: 2.429 (p-value 0.125)]
3) Optimal CA is stationary [PP-test]
4) Coefficient on
   a) $\Delta zb=0$ [F-stat: 7.201 (p-value: 0.009)]
   b) $ca=1$ [F-stat: 165.852 (p-value: 0.000)]

- CA fail to predict future changes in *zb*
- Capital flows do not reflect consumption-smoothing behaviour
- Private consumption in SA was not optimal after 1995
- Results (except 3) not consistent with present-value model



## Actual and optimal current account 1995Q1-2008Q4





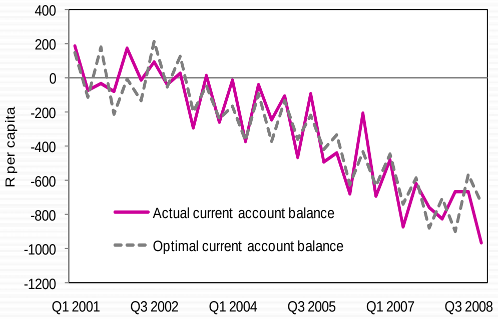

## Actual and optimal current account *(continued...)*

2001Q1-2008Q4

1) -0.046 [F-stat: 0.227 (p-value: 0.637)]
2) Fail to reject hypothesis that *ca* does not GC $\Delta zb$ [F-stat: 0.824 (p-value 0.371)]
3) Optimal CA is stationary [PP-test]
4) Coefficient on
   a) $\Delta zb=0$ [F-stat: 2.297 (p-value: 0.142)]
   b) $ca=1$ [F-stat: 113.674 (p-value: 0.000)]

- CA fail to predict future changes in *zb*
- Capital flows do not reflect consumption-smoothing behaviour
- Private consumption in SA was not optimal after 1995
- Results (except 3 & 4a) not consistent with present-value model

## Actual and optimal current account 2001Q1-2008Q4






## Actual and optimal current account *(continued…)*

- Other testable implications
- Ability of consumption-smoothing model to track actual CA

| Sample period | Variance (σ) ca | Variance (σ) ca* | σ-ratio | Tests for equality of σ | | Correlation coefficient (p-value) |
|---|---|---|---|---|---|---|
| | | | | F-test (p-value) | Siegel-Tukey (p-value) | |
| 1980-2008 | 76072 | 49326 | 1.542 | 1.542 (0.024) | 1.726 (0.084) | 0.805 (0.000) |
| 1980-1994 | 683115 | 16339 | 4.180 | 4.180 (0.000) | 3.508 (0.000) | 0.546 (0.000) |
| 1995-2008 | 85477 | 68446 | 1.248 | 1.248 (0.412) | 1.032 (0.301) | 0.890 (0.000) |
| 2001-2008 | 110384 | 94512 | 1.167 | 1.167 (0.668) | 1.148 (0.251) | 0.930 (0.000) |

Note: ca* denotes optimal current account
Variance ratio=σ(ca)/σ (ca*)



## Comparison of work on SA

| | **Saksonovs (2006)** | **Blignaut (2009)** |
|---|---|---|
| Time period | 1975Q1-2003Q4 | 1980Q1-2008Q4 |
| Data frequency | Quarterly | Quarterly |
| Model | Standard model extended | Standard model not extended |
| Variables | Tradable & Non-tradable prices (REER) | - |
| Current account | =Net output-c (in logs) | =GNP-c-i-g |
| National cash flow | =GDP-i-g (in logs) | =GDP+(rb)-i-g |
| Interest rate | G7 T-bill rate/money market rate | Fixed rate of 4% p.q. |
| Consumption tilting parameter | $1/(1-r^{-w})$ 0.98 (fixed across all countries) | Cointegrating vector between *zb* and *pc* 0.827 (1980Q1-2008Q4) |
| Variance | Optimal >actual | Actual>optimal |



## Concluding remarks

- Forward-looking intertemporal saving and investment decisions
- Consumption tilted towards present in SA
- Ability to track behaviour of SA current account
  - Current account help predict national cash flow (consumption-smoothing)
  - Strong correlation (unconstrained CA)
  - Actual CA more volatile that predicted optimal CA
  - Liberated capital inflows
  - “Over-borrowing” to finance consumption
  - Ostry (1997) & Goh (2007): problematic/unsustainable CA



## Concluding remarks *(continued…)*

- Some restrictions rejected
- Only partial support for intertemporal model
- Otto (1992) & Ostry (1997): although restrictions not met: model explains current account as long as predicted CA series tracks actual series well

- Standard model is stylized
- Extensions to relax assumptions to improve descriptive power
- Small open economies affected by external shocks
- Further empirical work to include time-varying interest rates, distinguish between tradable and non-tradable goods and global oil prices



