The Impact of Macroeconomic Influence on Retirement Investments: A Case Study of New Zealand[1a]

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Abstract

This study investigates how aging populations affect stock prices in New Zealand, in particular, the effect of the 50-64 cohort moving from their peak investment decade into disinvestment from a dynamic perspective by considering fast- and slow-moving institutional changes for the period 1991-2017. A scientific LASSO approach is used to select macroeconomic variables which affect stock prices. The findings suggest that fast-moving institutional changes are mostly associated with unexpected market shocks rather than policy changes in terms of timing. Furthermore, there exists a long-run relationship between stock prices and aging population with the influence of other macroeconomic factors. However, aging population does not affect stock prices negatively, rejecting the predictions of Life-Cycle and Permanent Income Hypotheses. The findings reveal that policies seeking to mitigate a *stock-market meltdown* may be superfluous if the macroeconomic factors (such as real GDP and money supply) are ignored.

Keywords: Aging demography; Institutional changes; Macroeconomic variables; Stock market; Structural breaks; New Zealand.

JEL classification: G23; J10; J11

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Introduction

Aging populations are a major policy concern for the developed countries (DCs), leading to increasing worry over maintaining sustainable socio-economic balances (Cobb-Clark and Stillman, 2009). Consistent with the Life Cycle Hypothesis (LCH), governments encourage workers to save more during their working life so as to complement government pensions. The great-and-rising flow of investment into stock markets resulting from such plans are seen in countries such as Australia, New Zealand and the US. The US *401(k)*[2] and Superannuation (Australia and NZ) illustrate the serious concerns over an aging population which causes a melt-down of asset prices.

In an effort to defer such a melt-down and to better meet the needs of an aging, longer-lived population, Australian governement has instituted a series of staged increases to the age at which funds deposite under its compulsory superannuation scheme can be withdrawn and converted to a pension. These policy changes are in response to a growing body of research on longevity risk, growing fiscal expenditure[3] and policy options for economies. Bielecki *et al.* (2016) compare the welfare and macroeconomic effects of raising retirement age, separating the role of decreasing fertility and increasing longevity and considering labour-market effects. Wang *et al.* (2016) evaluate the sufficiency of retirement saving at an individual level and the sustainability of superannuation system using Australian Data. The finding suggests for policy options on how to reform retirement planing with retired-to-working-population ratios which

[2] Details are available at: www.401k.com/401k/about/basics.htm.

[3] Details are available at https://www.parliament.uk/business/publications/research/key-issues-parliament-2015/social-change/aging-population/.

is expected to rise from a current level of 20 to 28 percent, by 2060. Australia's taxation and retirement schemes, age-dependent structure of government spending; and population effects of fertility, longevity and immigration were evaluated by Kudrna *et al.* (2015) and they found that population aging shifts the tax base from labour income towards asset income and consumption, and the old-age related government expenditures increase substantially. Their findings suggest that the driving factors of the increased fiscal costs are the increase in survival (longevity) and downplays increases in fertility and in turn immigrations appear to be the solutions to the coming fiscal challenges.

The relationship between business cycle patterns and demographic swings combined with the effect of risk-averse characteristics of an aging population on capital markets, have been a popular research focus over the past few decades (e.g., Abel (2001); Bakshi and Chen (1994); Brooks (1999); Holtz-Eakin *et al.* (1993); Huynh *et al.* (2006)). Poterba (2004) asserts that an aging population can influence the stock market by shifting portfolio decisions from a longer- to a shorter-term focus, as post-retirees start drawing down (rather than adding to) their wealth portfolio. Huynh *et al.* (2006) found that the relative size of the 40-64 age cohort and Australian superannuation funds have significant effects on share prices. This study extends the Ando and Modigliani (1963) seminal study '*Life-Cycle Hypothesis*' (LCH) to re-investigate how changing demography affects stock markets in an small open developed economy evidence from New Zealand. While the relationship between the stock market and non-demographic macroeconomic variables is well researched for large-open DCs (Fama, 1990; Chen, 1991), the findings are often contentious in terms of policy formation. Further, there is a significant knowledge gap on the effect of demographic and macroeconomic variables on growing stock markets in small-open DCs. Importantly, rapid globalization has made small-open DCs more vulnerable to external shocks, which warrants further empirical investigation of these processes. This study advances the literature in several ways:

i) It uses the relatively untapped information of New Zealand, a comparatively small-open DC in the Asia-pacific region where macroeconomic forces acting on its economy are clearer and less convoluted than those in larger and more developed economies. Also, the regulatory level of NZ's Stock Exchange (NZSE) is not as great as those in other DCs (Gan *et al.*, 2006). NZ shows potentially strong growth for a capital market with its: reputation for political stability and investment potential with significant foreign direct investments[4] including fast emerging oil and gas with under-explored basins; high-value low-cost opportunities including finance and real estate; strong ties to USA and proximity to the high growth Australasian markets; and reduced tax on investments and movement to a systematic superannuation system (KiwiSaver) with essential supporting underpinnings already in place. In counterpoint, as a primary-product exporter and a price taker in world markets, NZ is sensitive to world prices. Given these strong points and counterpoints, it is essential for investors to be well informed on changes and their effects on investment outcomes. In 2003, the NZ government established the NZ Superannuation Fund (NZSF) with $2.4bn NZD and the value in June 2014 was $25.82bn billion NZD. However, because NZ superannuation is not compulsory and still at a formative stage, this study does not consider superannuation funds to explore the link. An insignificant relationship between an aging demography and stock price would be surprising, given that LCH effects are likely to be even stronger in small-open economies.

ii) It overcomes the limited static perspective of earlier research by examining dynamic fast- and slow- institutional-changes models (Tylecote, 2016) to capture the significant changes in NZ such as economic liberalization over last three decades;

[4] Details are available at: https://www.nzte.govt.nz/investment-and-funding/investment-statistics.

floating of the exchange rate; lowering of trade protections; fiscal restraint and monetary deflation; drastic changes to government policies; an aging population (a key policy concern; Appendix Table A1). Culpepper (2005) and Roland (2004) touched-off demand for more robust models in macroeconomic analyses, with fast-moving (formal) and slow-moving (informal) changes. Fast-moving (or formal) institutions, such as political and/or legal systems, do not necessarily change frequently but can change very rapidly, even overnight. Political and/or legal reform is often a necessary but insufficient condition for statistically significant fast-moving institutional changes, given that people's shared beliefs can persist even after changing the laws. Slow-moving (or informal) institutions are related to culture and include values, beliefs and social norms. The development of technology and scientific knowledge drives the evolution of culture. Slow-moving institutions change continuously, which produces inconsistencies with fast-moving institutions which, in turn, create pressures for fast changes. It is the interaction between slow-moving and fast-moving institutions that drive the institutional changes which, in turn, drives the dynamics of asset prices (Zhang *et al.*, 2017). An aging population and changing beliefs drive the evolution of culture and those changes precipitate change to slow-moving institutions, which drives fast-moving institutional change. Hence, institutional change (associated with the dynamics of asset prices) is driven by slow-moving institutions influencing fast-moving ones. Following the literature (Brown *et al.*, 1997; Zhang *et al.*, 2017), we use a structural break test to identify fast-moving institutional change and a time-varying-coefficient approach to detect slow-moving institutional changes in investigating the impact of changing demographic and macro-economic-variables on the NZ stock market.

iii) The use of monthly data (1991 to 2017) provides more detail analysis than the quarterly data used by Huynh *et al.* (2006) to study the relationship between stock prices and demography. The higher-frequency data captures changes more effectively (Frazzini and Pedersen, 2014).

iv) Unlike previous studies, this study provides a rationale for its selection of macroeconomic variables, by using an advanced *machine-learning-based* algorithm (*least absolute shrinkage and selection operator* (LASSO)) model (Tibshirani, 2011).

v) It refines the pre-retirement target group from the 40-64 cohort (Huynh *et al.*, 2006) to the 50-64 ($DEM_{50\text{-}64}$) cohort to adjust for the current workplace shift of retirement from the 50s to 60s and often well beyond (i.e. people are living longer, healthier and stay in workplace longer than prior generations). This shift suggests that the first half of the previous $DEM_{40\text{-}64}$ cohort (i.e. the 40-50 cohort) are still saving and investing. Unlike previous generations who often lived for less than decade after retiring, baby-boomers and subsequent generations fund three to five decades of retirement after age 65 working longer, retiring later, and/or investing more aggressively/strategically than earlier generations.

The empirical findings add to the knowledge of the business community and understanding of the NZ stock market in two respects: 1) Fast-moving-institutional-changes appear to be better match the unexpected market shocks rather than changes in policies in terms of timing (see Appendix Table A2); and 2) Cointegration tests suggest that there is no long-run relationship with stock price when we consider demographic factor only. Furthermore, there exists a long-run relationship between stock prices and aging population with the influence of other macroeconomic factors. However, aging population does not negatively affect stock prices, which reject the predictions of Life-Cycle and Permanent Income Hypotheses. Overall, our findings are mostly consistent with Poterba (2004).

In the rest of this study: Section 2 reviews the extant literature and hypotheses; Section 3, provides an overview of the methodology; Section 4 discusses the results; and Section 5 concludes the study, discusses its limitations and provides suggestions for future research.

2. Literature review and hypotheses development

2.1 Theoretical underpinning

Life Cycle Hypothesis (LCH) and *Permanent Income Hypothesis (PIH)*

The LCH (Modigliani and Brumberg, 1954; Ando and Modigliani, 1963; Modigliani, 1986) highlighted the income-to-wealth relationship, *vis-à-vis* the consumption-investment trade-off across the life-cycle. LCH implies that older households do not invest as heavily as when they were younger, because there is less time to recoup possible losses and to enjoy the average expected returns from investment. As a result, older households tend to shift from high-risk to low-risk assets. Its simplicity made it well accepted by policymakers, as it provided a tool for macroeconomic predictions via the rate of growth of national income and retirement plans. When there is a steep demographic change as with the current baby-boomer effect in DCs, it is very important for policy makers to examine whether the earlier theoretical implications of LCH are still valid in their entirety for the current economy. Given the previous discussions, the retiring baby-boom generation may be less likely to cash-out stocks for less risky assets, which will make the feared *stock-price melt-down* less of an issue. While LCH provides simple theoretical foundation for studies on the economic effects of changing demography, it is essential to consider other macroeconomic variables to find whether the economic dynamism changes the predictive power of LCH. This study looks at whether the expected LCH effects can be validated when other macroeconomic variables are taken into account.

Friedman (1957) PIH suggests that there is a close long-term relationship between savings/investments and permanent income (Diamond, 1965). PIH states that people save only if their current income is higher than expected permanent income. Since majority of baby-boomers have passed the high-income-and-high-saving life stage and are entering or are well into the retirement-and-disinvestment life stage, it is essential to examine the possible impacts of their dissaving on the stock prices. Specifically, do they cash-in their accumulated relatively risky assets and buy traditionally less risky assets (e.g. houses, bonds, blue-chip stocks)? If a significant portion of the population follows such a path, what is the impact on the economy and are economic policies needed to maintain socioeconomic stability? The theories and effects of demographic changes on asset prices have been greatly studied (Takáts, 2010) but the results have been mixed.

Goyal (2004) study links between population age structure and net stock-market outflows in an overlapping generations framework, found supporting evidence for LCH with a positive relationship between net stock-market outflows and changes in the share of people in the over-65 cohort and a negative relationship between net stock-market outflows and changes in the share of people in the 45-64 cohort. Poterba (2004)[5] examining the age-specific patterns of asset holding in the United States found that asset holdings rise sharply when households are in their 30s and 40s. Though there was an automatic declined in the value of defined benefit pension assets as they come to the retirement, other financial assets declined only slowly during retirement. Also, in their predictions, there was no sharp decline in asset demand, questioning 'asset-market meltdown'; and Abel (2001) supports this notion.

We test the LCH and PIH after increasing the age cohort to DEM_{50-64}, with a hypothesis:

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[5] See Poterba (2001) for different modelling strategies used in examining equilibrium asset returns and population age structure.

H_1: There is a negative relationship between aging population and stock price.

A statistically significant negative coefficient for demography would favour the LCH. Otherwise, we reject the LCH. In order to rule out the concern that the relationship between stock prices and demography might be overwhelmed by other variables, literature also considers a variety of macroeconomic variables.