# Thank you

## Unit root tests

| Series | Level Form | | | First Difference | | |
|---|---|---|---|---|---|---|
| | ADF test | | PP- test | ADF test | | PP- test |
| | | Lag length | | | Lag length | |
| **1980Q1-2008Q4** | | | | | | |
| $ca_t$ (T) | -1.187 | 3 | -8.554*** | -11.508*** | 2 | |
| $pc_t$ (T) | -2.070 | 8 | -1.928 | -1.764* | 7 | -24.538*** |
| $zb_t$ (T) | -1.077 | 3 | -4.897*** | -12.523*** | 2 | |
| $\Delta zb_t$ (T) | -12.607*** | 2 | -23.794*** | | | |
| **1980Q1-1994Q4** | | | | | | |
| $ca_t$ (T) | -3.707** | 1 | -6.608*** | | | |
| $pc_t$ (T) | -3.106 | 9 | -5.447*** | *-2.272*** | 7 | |
| $zb_t$ (T) | -6.289*** | 1 | -8.233*** | | | |
| $\Delta zb_t$ (T) | -5.187*** | 10 | -21.705*** | | | |
| **1995Q1-2008Q4** | | | | | | |
| $ca_t$ (T) | -0.358 | 3 | -5.574*** | -9.133*** | 2 | |
| $pc_t$ (T) | -2.683 | 7 | -3.431* | -2.759* (I) | 4 | |
| $zb_t$ (T) | -4.537*** | 0 | -4.527*** | | | |
| $\Delta zb_t$ (T) | -7.401*** | 2 | -25.458*** | | | |
| **2001Q1-2008Q4** | | | | | | |
| $ca_t$ (T) | -8.414*** | 0 | -7.498*** | | | |
| $pc_t$ (I) | -3.141** | 7 | -4.255** | | | |
| $zb_t$ (T) | -3.451* | 1 | -3.794** | | | |
| $\Delta zb_t$ (T) | -7.312*** | 1 | -9.855*** | | | |

Note: T (Linear trend and intercept), I (Intercept) included in test equation in parentheses (). *(**)[***] Statistically significant at a 10(5)[1] % level. Lag length of ADF test was selected based on SIC criterion and PP-test is based on Newey-West using Bartlett Kernel method.



## Johansen cointegration test

| Null Hypothesis | | 5% critical value |
|---|---|---|
| **1980Q3-2008Q4 No deterministic trend (restricted constant) - 1 lag** | | |
| | $\lambda\ trace$ | |
| r=0 | 31.588 | 20.261 (0.000) |
| r≤1 | 7.570 | 9.164 (0.099) |
| | $\lambda\ max$ | |
| r=0 | 24.017 | 15.892 (0.002) |
| r=1 | 7.570 | 9.164 (0.099) |
| **1981Q3-1994Q4 No deterministic trend (restricted) - 5-lags** | | |
| | $\lambda\ trace$ | |
| r=0 | 13.071 | 12.320 (0.037) |
| r≤1 | 0.451 | 4.129 (0.565) |
| | $\lambda\ max$ | |
| r=0 | 12.620 | 11.224 (0.028) |
| r=1 | | |
| **1995Q3-2008Q4 Linear deterministic trend (restricted) - 1-lag** | | |
| | $\lambda\ trace$ | |
| r=0 | 25.601 | 25.872 (0.054) |
| r≤1 | 3.689 | 12.517 (0.786) |
| | $\lambda\ max$ | |
| r=0 | 21.911 | 19.387 (0.021) |
| r=1 | 3.689 | 12.517 (0.786) |
| **2002Q4-2008Q3 No deterministic trend (restricted constant) - 6-lags** | | |
| | $\lambda\ trace$ | |
| r=0 | 26.942 | 20.261 (0.005) |
| r≤1 | 4.368 | 9.164 (0.360) |
| | $\lambda\ max$ | |
| r=0 | 22.574 | 15.892 (0.003) |
| r=1 | 4.368 | 9.164 (0.360) |

*p* -value in parentheses ()



## VAR test (1980Q1-2008Q4)

| | $ca_t$ | $\Delta zb_t$ | $X_t$ |
|---|---|---|---|
| $ca_{t-1}$[t-statistic] | 0.706 [2.946] | -0.323 [-1.318] | |
| $ca_{t-2}$[t-statistic] | 0.018 [0.053] | -0.196 [-0.562] | |
| $ca_{t-3}$[t-statistic] | 0.216 [0.646] | 0.497 [1.450] | |
| $ca_{t-4}$[t-statistic] | 0.621 [1.848] | 0.320 [0.929] | |
| $ca_{t-5}$[t-statistic] | -0.865 [-3.331] | -0.534 [-2.006] | |
| $\Delta zb_{t-1}$[t-statistic] | -0.389 [-1.596] | -0.322 [-1.288] | |
| $\Delta zb_{t-2}$[t-statistic] | -0.243 [-0.988] | -0.004 [-0.019] | |
| $\Delta zb_{t-3}$[t-statistic] | -0.327 [-1.327] | -0.279 [-1.104] | |
| $\Delta zb_{t-4}$[t-statistic] | -0.748 [-2.984] | -0.417 [-1.624] | |
| $\Delta zb_{t-5}$[t-statistic] | 0.145 [1.577] | 0.154 [1.635] | |
| $\overline{R}^2$ | 0.601 | 0.426 | |
| | | | |
| Joint significance of lags of $ca_t$ F-statistic (p-value) | | | 80.431 (0.000) |
| Joint significance of lags of $\Delta zb_t$ F-statistic (p-value) | | | 12.412 (0.000) |
| | | | |
| Joint significance of lags of ca $H0: ca_{t-1\ldots-5} = 0$ F-statistic (p-value) | 2.825 (0.028) | | |
| Sum of coefficients on lags of $ca$ | -0.236 | | |
| $H0: \Delta zb_{t-1\ldots-5} = 0$ F-statistic (p-value) | 1.887 (0.103) | | |
| $H0: ca_{t-1\ldots-5} = 1$ F-statistic (p-value) | 686.751 (0.000) | | |
| $H0: \Delta zb\ does\ not\ GC\ ca$ F-statistic (p-value) $H0: \Delta ca\ does\ not\ GC\ \Delta zb$ F-statistic (p-value) | 6.294 (0.000) 2.252 (0.054) | | |