As part of evaluating the causes of financial instability and its influence on investment structure in Venezuela, Carvallo and Pagliacci (2016) found that neither house prices nor leverage seems to be crucial factors. Bakshi and Chen (1994) found that housing prices had increased when the baby-boomers were in their 20s and 30s and (further) aging of the population affects asset prices negatively. Takáts (2010) agrees on this finding, but states that a retirement-driven assert-meltdown is unlikely. Davis and Li (2003), examining OECD countries over 50 years, found an increase in DEM_{40-64} tends to increase real asset prices. While researchers do not agree on the degree of the impact, it appears that risk tolerance and aging populations are likely to be negatively related, as retiring baby-boomers seek to move from relatively high-risk financial assets to lower-risk assets. This effect is likely to be conflated as baby-boomers, also, seek to down-size their homes. Kapopoulos and Siokis (2005) argue that when the credit-price effect exists, a rise in housing prices can boost economic activity, and future profitability of firms which, in turn, drive stock prices. To rule out the concern that the stock prices are driven by house prices, we hypothesize:

H_2: There is a negative relationship between aging population and stock price after controlling for house prices.

2.2 General Equilibrium Theory (GET)

The GET (developed in 1870s) explains the operations of economic markets as a whole and believes that any individual market is necessarily in equilibrium if all other markets are also in equilibrium. As such, this study attempts to see the important markets together in its analysis. GET is well documented by researchers. Chen (1991), referring to GET in a macroeconomic analysis, stated that characteristics of the macro-economy should be related to asset returns. The relationship between macroeconomic variables and stock market is the focus of Fama (1990) and Chen (1991), as stock market can signal significant changes in real-economy along with *Flow-on-effects* via economic dynamism from fast growing regional markets. Other factors affecting stock-market prices include changes in regulation and financial market structures (Keim, 1985; Chen, 1991; Estrella and Hardouvelis, 1991; Kwon and Shin, 1999). Dent (1998) notes that high-economic growth in the early 1990s was combined with baby-boomers being in a high-earnings/savings age. Among others Abel (2001) and Takáts (2010) used an overlapping generation model (OLG) to explain the relationship between real economic factors, asset price and demographic. Moreover, Granger *et al.* (2000) argue that a change in exchange rate may change the value of a firm's foreign operation which can be seen from its balance sheet as a profit or a loss. Hence, exchange rate could either raise or lower a firm's stock price depending on whether that firm is import-oriented or export-oriented.

A historical view of capital market growth shows that a high level of market activity occurred in DCs during the robust economic conditions of 1990-2000, when baby-boomers were in their prime-earning/savings years. A few researchers have projected from the robust stock-market growth during the baby-boomer-generation-prime-earning period to forecast weak asset prices as they retire. Bakshi and Chen (1994) examined the relationship between the average age of the US populations and consumption, T-bill prices and stock returns emphasizing on Life Cycle Investment Hypothesis, found that investor's asset mix changes with the life cycle. They stated that business cycle patterns are partly due to demographic swings and an aging population characterizes with an increasing risk aversion accompanied with higher equilibrium risk premiums suggesting demographic movements can bring fluctuations in capital markets.

Brooks (1999) examining 14 industrial countries found a positive correlation between the presence of a large working-age population and stock and bond price increases. Abel (2001) included bequests in examining the impact of rising retiring age on asset prices. Holtz-Eakin *et al.* (1993) found evidence that the individuals who receive (large) bequests tend to leave the labor market.

After considering the above arguments, we hypothesize:

H_3: There is a negative relationship between aging population and stock price after controlling real GDP and CPI;

H_4: There is a negative relationship between aging population and stock price after controlling real GDP, housing prices and CPI;

H_5: There is a negative relationship between aging population and stock price after controlling for the LASSO selected macroeconomic variables.

It warrants further investigation as to whether this effect is offset by other macroeconomic variables or processes. Some questions that need to be examined are: if an equilibrium imbalance occurs, are there any corrective mechanisms (e.g. arbitrage) to restore stability? If selling pressure of assets is offset by the buying process, domestic capital markets can remain stable.

3. Data

Following the literature (Chen, 1991; Granger *et al.*, 2000; Poterba, 2001; Poterba, 2004; Kapopoulos and Siokis, 2005; Huynh *et al.*, 2006) and availability of data, this study uses 11 variables: stock-price index (SPI); real gross domestic product (RGDP); housing-price index (HPI); 3-month interest rate (3MINT); 10-year government bond yield (GBY); exchange rate (EX) of New Zealand Dollar per US Dollar; money supply (M2); consumer price index (CPI);

oil price (OLP); foreign-portfolio investment (FPI) and the population in the 50-64 age cohort divided by total population (DEM). The data range covers from 1991-2017 based on data availability. Initially, few variables (DEM_{50-64} and RGDP) are taken at a quarterly frequency from 1991Q1 to 2017Q2. However, monthly data for the housing price index is for 1992M1-2015M3. Quarterly frequency data are approximated to a monthly frequency via cubic spline interpolation[6]. Shifting to monthly data increases the number of observations from 106 to 316, which offsets the small-sample size and reduces the small-sample bias. All variables are transformed into natural logarithms. Except for SPI and HPI, the rest of the monetary variables are converted into real term based on the price level of 1991M3. The data description is reported in Appendix Table A3. For the robustness check, all the relevant empirical studies are re-estimated using the original quarterly data. Given that the findings based on monthly data and quarterly data are highly consistent, our main presentation is based on the monthly data, however, all the results for the quarterly data are shown in the Appendix from Tables A4 to A11.

All the time-series data are sourced from *Datastream*; except oil prices, all variables are seasonally adjusted and expressed in NZ dollars; the Brent oil price is in US dollars. In the spirit of Poterba (2004), this study uses the proportion of population in the age of 50-64 cohort to proxy the demography variable, DEM_{50-64}. The baby-boomer births are considered to have occurred from 1947-1966 by Statistics NZ. In 1991, baby boomers were 25-44 years and in 2017 they were 51-70 years old. In 1991, early baby-boomers were in their high-earnings/saving/investment period (LCH) and late baby-boomers were entering and/or settling into their earnings and arranging their consumption/investment decisions. In 2017, the early baby-boomers were entering retirement age and the late baby-boomers were entering their

[6] The cubic spline interpolation provides a piecewise continuous curve, passing through each of the values in the quarterly frequency.

high-earnings/saving/investment period. As mentioned earlier, people are living longer and staying longer in the workplace than prior generations, this study considered the pre-retirement cohort to better represented by ages 50-64 years than the often used broader range of 40-64.

4 Research Design

4.1.1 Unit root and Structural-break tests for fast-moving institutional changes

Fast-moving institutional changes are investigated using the Clemente *et al.* (1998) unit root test with double unknown structural-breaks.[7] It is essential to test the existence of a unit root when using time-series data for model estimation, failure to do so means that the standard asymptotic distribution theory does not apply, resulting in model misspecification, coefficient bias and spurious estimation inferences. Traditionally, Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are used to assess the order of integration of the variables. A weakness of the ADF and PP unit root tests is their potential confusion of structural-breaks in the series as evidence of non-stationarity (they may fail to reject the unit root hypothesis if the series have a structural-break); for the series that are found to be $I(1)$, there may be a possibility that they are in fact stationary around the structural-break(s), $I(0)$, but are erroneously classified as $I(1)$. Perron (1989) shows that failure to allow for an existing breaks leads to a bias that reduces the ability to reject a false unit root null hypothesis.

Following this development, researchers proposed determining the break point 'endogenously' from the data and the unit root tests allow for one structural-break (Perron and Vogelsang, 1992; Zivot and Andrews, 1992), whereas the Clemente *et al.* (1998) unit root test allows for two structural-breaks in the mean of the series.[8] Clemente *et al.* (1998) allow for two forms of structural-break: i). The *Additive-Outlier* (AO) model, which is more relevant for series

[7] Clemente et al. (1998) is a more approriate test for the unit roots for this study as it considers two structural breaks (Ben-David *et al.*, 2003), unlike Furuoka (2016) which allows only one structural break.
[8] The time span of data in this study is not very long; hence, two structural breaks for each time series variable are reasonable.

exhibiting a sudden change in the mean (the crash model); and ii). The *Innovational-Outlier* (IO) model which is designed to capture gradual changes over time. This study uses both AO and IO models to make more robust conclusions about the time series properties of the data series under investigation. Moreover, structural-breaks in AO and IO model can signal the existence of fast-moving and slow-moving changes in NZ economy.

If the estimates of Clemente *et al.* (1998) unit root test with two structural-breaks in AO and IO model show that there is no evidence of a statistically significant second break in the series, the original Perron and Vogelsang (1992) techniques should be used to test for a unit root in the presence of one structural-break. If the first structural-break is not statistically significant, the ADF unit root test is used to examine whether the underlying variable is statistically stationary. The work begins with Clemente *et al.* (1998) unit root test with two unknown structural breaks.

Tables 1 and 2 present the structural-break-test results for detecting slow- and fast-moving institutional changes in NZ stock prices using the IO and AO models, respectively. The results for both IO and AO models suggest that all the variables except DEM and CPI are statistically stationary after taking first log difference. The DEM and CPI are integrated of order 2. In addition, statistically significant structural-breaks for both the AO and IO models indicate the evidence of both fast- and slow-moving institutional changes in NZ's economy. Apart from the first difference of the natural log of the housing price index $\Delta LnHPI_t$, the first difference of the natural log of the 3-month interest rate $\Delta Ln3MINT_t$ and the first difference of the natural log of the real gross domestic product $\Delta LnRGDP_t$, all the rest stationary variables show more significant *t*-statistics for the IO model than the AO model. The significant political events are shown (Table A2) by comparing the dates of structural breaks reported in Tables 1 and 2. It seems the structural breaks are likely to match the unexpected market shocks rather than anticipated political or legal changes. Many structural-breaks are evident within a short time, especially between 2008 and 2010. Hence, the most significant structural-break, close to the period of subprime-mortgage crisis 2008M3 is considered for the analysis. Two dummy variables are created for the structural-break for the period 2008M3: a set of dummy variables: i) D=1 for 2008M3 only (to examine the temporary shock); ii) D=1 for the subsample from 2008M3 to 2017M6 (to examine the effect of crisis over time). Likewise, for the quarterly data, i) D=1 for 2008Q2 only (to examine the temporary shock); ii) D=1 for the subsample from 2008Q2 to 2017Q2 (to examine the effect of crisis over time).

[TABLE 1 and TABLE 2 ABOUT HERE]

4.1.2 The LASSO regression for macroeconomic variables selection

The relevant macroeconomic variables are determined by LASSO selection method[9] which reduces the effects of multicollinearity, the variance of the model and the mean square error. The LASSO regression result is reported in Table 3. Using Mallow's C_p, the number of covariates is determined. The C_p statistic is defined as a criterion to assess fits when models with different numbers of parameters are compared (Efron *et al.*, 2004a; Efron *et al.*, 2004b; Zou *et al.*, 2007; Kato, 2009). If model (p) is correct then C_p will tend to be close to, or smaller than p. The LASSO regression incorporates HPI, exchange rate, money supply, 3-month interest rate, real GDP, oil price, 10-year government bond yield, foreign portfolio investment and differenced CPI (which measures inflation rate) against the dependent variable the stock price index, and all the variables in Table 3 are log differenced to make them stationary. The result shows that the smallest value for C_p is achieved after the nine steps of running regressions. So, the LASSO selects the following eight macro-economic variables as our

[9] Least absolute shrinkage and selection operator (LASSO) shrinks some coefficients and sets others to 0 and hence tries to retain the good features of both subset selection and ridge regression (Tibshirani, 2011).

control variables for our hypothesis 5: HPI, money supply, 3-month interest rate, real GDP, oil price, 10-year government bond yield, inflation rate, and foreign portfolio investment.

[TABLE 3 ABOUT HERE]

4.1.3 Cointegration test for long-run relationship between stock price and demography

Johansen cointegration test: Examination of the long-run relationship of the proposed hypotheses is most efficiently done by testing and estimating the cointegrating relationships of *I*(1) series. The Johansen cointegration test gives two likelihood ratio tests for the number of cointegrating vectors the: i) *Maximal eigenvalue test*, which tests the null hypothesis *that there are at least* r *cointergration vectors*, vs. the alternative *that there are* $r + 1$*;* and ii) *Trace-test*, with the alternative hypothesis of *the number of cointegrating vectors equals or is less than* $r + 1$.

Given that there are structural-breaks at the log level, it is preferable to split the whole sample into subsamples before applying the cointegration test. Alternatively, to capture the regime change, the dummy for the particular period of the structural-break is constructed for the co-integration test. Table 4 panel A and panel B show the results of the cointegration test employing Johansen's maximum likelihood techniques for dummy variable for 2008M3 only and dummy variable for 2008M3 - 2017M6, respectively. All the variables in Table 3 are I(1) non-stationary for cointegration which refers to long-run or equilibrium relationship between non-stationary variables (Granger *et al.,* 2000; Farmer, 2015). Hence, the dependent variable is stock price rather than stock return. Both panels show the results of the five hypotheses tested with zero and at most one cointegrating vectors using trace and maximum eigenvalues test statistics generated from the maximum long run test statistic. It can be said from panel A that, for hypothesis 1, no cointegration is found between the stock price and baby-boomers' demography; suggesting that there is no long-run relationship between the stock market and aging baby-boomers.

However, there is a deterministic trend exists in models 2 to 4. It can be ascertained from the trace and eigenvalue statistics that at least one cointegration relationship is found for the hypotheses 2-4. However, for hypothesis 5, the Johansen cointegration trace test suggests that there are 4 statistically significant cointegrations at the 5% significance level. On the other hand, the Johansen cointegration Maximum-Eigenvalue test suggests that there is 1 statistically significant cointegration at the 5% significance level. For the sake of prudence, we use the first cointegration for models 2 through 5. It can be ascertained from the Max-EV and trace statistics that (Table 4, panel A) stock price index $LnSPI_t$, log changes in demography $\Delta LnDEM_t$, house price index $LnHPI_t$, real GDP $LnRGDP_t$, and inflation $\Delta LnCPI_t$ are cointegrated, for example hypothesis 4. Throughout the paper, the results show that there exists a linear combination of the $I(1)$ variables that links them in a stable long-run relationship. The results suggest that demography affects stock market only after the inclusion of macroeconomic factors, which in turn reflect that macroeconomic factors are important to be considered. The finding in Models 3 and 4 are mostly consistent with Huynh *et al.* (2006). The results can be explained by the fact that number of key macroeconomic variables (e.g. output, inflation, interest rates) as significant determinants of stock market movements (Dickinson, 2000). The results are roughly the same for the dummy variable 2008M3 to 2017M6. For the robustness check, we also estimated Model 6 considering all the regressors and the finding is highly consistent with Model 5.

[TABLE 4 ABOUT HERE]

When the variables such as $LnSPI_t$, $\Delta LnDEM_t$, $LnHPI_t$ and $LnRGDP_t$ for the model (for example hypothesis 4) are found to be cointegrated, then there must exist an associated ECM, which may take the following forms:

$$\Delta lnSPI_t = c + \sum_{i=1}^{p} \omega_i \, \Delta LnSPI_{t-p} + \sum_{j=1}^{p} \beta_{1j} \, \Delta\Delta LnDEM_{t-p} + \sum_{k=1}^{p} \beta_{2k} \, \Delta LnHPI_{t-p} + \sum_{l=1}^{p} \beta_{3l} \, \Delta lnRGDP_{t-p} + \rho_1 CI_{(t-1)} + \varepsilon_t \quad (1)$$

Where: c denotes the constant. ΔΔ denotes the second difference operator. $CI_{(t-1)}$ is the error correction term; p is the lag lengths (determined by Bayesian Information Criterion (BIC)); and ε_t is random disturbance terms. The series will converge to the long-run equilibrium if $-1 \leq \rho_1 < 0$ holds, but cointegration implies that $\rho_1 \neq 0$. Further, the Johansen cointegration test is performed with structural-breaks (Farmer, 2015). The coefficients for log changes in the relevant variables measure short-run elasticities, and the coefficient for error correction term represents the speed of adjustment of going back to the long-run relationship between the variables.

Bounds-testing approach: as a robustness check, we also employ the Autoregressive-Distributed Lag (ARDL) based bounds cointegration test. The bounds test is quite useful when variables are in different orders of integration and limited number of observations (Granville and Mallick, 2004). However, the bounds-testing approach can accommodate only one co-integrating relationship (Pesaran *et al.*, 2001). In practice, it is quite difficult priori to confirm the number of cointegrations for the multivariate regressions. Hence, we apply bounds-testing approach in hypothesis 1 only for the sake of prudence.[10]

To implement the bounds-testing procedure, it is essential to estimate a conditional autoregressive distributed lag model (ARDL), as follows:

$$\Delta lnSPI_t = c + \theta_1 LnSPI_{t-1} + \theta_2 \Delta LnDEM_{t-1} + \sum_{i=1}^{p} \omega_i \, \Delta LnSPI_{t-i} + \sum_{j=0}^{p} \beta_j \, \Delta\Delta LnDEM_{t-j} + \varepsilon_t \qquad (2)$$

The bounds-test for examining evidence for a long-run relationship can be conducted using the *F*-test. The *F*-test statistic tests the joint significance of the coefficients on the one period lagged levels of the variables in equation (6), that is, H_0: $\theta_1 = \theta_2 = 0$. The asymptotic distribution of

[10] ARDL model was introduced by Pesaran *et al.* (2001) in order to incorporate I(0) and I(1) variables in same estimation so if the variables are stationary I(0) then OLS is appropriate and if all are non-stationary I(1) then it is advisable to do VECM (Johanson) approach as it is a much simpler model.

critical values is obtained for cases in which all independent variables are purely $I(1)$ as well as when the independent variables are purely $I(0)$ or mutually cointegrated.

The F test has a non-standard distribution which depends on: a) Whether variables included in the ARDL model are $I(0)$ or $I(1)$; b) The number of independent variables; c) Whether the ARDL model contains an intercept and/or a trend; and d) The sample size. The two sets of critical values give critical value bounds for all classifications of the independent variables into purely $I(1)$, purely $I(0)$ or mutually cointegrated. If the computed F statistic is higher than the upper bound of the critical value then the null hypothesis of no cointegration is rejected (Pesaran *et al.*, 2001).

Table 5 reports the Pesaran *et al.* (2001) ARDL cointegration test results for hypothesis 1, the estimated F-statistic is 1.689 less than the lower bound critical value of 4.94 at the 5% level. The result suggests that the null hypothesis of no cointegration cannot be rejected with regime change (dummy variable = 2008M3). The same conclusion can be drawn for the dummy period 2008M3 to 2017M6 (right panel, Table 5). Both the results do not verify a long-run relationship between stock price $LnSPI_t$ and log changes in demography $\Delta LnDEM_t$ over 1991-2017 with monthly frequency. The test results corroborate the results of Johansen testing approach, leading to the conclusion that there is compelling evidence that stock market and baby-boomers demography are not cointegrated if we exclude macroeconomic factors.

[TABLE 5 ABOUT HERE]

4.1.4 Time-varying Parameter with Error Correction model *for Slow-moving institutional changes*

Although IO model in Table 1 is able to test the existence of slow-moving institutional changes, however, it cannot quantity the level of slow-moving institutional changes by nature. Hence, the level of slow-moving institutional changes are quantified using the State-space based time-varying parameter (TVP) models which consists of two equations: i) Measurement-equation; and ii) State- equation with random-walk specification which is appropriate when there are changes in the policy regime (Brown *et al.*, 1997):

Measurement-equation:

$$\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{k,t}C_{k,t} + \varepsilon_t \tag{3}$$

State-equation with random-walk specification:

$$sv_{k,t} = sv_{k,t-1} + u_t \tag{4}$$

$$(\varepsilon_t, u_t)' \sim N\left(\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\sigma^2 & 0\\ 0 & Q\end{pmatrix}\right) \tag{5}$$

Where, $\Delta lnSPI_t$ stands for the first natural log differenced stock price index; $sv_{k,t}$ is the time-varying coefficient for the $k\text{-}th$ control variable at time t; $C_{k,t}$ is the $k\text{-}th$ control variable at time t; $\Delta\Delta lnDEM_t$ is the second log differenced demography variable; c is the constant; ε_t and u_t are temporary- and permanent-disturbance terms, respectively, ε_t and u_t are Gaussian disturbances, which are serially independent as well as independent of each other over the sample. Once the TVP models are specified as equations (3) thru (5), the time-varying coefficients $sv_{k,t}$ can be estimated by using a Kalman filter. The state-space model has three unknown parameters $\Psi = \left(c, \sigma^2_{\varepsilon_t}, \sigma^2_{u_t}\right)'$. The symbol Ψ is a *hyper-parameter* and is estimated with Maximum Likelihood Estimation (MLE), using the Marquardt algorithm (Van den Bossche, 2011).

In order to investigate the long- and short-run effects of demographics and other macro-economic variables on stock returns, the measurement equation of state-space model takes the form of the Error-Correction Model (ECM) shown in equation (1) when the underlying variables are cointegrated. Figure 1 shows the time-varying coefficients $sv_{k,t}$ for the five models over 1991M3-2017M6. The time-varying parameter for the second difference of demography (or $\Delta\Delta LnDEM_t$) in hypotheses 1 to 4 suggest that the coefficients are positive but declined between 1994M1 and 1999M12 albeit they experienced various levels of spikes in the short-run especially in the beginning months till 1993; the coefficients remain negative from 1999 to 2002; thereafter, the coefficients stabilize at a positive value. The results for hypothesis 5 after incorporating eight macroeconomic variables using LASSO selection criteria imply that the eight macroeconomic factors, in general, play a declining role in driving the log changes in stock prices $\Delta LnSPI_t$ over 1991M3-2017M6. More specifically, in hypothesis 5, the coefficient for the log changes in growth rate of baby-boomers demography, $\Delta\Delta LnDEM_t$, remains negative prior to 2002M5 and positive thereafter, and the coefficient shows a "W" pattern from 2006M1 to 2013M5. The coefficient for log changes in house price, $\Delta LnHPI_t$, shows sharp ups and downs till 2001M3 and then increases from -0.2 in 2001M4 to 0.2 in 2010M6. The coefficient for log changes in real GDP, $\Delta LnRGDP_t$ increases from 1994M5 to 1999M2 and then declines without significant recovery by 2017M6. The coefficients for log changes in inflation, $\Delta\Delta LnCPI_t$; log changes in 3-month interest rate, $\Delta Ln3MINT_t$; log changes in oil price, $\Delta LnOLP_t$; and log changes in foreign portfolio investment $\Delta LnFPI_t$ tend toward to zero over-time. The coefficient for log changes in money supply, $\Delta LnM2_t$ declines sharply from 0.2 in 1997M11 to -0.25 in 2002M11, and then remains stable. The coefficient for log changes in 10-year government bond yield, $\Delta LnGBY_t$, declines from 0.2 in 1996 to -0.3 in 1999 and then rebound to -0.05 in 2012. In general, the signs for the coefficients for cointegrations are positives prior to 1995, indicating that the self-correction process could drive the stock market away from equilibrium occasionally. Thereafter, the coefficients for the cointegration terms are negatives by 2017M6, suggesting that market forces will drive stock market converge to equilibrium over-time. Figure 1 suggests the turning points for coefficients appear in 1998M09-2000M09 and 2008M03-2009M05, which are roughly consistent with unit root test results reported in Table 1 and Table 2.

[FIGURE 1 ABOUT HERE]

Table 6 exhibits the results of the hypotheses tests for statistical significance of the TVPs. In models 1 through 5, the coefficients for log changes in real GDP, $\Delta LnRGDP_t$ are statistically significant and positive at the 5% significance level. While the coefficients for log changes in money supply, $\Delta LnM2_t$, and error correction term are significantly negative at the 5% significance level. The coefficient for log changes in foreign portfolio investment, $\Delta LnFPI_t$, is negative and marginally significant at the 10% significance level. Overall, the results so far suggesting that log changes in real GDP plays significant and positive role on stock return; surprisingly, log changes in real money supply and log changes in foreign portfolio investment play negative role. All the rest coefficients are statistically insignificant at the conventional significance levels. In other words, economic growth boosts stock market activities. However, log changes in real money supply and log changes in foreign portfolio investment show the opposite effect. Furthermore, speculative or market shocks could drive stock prices away from market equilibriums in the short-run, but fundamentals will cause stock prices to converge to an equilibrium in the long-run.

[TABLE 6 ABOUT HERE]

The finding that there is no evidence of baby boomers demography influences stock market is consistent with Poterba (2001). The results reveal that the short run volatility might be explained partly by irrational behavior of investors (Shiller, 1990) and partly by other factors. Given the fast-moving information technology plays a crucial role in economic growth (Colecchia and Schreyer, 2002), thus technology-based productivity growth may accelerate economic growth and mitigate the influence of the changing $DEM_{50\text{-}64}$. Also, while the sampling period is long enough to suggest relationships, it needs to be longer to make significant conclusions about future effects. Consequently, non-fundamental economic factors are likely playing a key role in driving the NZ stock prices, in the short-run.