## VAR test (1980Q1-1994Q4)

| | $ca_t$ | $\Delta zb_t$ | $X_t$ |
|---|---|---|---|
| $ca_{t-1}$[t-statistic] | 0.475 [3.332] | -0.435 [-3.143] | |
| $\Delta zb_{t-1}$[t-statistic] | -0.170 [-1.293] | -0.225 [-1.758] | |
| $\overline{R}^2$ | 0.198 | 0.443 | |
| | | | |
| Joint significance of lags of $ca_t$ F-statistic (p-value) | | | 4.519 (0.037) |
| Joint significance of lags of $\Delta zb_t$ F-statistic (p-value) | | | 0.236 (0.628) |
| | | | |
| Joint significance of lags of ca $H0: ca_{t-1} = 0$ F-statistic (p-value) | 9.880 (0.002) | | |
| Sum of coefficients on lags of $ca$ | -0.435 | | |
| $H0: \Delta zb_{t-1} = 0$ F-statistic (p-value) | 3.093 (0.084) | | |
| $H0: ca_{t-1} = 1$ F-statistic (p-value) | 107.383 (0.000) | | |
| $H0: \Delta zb\ does\ not\ GC\ ca$ F-statistic (p-value) $H0: \Delta ca\ does\ not\ GC\ \Delta zb$ F-statistic (p-value) | 0.007 (0.932) 14.116 (0.000) | | |



## VAR test (1995Q1-2008Q4)

| | $ca_t$ | $\Delta zb_t$ | $X_t$ |
|---|---|---|---|
| $ca_{t-1}$[t-statistic] | 0.940 [12.157] | -0.093 [-1.096] | |
| $\Delta zb_{t-1}$[t-statistic] | -0.415 [-3.486] | -0.350 [-2.683] | |
| $\overline{R}^2$ | 0.765 | 0.403 | |
| | | | |
| Significance of lag of $ca_t$ F-statistic (p-value) | | | 9.988 (0.051) |
| Significance of lag of $\Delta zb_t$ F-statistic (p-value) | | | 0.582 (0.448) |
| | | | |
| Significance of lag of ca $H0: ca_{t-1} = 0$ F-statistic (p-value) | 1.201 (0.278) | | |
| Sum of coefficient on lag of $ca$ | -0.093 | | |
| $H0: \Delta zb_{t-1} = 0$ F-statistic (p-value) | 7.201 (0.009) | | |
| $H0: ca_{t-1} = 1$ F-statistic (p-value) | 165.852 (0.000) | | |
| $H0: \Delta zb\ does\ not\ GC\ ca$ F-statistic (p-value) $H0: \Delta ca\ does\ not\ GC\ \Delta zb$ F-statistic (p-value) | 5.816 (0.019) 2.429 (0.125) | | |



## VAR test (2001Q1-2008Q4)

| | $ca_t$ | $\Delta zb_t$ | $X_t$ |
|---|---|---|---|
| $ca_{t-1}$[t-statistic] | 0.959 [11.236] | -0.046 [-0.477] | |
| $\Delta zb_{t-1}$[t-statistic] | -0.531 [-3.052] | -0.303 [-1.515] | |
| $\overline{R}^2$ | 0.826 | 0.437 | |
| | | | |
| Joint significance of lags of $ca_t$ F-statistic (p-value) | | | 2.702 (0.111) |
| Joint significance of lags of $\Delta zb_t$ F-statistic (p-value) | | | 0.485 (0.491) |
| | | | |
| Joint significance of lags of ca $H0: ca_{t-1} = 0$ F-statistic (p-value) | 0.227 (0.637) | | |
| Sum of coefficients on lags of $ca$ | -0.046 | | |
| $H0: \Delta zb_{t-1} = 0$ F-statistic (p-value) | 2.297 (0.142) | | |
| $H0: ca_{t-1} = 1$ F-statistic (p-value) | 113.674 (0.000) | | |
| $H0: \Delta zb\ does\ not\ GC\ ca$ F-statistic (p-value) $H0: \Delta ca\ does\ not\ GC\ \Delta zb$ F-statistic (p-value) | 2.121 (0.156) 0.824 (0.371) | | |