4. 6 Diagnostic tests

In assessing whether the five two-step TVP models are valid, Table 7 tests the standardized prediction errors of the five TVP models in terms of independence, homoscedasticity and normality, which are listed in a decreasing order of importance (Commandeur and Koopman, 2007). As the measure of the relative quality of a statistical model, Table 7 also presents the Akaike Information Criterion (AIC) and BIC.

[TABLE 7 ABOUT HERE]

In Table 7, the Ljung-Box test fails to reject the residual independence and the McLeod-Li test does not reject the residual homoscedasticity for models 1 to 5. The Jarque-Bera test significantly rejects the normality of residuals for the model 1. Table 7 indicates that the models 2-4 meet the three assumptions concerning the residuals of the analysis. The model 1 is somewhat problematic but still provides sensible outputs, given that the residual normality is the least important assumption. Model 5 reports the smallest AIC and BIC, and, thereby, provides the best estimation. Overall, the findings of the five applied TVP models are valid.

5. Conclusion

5.1 Summary

This study examines the long-run influence of change in demography - individually and in combination with other macro-economic factors - on stock prices, using NZ monthly and quarterly data (1991-2017). The dynamic perspective of the influence of macro-economic factors on stock prices and the economy is examined using fast- and slow-moving-institutional changes.

The structural-break test with additive and innovational outliers, state-space model based error correction model are employed to study the short-run and long-run effects of institutional change of each independent variable. The *least absolute shrinkage and selection operator* (LASSO) model is used to select crucial macroeconomic variables that can influence the NZ stock market. This study considers a range of non-demographic factors (ignored in many studies) as control variables. As a result, our findings suggests that there is no long-run relationship with stock price if demographic factor are considered alone. However, when other macro-economic factors are considered, demographic changes become an important part of explaining stock price changes. In other words, stock market is cointegrated with macroeconomic fundamentals and ignoring macroeconomic factors may misinterpret the relationship between stock price and aging population. Another key issue suggested by this study is that, due to improved health and lengthening work-lives, the commonly used 40-64 pre-retirement cohort might best be split into a 40-49 working cohort and a 50-64 pre-retirement cohort. Future studies should continually reconsider this evolving issue; for example, the ≥65 cohort might best be separated into 65-69 and ≥70 cohorts to reflect changes to health, attitudes, and retirement prospects. The on-going nature of such changes suggest that pre- and post-retirement cohorts should be constantly reconsidered.

These findings reveal that adjustments to sustain the market equilibrium occur mainly via changes in, money supply, real GDP, government-bond yield, housing price and foreign-portfolio investment. These variables help to re-establish market equilibrium after a disturbance and can be summarized as arbitrage/market-efficiency processes.

While the effect of changing demographics, increased longevity and flow-on effects on stock markets are well researched for other DCs, the relatively small, low political risk, NZ economy provides an excellent case study. This study differs from earlier studies in that it uses a more sophisticated LASSO selection method in selecting the macroeconomic variables.

The findings of this study should be of interest to: Policy makers in their role of sustaining socio-economic growth; Investors in their search for timely insights on global conditions; and Researchers as globalization integrates investment markets and puts many well-researched relations into flux. Unlike many earlier studies, which promote the need for policy intervention, this study suggests that retirement of the baby boomer generation is unlike to produce a *market meltdown* because arbitrage via macroeconomics variables pressure asset prices to revert to their market-efficient level. Thus this study warns that policy intervention based on concerns expressed in earlier studies that aging populations will cause asset prices to fall, may cause the market to overcorrect and possibly even overheat if macroeconomic factors are ignored or excluded.

5.1 Limitations and future research:

Researchers should allow for demand-supply relationships as the rising demand for stocks from emerging markets may affect the overall market trend and consider these demand effects coming from other countries, as political stability of NZ may make a desirable destination for money leaking from less-stable emerging economies. This study (due to the complexity and the non-availability of accurate data) did not examine the effect of bequests (with demographic changes) or separate the target population by employment type and/or their impact on asset prices. Specifically, retirement age often varies with employment type. Thus, a review of how different employment groups affect investment decisions at retirement age would be a valuable contribution. As the relatively new NZ superannuation industry has a growing investment portfolio, more comparative studies would provide essential information for policy decisions. While the findings address a major concern across most DCs, as a general caution, care should be exercised in applying the findings of this study to other countries, and or time periods. Last but not the least, it remains curious whether the insignificant relationship between aging structure and stock prices is due to NZ baby-boomers traditionally invest in other asset classes rather than equities.

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Table 1 Unit root test with structural-breaks: IO Model

Unit Root Test with Two Endogenous Structural Breaks: Clemente–Montañés–Reyes (1998) Test					
Variables	Min t (Level)	Break Points (Level)	Min t (1st Difference)	Break Points (1st Difference)	Result
Exchange rate ($LnEX_t$)	-4.282	1997m5***, 2002m8***	-8.982**	2008m5***, 2009m1***	I(1)
Housing price index ($LnHPI_t$)	-3.09	2001m12***, /	-5.493**	2001m12***, 2007m4***	I(1)
Money supply ($LnM2_t$)	-3.054	1998m6***, 2010m12***	-5.962**	2008m10***, 2010m7***	I(1)
3M Interest rate ($Ln3MINT_t$)	-4.034	1998m2**, 2008m8***	-6.905**	2008m9***, 2008m12***	I(1)
Real GDP ($LnRGDP_t$)	-0.871	/, /	-5.617**	2008m1***, 2009m1***	I(1)
Oil price ($LnOLP_t$)	-4.021	1998m11***, 2004m3***	-5.711**	2008m9***, 2009m1***	I(1)
% Pop age 50-64 ($LnDEM_t$)	-3.426	1996m2***, 1999m9**	-3.609	1996m1***, 2011m3***	I(2)
Stock price index ($LnSPI_t$)	-2.646	2003m2**, /	-14.843**	2007m9***, 2009m2***	I(1)
10Y bond yield ($LnGBY_t$)	-4.802	1997m3***, 2011m3***	-12.304**	/, /	I(1)
CPI ($LnCPI_t$)	-3.118	1999m11***, 2007m8**	-4.87	2010m8***, 2010m11***	I(2)
FPI ($LnFPI_t$)	-2.542	2008m9***, 2008m11***	-11.162**	2008m11***, 2009m3***	I(1)

Notes: Innovational Outliers (IO) model allowing for a gradual shift in the mean of the series. Min t is the minimum t-statistic calculated. Triming = 10%. The value of optimal lag length was selected following the procedure suggested in Perron and Vogelsang (1992). The max length is 12. The 5% critical value for the IO model is -5.490. * denotes 10% level of significance for structural break. ** denotes 5% level of significance for structural break. *** denotes 1% level of significance. There are negative values FPI, so constants are added to the variable that ensure the minimum value equal to 1. $LnDEM_t$ and $LnCPI_t$ are integrated of order 2.

Table 2 Unit root test with structural-breaks: AO Model

Unit Root Test with Two Endogenous Structural Breaks: Clemente–Montañés–Reyes (1998) Test					
Variables	Min t (Level)	Break Points (Level)	Min t (1st Difference)	Break Points (1st Difference)	Result
Exchange rate ($LnEX_t$)	-3.919	1998m9***, 2003m6***	-5.546**	2008m8*, 2009m3**	I(1)
Housing price index ($LnHPI_t$)	-2.047	2002m12***, 2005m3***	-5.51**	2001m11***, 2007m5***	I(1)
Money supply ($LnM2_t$)	-2.832	2001m10***, 2012m7***	-12.417**	/, /	I(1)
3M Interest rate ($Ln3MINT_t$)	-4.37	1998m11***, 2009m2***	-5.579**	2008m11***, 2009m6***	I(1)
Real GDP ($LnRGDP_t$)	-2.173	2001m7***, 2007m10***	-5.598**	2008m1***, 2009m1***	I(1)
Oil price ($LnOLP_t$)	-3.944	1999m11***, 2004m1***	-5.574**	2008m9***, 2009m1***	I(1)
% Pop age 50-64 ($LnDEM_t$)	-2.929	2002m8***, 2008m8***	-3.367	1997m6***, 2012m3***	I(2)
Stock price index ($LnSPI_t$)	-2.372	2004m8***, 2008m3***	-14.938**	2007m11***, 2008m12***	I(1)
10Y bond yield ($LnGBY_t$)	-4.815	1997m12***, 2010m11***	-12.304**	/, /	I(1)
CPI ($LnCPI_t$)	-2.637	2002m7***, 2008m10***	-4.776	1998m8***, 2010m8***	I(2)
FPI ($LnFPI_t$)	-2.837	2008m10***, /	-9.044**	2008m10**, 2009m1**	I(1)

Notes: Additive outliers (AO) model captures a sudden change in a series. Min t is the minimum t-statistic calculated. Triming = 10%. The value of optimal lag length was selected following the procedure suggested in Perron and Vogelsang (1992). The max length is 12. The 5% critical value for the AO model is -5.490. There are negative values FPI, so constants are added to the variable that ensure the minimum value equal to 1. $LnDEM_t$ and $LnCPI_t$ are integrated of order 2.

Table 3 LASSO regression

Step	Cp	R-square	Action
1	19.4972	0.0000	
2	16.8718	0.0536	+$\Delta LnHPI_t$
3	15.9228	0.1106	+ $\Delta LnM2_t$
4	14.5635	0.1281	+$\Delta LnFPI_t$
5	14.4173	0.1383	+$\Delta Ln3MINT$
6	13.8201	0.1909	+ $\Delta LnRGDP_t$
7	13.6048	0.2314	+$\Delta\Delta LnCPI_t$
8	9.5172	0.2364	+$\Delta LnGBY_t$
9	9.0000*	0.2470	+$\Delta LnOLP_t$

Notes: The macro variables considered for the LASSO regression are: $\Delta LnHPI_t$, $\Delta LnEX_t$, $\Delta LnM2_t$, $\Delta Ln3MINT_t$, $\Delta LnRGDP_t$, $\Delta LnOLP_t$, $\Delta LnGBY_t$, $\Delta LnFPI_t$, $\Delta\Delta LnCPI_t$ and the variables actually selected are noted in the action column. The dependent variable is $\Delta LnSPI_t$, and all the variables are stationary at I(0). * indicates the smallest value for Cp.

Table 4 Johansen Cointegration Test: Panel A

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy_{2008M3} + \varepsilon_t$: Life cycle hypothesis			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
9.5553	8.3762	1.1791	1.1791
Model 2: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnHPI_t + \beta_3 Dummy_{2008M3} + \varepsilon_t$: Credit effect hypotheses			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
28.922*	20.9413*	6.9813	6.8245
Model 3: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnRGDP_t + \beta_3 \Delta LnCPI_t + \beta_4 Dummy_{2008M3} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
49.757**	25.677*	24.0801	12.219
Model 4: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_3 LnRGDP_t + \beta_2 LnHPI_t + \beta_4 \Delta LnCPI_t + \beta_5 Dummy_{2008M3} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
66.834*	34.8415**	38.992	17.824
Model 5: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} Dummy_{2008M3} + \varepsilon_t$: LASSO selection			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
407.7048***	88.53.564***	319.156***	50.4895
Model 6: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} LnEX_t + \beta_{11} Dummy_{2008M3-2017M6} + \varepsilon_t$: All control variables			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
396.7323***	108.8997***	287.8326***	82.89562***

Notes: The table uses the most significant structural break March 2008 as exogenous variable and set dummy variable D=1 for March 2008 only. For Model 5, the trace test suggests that there are 4 statistically significant cointegrations at the 5% level of significance, while the Johansen cointegration Max-EV test suggests there is 1 statistically significant cointegration at the 5% significance level. For Model 6, both the trace test and Max-EV test suggest there are 3 cointegrations. For the sake of prudence, we report the first 2 cointegrations.

Johansen Cointegration Test: Panel B

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy_{2008M3\_2017M6} + \varepsilon_t$: Life cycle hypothesis			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
12.878	9.6473	3.2307*	3.2307*
Model 2: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnHPI_t + \beta_3 Dummy_{2008M3\_2017M6} + \varepsilon_t$: Credit effect hypotheses			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
29.972**	20.969*	5.0025	4.7989
Model 3: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnRGDP_t + \beta_3 \Delta LnCPI_t + \beta_4 Dummy_{2008M3\_2017M6} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
60.3503***	34.513***	25.8367	13.8172
Model 4: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnRGDP_t + \beta_3 LnHPI_t + \beta_4 \Delta LnCPI_t + \beta_5 Dummy_{2008M3\_2017M6} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
75.5356**	40.2043***	35.3313	14.9514
Model 5: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} Dummy_{2008M3-2017M6} + \varepsilon_t$: LASSO selection			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
327.88***	83.177***	244.711***	54.2146

Model 6: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} LnEX_t + \beta_{11} Dummy_{2008M3-2017M6} + \varepsilon_t$: All control variables			
0 CI vectors	At most 1 CI vectors		
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
441.8989***	110.6352***	331.2637***	98.49402***

Notes: The table uses the most significant structural break March 2008 as exogenous variable and set dummy variable $D = 1$ for the subsample from March 2008 to the June 2017. For Model 5, the Johansen trace test suggests that there are 5 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there is 1 statistically significant cointegration at the 5% significance level. For Model 6, the trace test suggests that there are 5 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there are 2 statistically significant cointegrations at the 5% significance level. For the sake of prudence, we report the first 2 cointegrations for Models 5 and 6.

Table 5 Auto Regressive Distributed Lag (ARDL) bounds testing for cointegration

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy + \varepsilon_t$: Life cycle hypothesis			
ADJ	Coefficient (Standard Error)	ADJ	Coefficient (Standard Error)
$LnSPI_{t-1}$	-0.012 (0.0096)	$LnSPI_{t-1}$	-0.0138 (0.0105)
Long Run		Long Run	
$\Delta LnDEM_t$	-184.1908 (253.8364)	$\Delta LnDEM_t$	-160.15 (224.3225)
$Dummy_{2008M3}$	-0.0494 (0.3898)	$Dummy_{2008M3-2017M6}$	0.0018 (0.0051)
Short Run		Short Run	
constant	0.0864 (0.0638)	constant	0.0978 (0.0693)
F-test	1.689	F-test	1.907
ARCH LM test	2.039	ARCH LM test	1.994
Breusch Godfrey LM test	0.498	Breusch Godfrey LM test	0.462
Ramsey RESET test	0.31	Ramsey RESET test	0.9
Jarque-Bera test	2.623	Jarque-Bera test	2.48

Notes: If the computed F-statistics is less than the lower bound of the critical values then the null hypothesis of no cointegration is not rejected. The lower bound critical value for the F-statistics is 4.94 at the 5% level. The null hypothesis of Jarque-Bera test is normality. The null hypothesis of Ramsey RESET test is the model has no omitted variables. The null hypothesis for Breusch-Godfrey LM test is no autocorrelation. The null hypothesis of ARCH LM test is no ARCH effects.

Table 6 The hypotheses tests for statistical significance of the Time-varying Parameters

	Final State	Z-statistic	p-value
Model 1: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	6.5328	0.5259	0.599
Model 2: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	3.8411	0.2643	0.7915
$\boldsymbol{sv_{2,t}}$	0.0058	0.0349	0.9722
$\boldsymbol{sv_{3,t}}$	-0.0253	-1.9126	0.0558
Model 3: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnRGDP_t + sv_{3,t}\Delta\Delta LnCPI_t + sv_{4,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	6.5644	0.5234	0.6007
$\boldsymbol{sv_{2,t}}$	1.4213	3.1995	0.0014
$\boldsymbol{sv_{3,t}}$	-0.2925	-0.1389	0.89
$\boldsymbol{sv_{4,t}}$	-0.0102	-1.977	0.048
Model 4: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	5.2006	0.3618	0.7175
$\boldsymbol{sv_{2,t}}$	-0.0751	-0.4438	0.6572
$\boldsymbol{sv_{3,t}}$	1.4929	3.0636	0.0022
$\boldsymbol{sv_{4,t}}$	0.6167	0.288	0.7733
$\boldsymbol{sv_{5,t}}$	-0.0198	-2.335	0.0195
Model 5: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}\Delta LnM2_t + sv_{6,t}\Delta Ln3MINT_t + sv_{7,t}\Delta LnOLP_t + sv_{8,t}\Delta LnGBY_t + sv_{9,t}\Delta LnFPI_t + sv_{10,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	14.16297	0.881179	0.3782
$\boldsymbol{sv_{2,t}}$	0.084254	0.447715	0.6544
$\boldsymbol{sv_{3,t}}$	1.519117	2.83958	0.0045
$\boldsymbol{sv_{4,t}}$	0.878817	0.354313	0.7231
$\boldsymbol{sv_{5,t}}$	-0.234932	-2.242807	0.0249
$\boldsymbol{sv_{6,t}}$	0.002659	0.067937	0.9458
$\boldsymbol{sv_{7,t}}$	0.014159	0.517041	0.6051
$\boldsymbol{sv_{8,t}}$	-0.07405	-1.160431	0.2459
$\boldsymbol{sv_{9,t}}$	0.005989	1.629056	0.1033
$\boldsymbol{sv_{10,t}}$	-0.008741	-2.369425	0.0178
Model 6: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}\Delta LnM2_t + sv_{6,t}\Delta Ln3MINT_t + sv_{7,t}\Delta LnOLP_t + sv_{8,t}\Delta LnGBY_t + sv_{9,t}\Delta LnFPI_t + sv_{10,t}\Delta LnEX_t + sv_{11,t}CI_{1,t-1} + sv_{12,t}CI_{2,t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	2.040692	0.138006	0.8902
$\boldsymbol{sv_{2,t}}$	0.025705	0.146999	0.8831
$\boldsymbol{sv_{3,t}}$	1.428090	2.788407	0.0053
$\boldsymbol{sv_{4,t}}$	-1.145675	-0.465486	0.6416
$\boldsymbol{sv_{5,t}}$	-0.207036	-2.136564	0.0326
$\boldsymbol{sv_{6,t}}$	-0.030178	-0.799658	0.4239
$\boldsymbol{sv_{7,t}}$	-0.003135	-0.120335	0.9042
$\boldsymbol{sv_{8,t}}$	-0.071219	-1.186174	0.2356
$\boldsymbol{sv_{9,t}}$	0.009750	2.713265	0.0067
$\boldsymbol{sv_{10,t}}$	-0.331878	-4.962848	0.0000
$\boldsymbol{sv_{11,t}}$	-4.87E-05	-0.036109	0.9712
$\boldsymbol{sv_{12,t}}$	-0.876046	-1.421136	0.1553

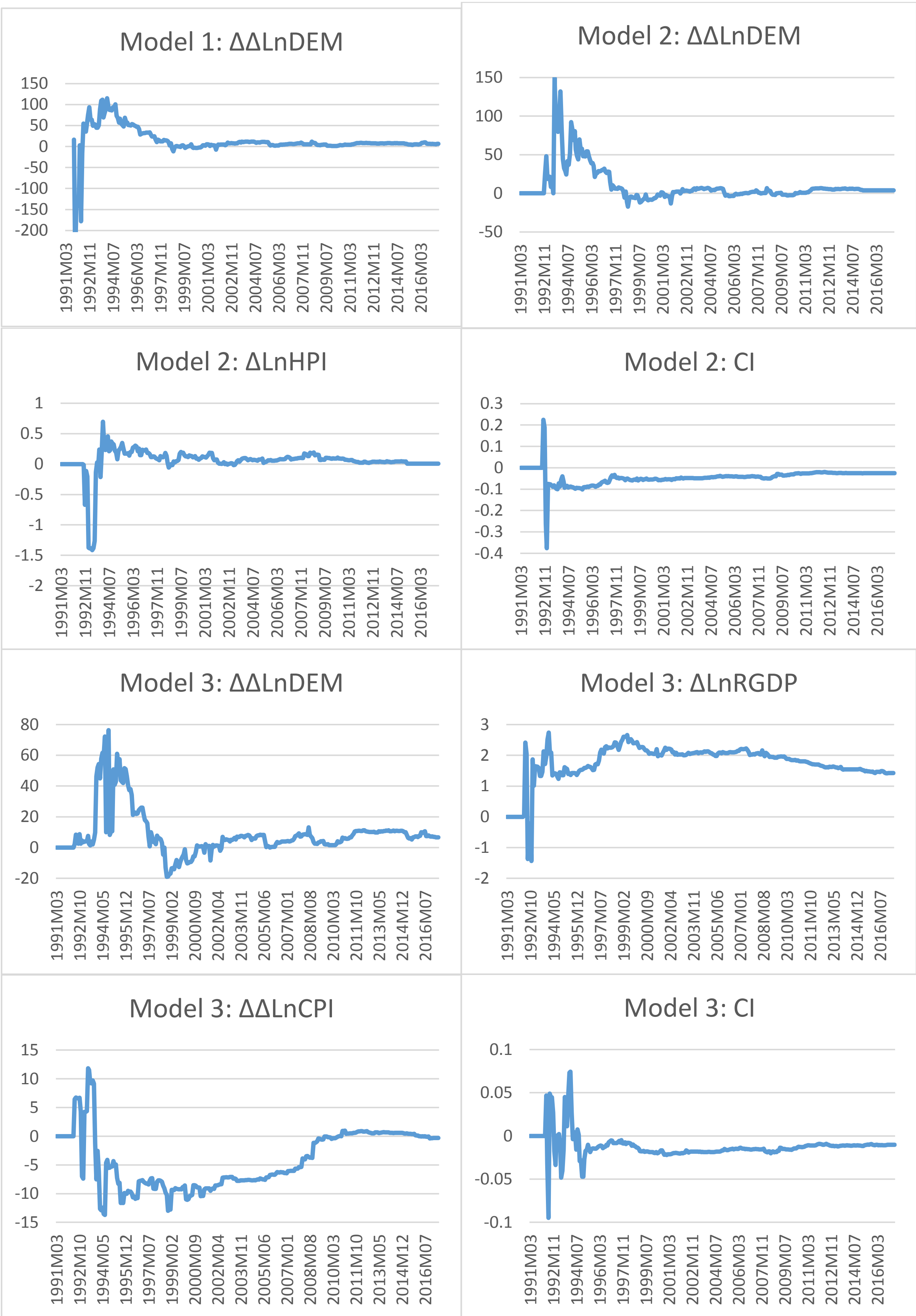
Notes: Root MSE stands for Root Mean Square Error. $\boldsymbol{CI_t}$ stands for cointegration term.

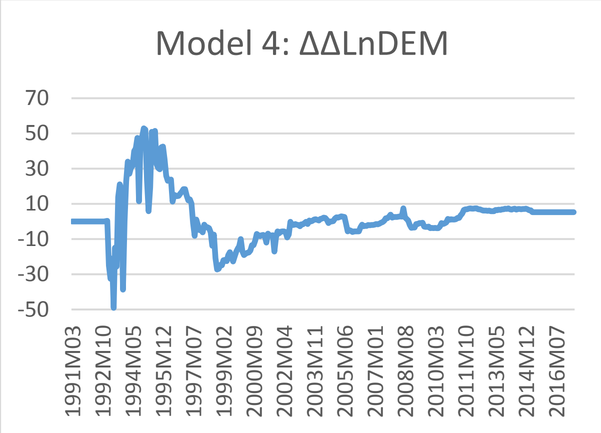
Table 7 Diagnostic testing for the State-space based time-varying parameter model

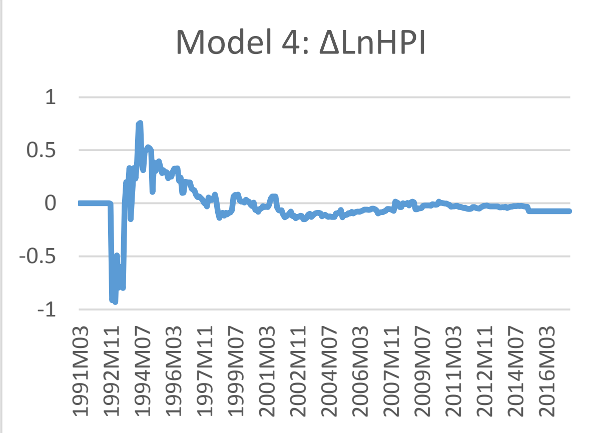
	Independence (L-B Test)	Homoscedasticity (McLeod-Li Test)	Normality (J-B Test)	AIC	BIC	Remark
Model 1	13.593	No ARCH effect	34.66**	-3.618	-3.594	Acceptable
Model 2	13.244	No ARCH effect	3.350	-3.448	-3.421	Valid
Model 3	11.794	No ARCH effect	1.255	-3.476	-3.451	Valid
Model 4	12.774	No ARCH effect	4.986	-3.378	-3.351	Valid
Model 5	12.682	No ARCH effect	4.368	-3.938	-3.907	Valid
Model 6	12.990	No ARCH effect	21.23**	-2.902	-2.871	Acceptable

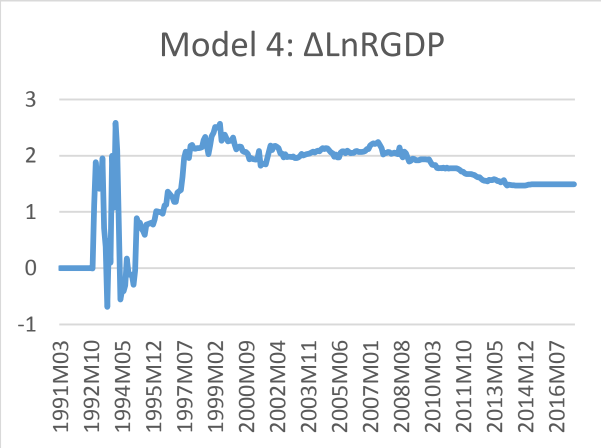
Notes: The null hypothesis for the Ljung-Box (L-B) test is that the residuals are independent at Q(12). The null hypothesis for the Jarque-Bera (J-B) test is that the residuals are a normally distributed. *** represents the statistical significance at the 1% significance level. The null hypothesis of the McLeod_Li test is the independence of returns and if it is rejected, it indicates the presence of ARCH/GARCH nonlinear effects in the data. The residuals should satisfy independence, homoscedasticity and normality in decreasing order of importance. The diagnostic tests are applied to the standardized prediction errors (Commandeur and Koopman, 2007, p. 90).

Figure 1 Time-varying coefficients




Model 4: ΔΔLnDEM
70
50
30
10
-10
-30
-50
1991M03
1992M10
1994M05
1995M12
1997M07
1999M02
2000M09
2002M04
2003M11
2005M06
2007M01
2008M08
2010M03
2011M10
2013M05
2014M12
2016M07


Model 4: ΔLnHPI
1
0.5
0
-0.5
-1
1991M03
1992M11
1994M07
1996M03
1997M11
1999M07
2001M03
2002M11
2004M07
2006M03
2007M11
2009M07
2011M03
2012M11
2014M07
2016M03


Model 4: ΔLnRGDP
3
2
1
0
-1
1991M03
1992M10
1994M05
1995M12
1997M07
1999M02
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2003M11
2005M06
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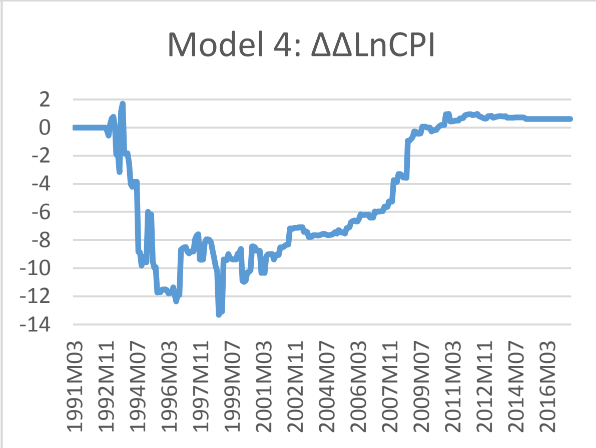
2010M03
2011M10
2013M05
2014M12
2016M07


Model 4: ΔΔLnCPI
2
0
-2
-4
-6
-8
-10
-12
-14
1991M03
1992M11
1994M07
1996M03
1997M11
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2002M11
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2006M03
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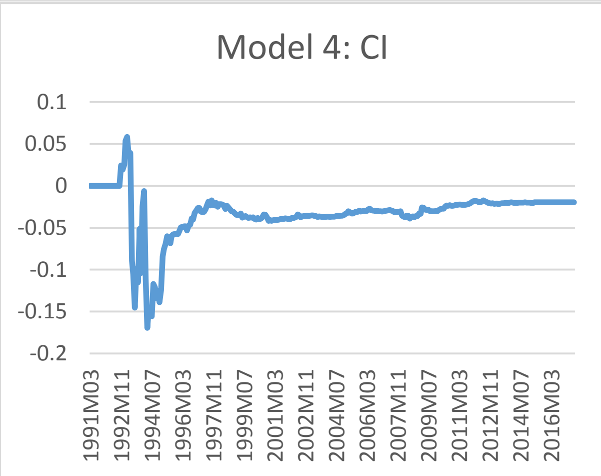
2009M07
2011M03
2012M11
2014M07
2016M03


Model 4: CI
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
1991M03
1992M11
1994M07
1996M03
1997M11
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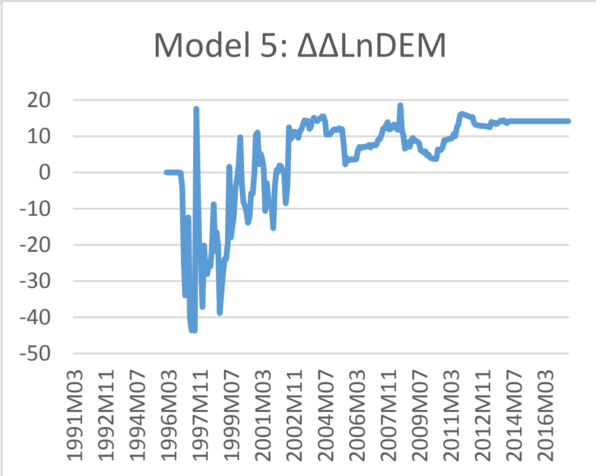
2012M11
2014M07
2016M03


Model 5: ΔΔLnDEM
20
10
0
-10
-20
-30
-40
-50
1991M03
1992M11
1994M07
1996M03
1997M11
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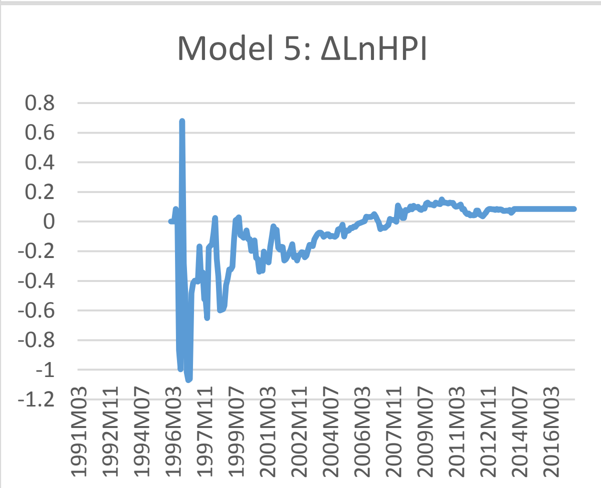
2012M11
2014M07
2016M03


Model 5: ΔLnHPI
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
1991M03
1992M11
1994M07
1996M03
1997M11
1999M07
2001M03
2002M11
2004M07
2006M03
2007M11
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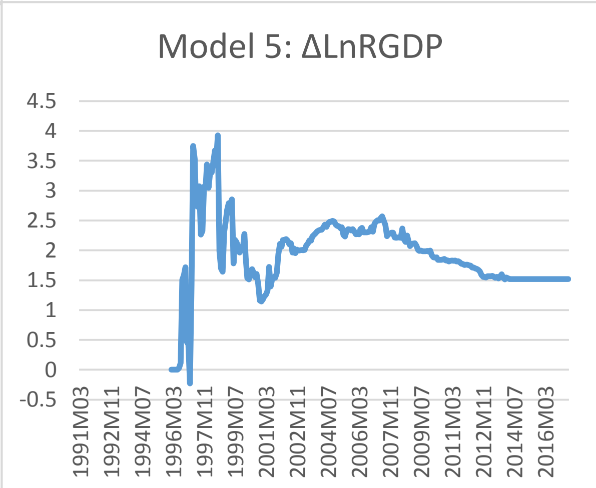
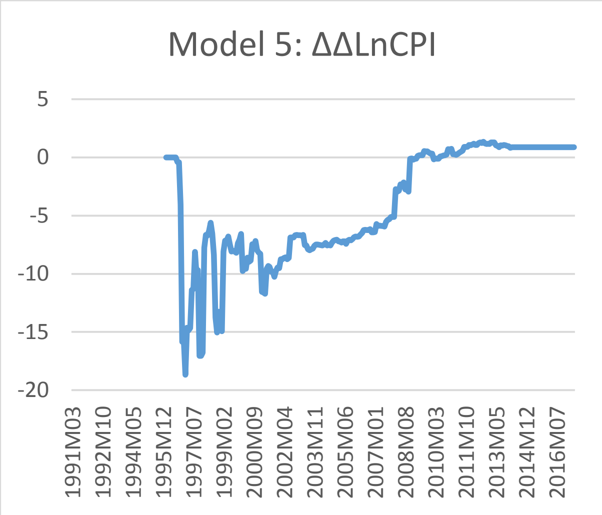
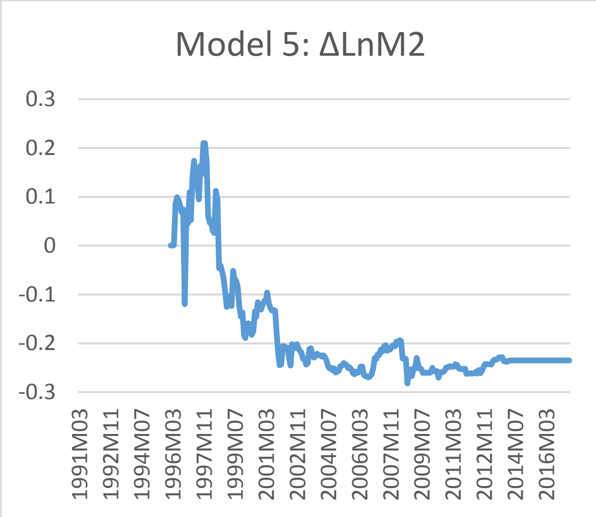
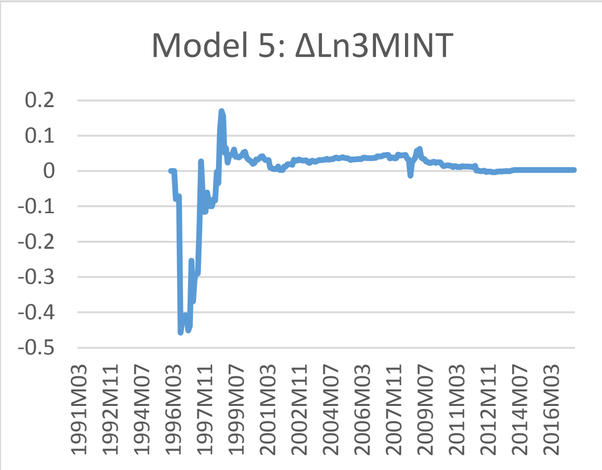
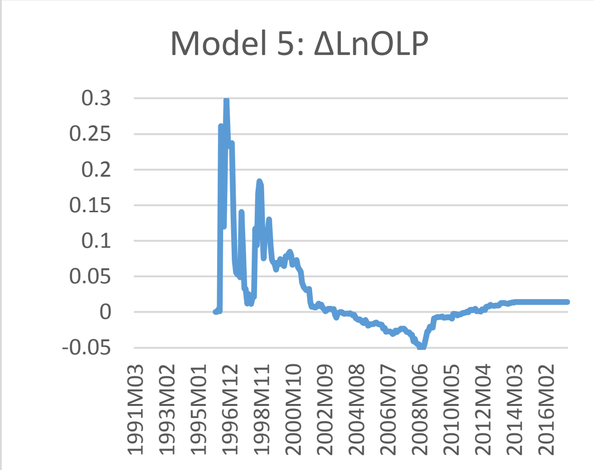
2012M11
2014M07
2016M03

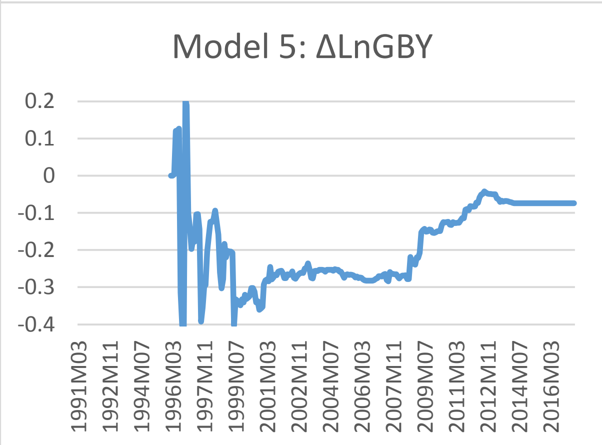

Model 5: ΔLnRGDP
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
1991M03
1992M11
1994M07
1996M03
1997M11
1999M07
2001M03
2002M11
2004M07
2006M03
2007M11
2009M07
2011M03
2012M11
2014M07
2016M03

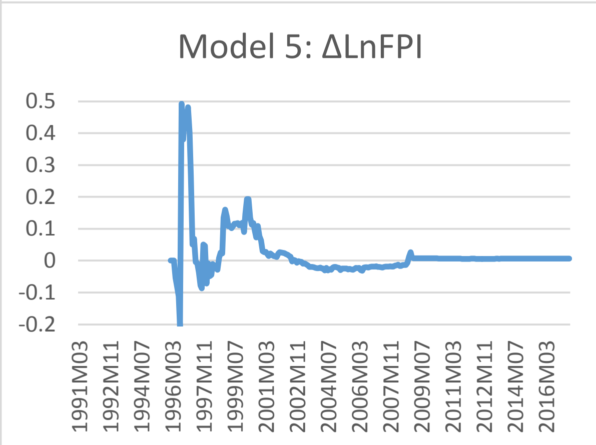


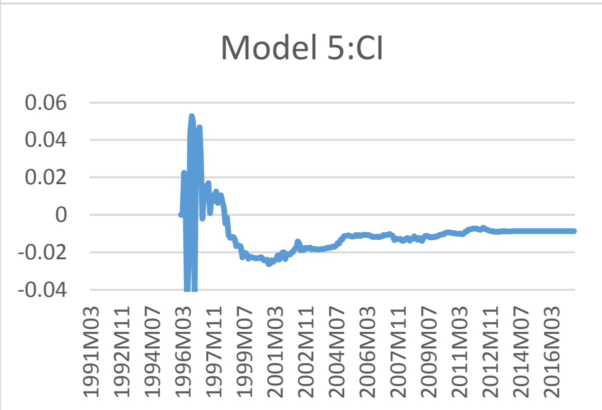












Notes: CI stands for Cointegration.

Appendix

Table A1 – Percentage of Population in Three Age Groups (1951-2051 Projection)

Age	1951	1961	1971	1981	1991	2001	2011	2021	2031	2041	2051
0-14	29.4	33.1	31.8	26.7	22.8	23	19	18	17	16	16
15-64	61.4	58.3	59.7	63.3	65.9	66	67	65	61	59	59
65+	9.2	8.6	8.5	10	11.2	12	14	18	22	25	25

Source: Statistics NZ. http://www.stats.govt.nz/Census.aspx

Table A2 List of major political, social and economic events over 1990-2017

Year	Event	Source
1990M03	Inflation targeting implemented	http://www.imf.org/external/pubs/ft/fandd/basics/target.htm
1992M09	Recession	http://www.dol.govt.nz/publications/discussion-papers/current-recession/
1997M09	Asian financial crisis	http://www.treasury.govt.nz/publications/research-policy/wp/2011/11-01/05.htm
1998M06	Recession	http://www.stats.govt.nz/browse_for_stats/income-and-work/employment_and_unemployment/wage-slow-down.aspx
1999M12	Labour party wins election. Helen Clark becomes prime minister	http://www.nzhistory.net.nz/people/helen-clark
2007M07	Kiwisaver policy implemented	http://docs.business.auckland.ac.nz/Doc/WP-2014-1-KiwiSaver.-Now-we-are-six.pdf
2008M09	Global financial crisis	http://www.stats.govt.nz/browse_for_stats/income-and-work/employment_and_unemployment/nz-labour-market-during-recession.aspx
2008M11	John Key leads the centre-right National party to victory in a general election, ending nine years of Labour-led government	https://national.org.nz/about/nationals-history
2009M03	Official figures show the NZ economy shrank at its fastest rate in 17 years in the last three months of 2008	http://www.stats.govt.nz/browse_for_stats/income-and-work/employment_and_unemployment/nz-labour-market-during-recession.aspx
2010M05	Significant tax cut	http://taxpolicy.ird.govt.nz/publications/2010-sr-budget2010-special-report/personal-tax-cuts
2011M02	Christchurch earth quakes	http://www.teara.govt.nz/en/historic-earthquakes/page-13
2011M09	NZ hosted rugby world cup	http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/impact-of-rugby-world-cup.aspx
2016M12	Bill English becomes prime minister after John Key quits unexpectedly	http://www.bbc.co.uk/news/world-asia-pacific-15370160
2017M05	A New Zealand-American company, Rocket Lab, launches its first test rocket into space	http://www.bbc.co.uk/news/world-asia-pacific-15370160
2017M10	Labour's Jacinda Ardern forms coalition government after the parliamentary elections	http://www.bbc.co.uk/news/world-asia-pacific-15370160

Table A3 Data description

Variable	Sample range	No. of Obs	Mean	Standard Deviation	Min	Max	Normality
$LnEX_t$	1991m3/2016m12	310	0.5107	0.1928	0.1658	0.9911	17.4***
$LnHPI_t$	1992m1/2015m3	279	7.6532	0.4341	6.9078	8.3758	24.81***
$LnM2_t$	1991m3/2017m1	311	10.668	0.3862	10.032	11.466	10.8***
$Ln3MINT_t$	1991m4/2017m6	315	1.6471	0.4287	0.7181	2.3145	26.69***
$RGDP_t$	1991m3/2017m3	313	10.2426	0.2193	9.8209	10.6132	19.76***
$LnOLP_t$	1991m3/2016m12	310	3.3493	0.5171	2.2504	4.4899	20.83***
$LnDEM_t$	1991m3/2017m6	316	2.2652	0.141	2.0774	2.466	33.17***
$LnSPI_t$	1991m3/2017m6	316	6.7077	0.2449	6.0666	7.2438	0.2477
$LnGBY_t$	1991m4/2017m6	315	1.7481	0.3021	0.7836	2.3786	38.43***
$LnCPI_t$	1991m3/2017m6	316	4.861	0.167	4.6052	5.1162	26.23***
$LnFPI_t$	1995m6/2014m3	226	9.1121	0.7192	-0.3748	9.6092	170***
$\Delta LnEX_t$	1991m4/2016m12	309	-0.00035	0.0338	-0.1252	0.1396	61.48***
$\Delta LnHPI_t$	1992m2/2015m3	278	0.00528	0.0138	-0.0259	0.0645	4.188
$\Delta LnM2_t$	1991m4/2017m1	310	0.00448	0.0249	-0.0683	0.0859	3.176
$\Delta Ln3MINT_t$	1991m5/2017m6	314	-0.00508	0.0667	-0.3447	0.2872	386.9***
$\Delta RGDP_t$	1991m4/2017m3	312	0.00251	0.0044	-0.0118	0.0147	2.129
$\Delta LnOLP_t$	1991m4/2016m12	309	0.0013	0.0912	-0.4113	0.2983	33.46***
$\Delta\Delta LnDEM_t$	1991m4/2017m6	315	0.0000078	0.00018	-0.00047	0.00063	1.99
$\Delta LnSPI_t$	1991m4/2017m6	315	0.0037	0.0391	-0.1496	0.1278	21.95***
$\Delta LnGBY_t$	1991m5/2017m6	314	-0.0043	0.0432	-0.1605	0.1672	23.18***
$\Delta\Delta LnCPI_t$	1991m4/2017m6	315	-0.000003	0.00109	-0.00619	0.00636	1502***
$\Delta LnFPI_t$	1995m7/2014m3	225	-0.0024	0.7034	-7.8755	6.3418	890***

Notices: *** stands for statistically significant at the 1% significance level. All the variables in this table are in natural log level. The null hypothesis of Jarque-Bera normality test is normal distribution. Δ stands for the first difference of the variables.

Table A4 Unit root test with structural-breaks: IO Model based on quarterly data

Unit Root Test with Two Endogenous Structural Breaks: Clemente–Montañés–Reyes (1998) Test					
Variables	Min t in Level	Break Points (Level)	Min t in 1st Difference	Break Points (1st Difference)	Result
Exchange rate ($LnEX_t$)	-4.290	1997q1***, 2002q2***	-9.607**	1996q3**, 2000q2**	I(1)
Housing price index ($LnHPI_t$)	-3.285	2002q1***	-6.999**	2002q1***, 2006q4***	I(1)
Money supply ($LnM2_t$)	-2.523	1998q1**, 2010q3***	-6.428**	2008q4**, 2010q2***	I(1)
3M Interest rate ($Ln3MINT_t$)	-4.458	1997q4**, 2008q2***	-7.259**	2008q2***, 2009q2***	I(1)
Real GDP ($LnRGDP_t$)	-3.760	1998q2***, 2012q4***	-10.828***	/, /	I(1)
Oil price ($LnOLP_t$)	-4.035	1998q3*, 2003q3**	-6.474**	1998q3**, 2008q3**	I(1)

Population age 50-64 ($LnDEM_t$)	-3.679	1996q1***, 1999q3**	-3.511	2011q1**, /	I(2)
Stock price index ($LnSPI_t$)	-2.943	2002q4**, /	-10.436**	2007q3***, 2008q4***	I(1)
10y bond yield ($LnGBY_t$)	-2.268	2010q4***, /	-9.967***	/, /	I(1)
CPI ($LnCPI_t$)	-3.626	1999q3***, 2004q2***	-3.477	2010q3**, /	I(2)
FPI ($LnFPI_t$)	-2.542	2008q2***, 2009q2***	-6.670**	2008q3***, 2009q3***	I(1)

Notes: Innovational Outliers (IO) model allowing for a gradual shift in the mean of the series. Min t is the minimum t-statistic calculated. Triming = 10%. The value of optimal lag length was selected following the procedure suggested in Perron and Vogelsang (1992). The max length is 12. The 5% critical value for the IO model is -5.490. * denotes 10% level of significance for structural break. ** denotes 5% level of significance for structural break. *** denotes 1% level of significance. There are negative values FPI, so constants are added to the variable that ensure the minimum value in each variable equal to 1.

Table A5 Unit root test with structural-breaks: AO Model based on quarterly data

Unit Root Test with Two Endogenous Structural Breaks: Clemente–Montañés–Reyes (1998) Test					
Variables	Min t in Level	Break Points (Level)	Min t in 1st Difference	Break Points (1st Difference)	Result
Exchange rate ($LnEX_t$)	-3.273	1998q4***, 2004q1***	-9.626**	1996q4**, 2000q1**	I(1)
Housing price index ($LnHPI_t$)	-1.536	2002q4***, 2005q4***	-6.776**	2001q4***, 2007q4***	I(1)
Money supply ($LnM2_t$)	-3.028	2000q1***, 2012q1***	-11.730***	/, /	I(1)
3M Interest rate ($Ln3MINT_t$)	-3.014	1997q3***, 2009q3***	-6.794***	/, /	I(1)
Real GDP ($LnRGDP_t$)	-2.106	2000q1***, 2005q3***	-10.828***	/, /	I(1)
Oil price ($LnOLP_t$)	-3.660	2000q1***, 2004q4***	-6.934**	1999q1**, 2008q2**	I(1)
Population age 50-64 ($LnDEM_t$)	-3.203	2001q2***, 2008q3***	-2.973	1997q3***, 2010q4***	I(2)
Stock price index ($LnSPI_t$)	-1.910	2004q1***, 2008q2**	-10.369**	2007q3***, 2008q3***	I(1)
10y bond yield ($LnGBY_t$)	-3.942	1997q3***, 2010q4***	-9.967***	/, /	I(1)
CPI ($LnCPI_t$)	-1.037	/, /	-2.179	/, /	I(2)
FPI ($LnFPI_t$)	-0.605	2008q2**, /	-13.912***	/, /	I(1)

Notes: Additive outliers (AO) model captures a sudden change in a series. Min t is the minimum t-statistic calculated. Triming = 10%. The value of optimal lag length was selected following the procedure suggested in Perron and Vogelsang (1992). The max length is 12. The 5% critical value for the AO model is -5.490. There are negative values FPI, so constants are added to the variable that ensure the minimum value in each variable equal to 1.

Table A6 Correlation matrix based on quarterly data

Variables	$\Delta LnEX_t$	$\Delta LnHPI_t$	$\Delta LnM2_t$	$\Delta Ln3MINT_t$	$\Delta LnRGDP_t$	$\Delta LnOLP_t$	$\Delta\Delta LnDEM_t$	$\Delta LnSPI_t$	$\Delta LnGBY_t$	$\Delta\Delta LnCPI_t$	$\Delta LnFPI_t$
$\Delta LnEX_t$	1.000										
$\Delta LnHPI_t$	- 0.30***	1.000									
$\Delta LnM2_t$	0.016	0.216**	1.000								
$\Delta Ln3MINT_t$	-0.145	0.173*	-0.165*	1.000							
$\Delta LnRGDP_t$	-0.061	0.155	0.019	-0.024	1.000						
$\Delta LnOLP_t$	- 0.206**	-0.073	-0.149	0.272***	0.076	1.000					
$\Delta\Delta LnDEM_t$	-0.080	-0.112	0.093	-0.137	0.096	0.034	1.000				
$\Delta LnSPI_t$	- 0.32***	0.271***	-0.037	0.017	0.154	-0.062	-0.009	1.000			
$\Delta LnGBY_t$	-0.163*	0.137	-0.02	0.256***	-0.000	0.413***	-0.034	-0.052	1.000		
$\Delta\Delta LnCPI_t$	-0.164*	-0.031	-0.184*	0.172*	-0.071	0.237**	-0.090	0.016	0.331***	1.000	
$\Delta LnFPI_t$	-0.186	0.015	0.016	0.115	-0.101	0.283**	-0.103	0.153	0.165	0.281**	1.000

Table A7 LASSO regression based on quarterly data

Step	Cp	R-square	Action
1	26.847	0.000	
2	24.885	0.384	$+\Delta LnHPI_t$
3	17.286	0.456	$+\Delta LnOLP_t$
4	16.509	0.470	$+\Delta LnFPI_t$
5	15.952	0.472	$+\Delta\Delta LnCPI_t$
6	15.457	0.643	$+\Delta LnM2_t$
7	13.70	0.683	$+\Delta LnRGDP_t$
8	9.530	0.743	$+\Delta LnGBY_t$
9	9.000*	0.752	$+\Delta Ln3MINT$

Notes: The variables actually selected are noted in the action column. * indicates the smallest value for Cp.

Table A8 Net Elastic regression on stationary and non-stationary variables based on quarterly data

$\Delta LnSPI_t$	Coefficient	$LnSPI_t$	Coefficient
$\Delta LnHPI_t$	0.336	$LnHPI_t$	0.258
$\Delta LnRGDP_t$	0.760	$LnRGDP_t$	0
$\Delta\Delta LnCPI_t$	0	$\Delta LnCPI_t$	0
$\Delta LnM2_t$	0	$LnM2_t$	0
$\Delta Ln3MINT_t$	0	$Ln3MINT_t$	0.174
$\Delta LnOLP_t$	0	$LnOLP_t$	0
$\Delta LnGBY_t$	0	$LnGBY_t$	0
$\Delta LnFPI_t$	0	$LnFPI_t$	0.018
$\Delta LnEX_t$	-0.184	$LnEX_t$	-0.114
C	-0.006	C	4.318
R^2	0.225	R^2	0.592

Table A9 Johansen Cointegration Test: Panel A based on quarterly data

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy + \varepsilon_t$: Life cycle hypothesis			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
10.3806	8.3629	2.0176	2.1049
Model 2: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnHPI_t + \beta_3 Dummy_{2008Q2} + \varepsilon_t$: Credit effect hypotheses			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
31.6653**	17.8328	11.8325	13.0884
Model 3: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnRGDP_t + \beta_3 \Delta LnCPI_t + \beta_4 Dummy_{2008Q2} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
37.4137**	15.4509	21.9627	11.9486
Model 4: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_3 LnRGDP_t + \beta_2 LnHPI_t + \beta_4 \Delta LnCPI_t + \beta_5 Dummy_{2008Q2} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
91.3274***	37.5256***	23.2297	12.9778
Model 5: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} Dummy_{2008Q2} + \varepsilon_t$: LASSO selection			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
556.0280***	162.1166***	393.9113***	113.5285***
Model 6: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} LnEX_t + \beta_{11} Dummy_{2008Q2} + \varepsilon_t$: All control variables			
0 CI vectors	At most 1 CI vectors		
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
977.5802***	304.1397***	673.4405***	189.0735***

Notes: The table uses the most significant structural break March 2008 as exogenous variable and set dummy variable D=1 for 2008Q2 only. For Model 5, the Johansen trace test suggests that there are 4 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there are 2 statistically significant cointegrations at the 5% significance level. For Model 6, the trace test suggests that there are 6 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there are 2 statistically significant cointegrations at the 5% significance level.

Johansen Cointegration Test: Panel B based on Quarterly Data

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: Life cycle hypothesis			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
6.3728	5.2459	2.1269	3.1269
Model 2: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 \Delta LnHPI_t + \beta_3 Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: Credit effect hypotheses			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
34.5538**	27.3873***	7.1664	6.9346
Model 3: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 LnRGDP_t + \beta_3 \Delta LnCPI_t + \beta_4 Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
29.8355**	28.2144***	11.6211	8.8841
Model 4: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_3 LnRGDP_t + \beta_2 LnHPI_t + \beta_4 \Delta LnCPI_t + \beta_5 Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: General Equilibrium theory			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
65.6856***	32.8585***	32.8271**	24.5695**
Model 5: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: LASSO selection			
0 CI vectors		At most 1 CI vectors	
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
618.9869***	165.5611***	453.4258***	112.4470***
Model 6: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 HPI_t + \beta_3 LnRGDP + \beta_4 Ln\Delta CPI_t + \beta_5 LnM2_t + \beta_6 Ln3MINT_t + \beta_7 LnOLP_t + \beta_8 LnGBY_t + \beta_9 LnFPI_t + \beta_{10} LnEX_t + \beta_{11} Dummy_{2008Q2\_2017Q2} + \varepsilon_t$: All control variables			
0 CI vectors	At most 1 CI vectors		
Trace Test Statics	Max-EV Test Statics	Trace Test Statics	Max-EV Test Statics
1104.569***	309.8861***	794.6828***	224.3365***

Notes: The table uses the most significant structural break 2008Q2 as exogenous variable and set dummy variable $D = 1$ for the subsample from 2008Q2 to the 2017Q2. For Model 5, the Johansen trace test suggests that there are 5 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there are 2 statistically significant cointegrations at the 5% significance level. For Model 6, the trace test suggests that there are 7 statistically significant cointegrations at the 5% level of significance. The Johansen cointegration Max-EV test suggests there are 3 statistically significant cointegrations at the 5% significance level.

Table A10 Auto Regressive Distributed Lag (ARDL) bounds testing for cointegration based on quarterly data

Model 1: $LnSPI_t = c + \beta_1 \Delta LnDEM_t + \beta_2 Dummy + \varepsilon_t$: Life cycle hypothesis			
ADJ	2008Q2	ADJ	2008Q2 to end
$LSPI_{t-1}$	-0.0429 (0.0292)	$LSPI_{t-1}$	-0.0485 (0.0317)
Long Run		Long Run	-63.4873
$\Delta LnDEM_t$	-70.4392 (74.2584)	$\Delta LnDEM_t$	(68.3017)
Short Run		Short Run	
$Dummy_{2008Q2}$	-0.0790 (0.0665)	$Dummy_{2008Q2\_2017Q2}$	0.0056 (0.0149)
constant	0.3113 (0.1956)	constant	0.3454 (0.2094)
F-test	2.309	F-test	2.607
ARCH LM test	2.992*	ARCH LM test	3.294*
Breusch Godfrey LM test	0.066	Breusch Godfrey LM test	0.586
Ramsey RESET test	1.10	Ramsey RESET test	1.77
Jarque-Bera test	3.374	Jarque-Bera test	2.452

Notes: If the computed *F*-statistics is less than the lower bound of the critical values then the null hypothesis of no cointegration is not rejected. The lower bound critical value for the *F*-statistics is 4.94 at the 5% level. The null hypothesis of Jarque-Bera test is normality. The null hypothesis of Ramsey RESET test is the model has no omitted variables. The null hypothesis for Breusch-Godfrey LM test is no autocorrelation. The null hypothesis of ARCH LM test is no ARCH effects.

Table A11 The hypotheses tests for statistical significance of the Time-varying Parameters based on quarterly data

	Final State	Z-statistic	p-value
Model 1: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	-0.505176	-0.094066	0.9251
Model 2: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	1.544960	0.262487	0.7929
$\boldsymbol{sv_{2,t}}$	0.945892	3.851834	0.0001
$\boldsymbol{sv_{3,t}}$	-0.082513	-2.338845	0.0193
Model 3: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnRGDP_t + sv_{3,t}\Delta\Delta LnCPI_t + sv_{4,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	-1.394804	-0.235047	0.8142
$\boldsymbol{sv_{2,t}}$	1.583458	3.351940	0.0008
$\boldsymbol{sv_{3,t}}$	0.318509	0.261646	0.7936
$\boldsymbol{sv_{4,t}}$	-0.071530	-2.527606	0.0115
Model 4: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}CI_{t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	-0.123055	-0.020790	0.9834
$\boldsymbol{sv_{2,t}}$	0.758624	2.787851	0.0053
$\boldsymbol{sv_{3,t}}$	1.338723	2.529838	0.0114
$\boldsymbol{sv_{4,t}}$	1.120077	0.963451	0.3353
$\boldsymbol{sv_{5,t}}$	-0.046831	-1.721035	0.0852
Model 5: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}\Delta LnM2_t + sv_{6,t}\Delta Ln3MINT_t + sv_{7,t}\Delta LnOLP_t + sv_{8,t}\Delta LnGBY_t + sv_{9,t}\Delta LnFPI_t + sv_{10,t}CI_{1,t-1} + sv_{11,t}CI_{2,t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	7.992859	1.107356	0.2681
$\boldsymbol{sv_{2,t}}$	1.027849	2.978058	0.0029
$\boldsymbol{sv_{3,t}}$	1.434959	2.371173	0.0177
$\boldsymbol{sv_{4,t}}$	0.100091	0.071638	0.9429
$\boldsymbol{sv_{5,t}}$	-0.131526	-0.594557	0.5521
$\boldsymbol{sv_{6,t}}$	0.038293	0.534371	0.5931
$\boldsymbol{sv_{7,t}}$	0.019308	0.343141	0.7315
$\boldsymbol{sv_{8,t}}$	-0.010399	-0.092013	0.9267
$\boldsymbol{sv_{9,t}}$	0.007927	1.495403	0.1348
$\boldsymbol{sv_{10,t}}$	-0.002078	-0.247679	0.8044
$\boldsymbol{sv_{11,t}}$	5.308592	1.623443	0.1045
Model 6: $\Delta LnSPI_t = c + sv_{1,t}\Delta\Delta LnDEM_t + sv_{2,t}\Delta LnHPI_t + sv_{3,t}\Delta LnRGDP_t + sv_{4,t}\Delta\Delta LnCPI_t + sv_{5,t}\Delta LnM2_t + sv_{6,t}\Delta Ln3MINT_t + sv_{7,t}\Delta LnOLP_t + sv_{8,t}\Delta LnGBY_t + sv_{9,t}\Delta LnFPI_t + sv_{10,t}\Delta LnEX_t + sv_{11,t}CI_{1,t-1} + sv_{12,t}CI_{2,t-1} + \varepsilon_t$			
$\boldsymbol{sv_{1,t}}$	2.148890	0.308904	0.7574
$\boldsymbol{sv_{2,t}}$	0.705710	2.013555	0.0441
$\boldsymbol{sv_{3,t}}$	1.335528	2.242988	0.0249
$\boldsymbol{sv_{4,t}}$	0.104237	0.074005	0.9410
$\boldsymbol{sv_{5,t}}$	-0.123730	-0.584355	0.5590
$\boldsymbol{sv_{6,t}}$	0.041802	0.624664	0.5322
$\boldsymbol{sv_{7,t}}$	-0.002488	-0.045839	0.9634
$\boldsymbol{sv_{8,t}}$	-0.051124	-0.448271	0.6540
$\boldsymbol{sv_{9,t}}$	0.005335	1.030019	0.3030
$\boldsymbol{sv_{10,t}}$	-0.329308	-2.330867	0.0198
$\boldsymbol{sv_{11,t}}$	0.085377	1.342228	0.1795
$\boldsymbol{sv_{12,t}}$	-1.210891	-1.478906	0.1392

Notes: Root MSE stands for Root Mean Square Error. $\boldsymbol{CI_t}$ stands for cointegration term.