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Population Neutralism: A Test for Australia and its Regions

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ABSTRACT

The hypothesis that population growth and ageing have no effect on the pace of economic growth (population neutralism) is tested for Australia and its regions. National and regional growth models are developed and contain key components of population growth (natural increase, overseas and internal migration) plus an ageing variable as explanators, along with standard growth explanators such as investment in human and physical capital, government expenditure and net exports. The time series modelling indicates that demographic characteristics make only limited contributions to growth. However, natural increase and overseas migration have a significant effect on economic growth when a panel data set is formed by combining the time series with a cross-section of the eight Australian states and territories. Ageing appears to dampen growth when panel data are applied. The standard explanators of growth: investment, education expenditure, government expenditure and net exports all contribute to growth. There is no evidence of endogeneity among the explanatory demographic variables and so reverse causation is not evident.

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1. Introduction

Population neutralism is according to Bloom and Freeman (1986) a doctrine positing the absence of any significant relationship between population growth and the rate of economic growth. It is a doctrine which according to Kelley and Schmidt (1995) held sway throughout the 1970s and 1980s based on the evidence from those eras. However, most developed countries have now completed a demographic transition from high to low fertility and mortality rates, so the demographic fundamentals underpinning any link between population and economic growth have changed. This demographic shift has encouraged researchers to revisit the issue of the population/economic growth nexus. The studies by Bloom and Canning (1999) and Bloom et al (1998) are among several which explore this relationship. The results for or against population neutralism are quite mixed. According to Bloom, Canning and Malaney (2000, p.258) the leading edge of the demographic transition is evident in the declining mortality of infants and young people creating the conditions for a younger population. The trailing edge is declining fertility which in the later stages of the transition engenders ageing. Ageing and the slowing of population growth are natural correlates, none of which matters for living standards unless demographic change does affect the pace of economic growth or development and so demographic effects should be accommodated in this study.

The purpose of this study is to test the population neutralism hypothesis on Australian data at the regional level, taking into account the fact that both the economic and population growth rates are potentially endogenous. The possibility of reverse causality cannot be entirely discounted.

The motivation for this study comes from the economic significance of certain demographic characteristics. In this respect, the focus of Australian research relates to the economic impacts of one particular characteristic, namely, ageing. The original tenet about the effects of ageing on aggregate saving[1] held that Australians were undersavers, a view refuted by Guest and McDonald (1998) who find that Australians tended to oversave until the mid 1970s and to undersave throughout the 1980s and 1990s. Further, Guest and McDonald (2001) find that ageing will have a minimal impact on future Australian living standards and therefore that serious policy intervention to boost national savings is not justified.

This study departs from this aggregate savings/ageing line of inquiry in three ways. First it examines directly the link between the individual components of population growth (overseas migration, natural increase and interregional migration) and the pace of economic growth. The focus on one demographic component in the current literature, namely ageing could lead to a lack of information about the effects of other demographic issues. This is addressed by conducting a study of the relationship between the components of population growth and the pace of economic growth. The second departure is to conduct the analysis at two levels: the aggregate national level and for regional Australia (the states and territories). Jackson and Felmingham (2002) in their analysis of population ageing in the states and territories find such disparate regional demographic experiences that it will not surprise if the population/regional growth link is also remarkably disparate for Australia's regions. This will have fiscal and financial policy implications. The final point of departure from the ageing/savings literature is to be found in tests for contemporaneous reverse causality which may obscure the nature of the population/economic growth rate relationship.

The following section (2) of the paper details the approach adopted in this study, while section (3) contains a report of the outcomes. Interpretations and conclusions are drawn out in a closing section (4).

[1] See Fitzgerald (1993), Argy (2001) and Wood (2001) for expressions of this view.

2. Approach and Data

A standard economic growth model, augmented with demographic variables is developed for this study. To this end, the model includes some of the usual explanators of growth, in particular private investment in capital (I), government consumption and investment expenditure (G), education expenditure (EDU), net exports (NX) and also the demographic variables of interstate migration (IM), natural increase (NI) and overseas migration (OM) to capture population growth and a variable that measures the proportion of the population aged over 65 (AGE) to capture the ageing of the population.

Private investment and expenditure on education are acknowledged to be major drivers of growth. General government expenditure has also been included due to the possibility that it provides a stimulus to growth, through the development of infrastructure, for example. Net exports from the nation or a region are also included in recognition of the fact that a strong export sector can be a major driver of growth. Internal migration at the regional level and natural increase and overseas migration at both the national and state levels have been included to measure the components of population change. There is a potential correlation between natural increase and the age variable, as a young population is the natural corollary of a high natural increase. Nevertheless, the correlation was found to be only –0.35 at the national level, so both variables were maintained in the model.

The data sources which represent the variables in the paragraph above are described at the end of the text. Attention is drawn to the fact that in contrast to previous studies, which aim to explain the relationship between income per capita and demographic variables, this study focuses on the explanation of state and national level economic growth[2]. It should also be noted that the measurement of the education expenditure variable differs between the state and national level studies, due to data limitations. At the national level, the education

[2] It should be noted that the regressions were also conducted using GDP per capita and the results did not differ substantially from those generated when economic growth is the dependent variable.

expenditure variable is constructed as the sum of private and public expenditure at all levels of education[3]. Consistent data of this type were not available at the state level, however, so the state education expenditure series relates only to tertiary education.

Another point of departure of this study from the existing literature, is the time period over which the relationships between demographic and economic variables are analysed. The use of quarterly data in this paper captures the within quarter relationships between population and economic growth. This is in contrast to Felmingham and Jackson (2003), who use annual data. Nevertheless, in recent times, particularly in regards to ageing in Tasmania (Felmingham and Jackson 2002), the speed of demographic change has increased, warranting the use of quarterly data on the relatively recent time series employed in this study. The time period studied is simply the longest period for which all data were available. Due to the mix of variables chosen it is substantially shorter than that employed by Felmingham and Jackson (2003). The national level study is conducted on data from 1971(III) to 2001(II), while the state level covers the period 1986(IV) to 2002(II), except for the Australian Capital Territory (ACT), for which a complete data set was only available from 1989(III) to 2002(II).

The economic growth model used in this study only captures the contemporaneous relationship between economic growth and its determinants. This is in contrast to Felmingham and Jackson (2003), who adopt a vector error correction model (VECM). Their VECM captures both the long-run and short-run relationship between population and living standards in a dynamic growth model and allows the existence and direction of granger causality between population growth and economic growth to be determined. The economic growth model adopted in this paper, however, is based on different variables to that of Felmingham and Jackson, importantly the components of population change are decomposed. No cointegration between the variables used in this study was found, so a VECM, which

[3] This includes government and private operating expenses and investment.

relies on cointegration, could not be used. Furthermore, a vector autoregression (VAR) was not employed in the paper. This is not only due to limitations in finding enough data at the regional level to permit the estimation of the large number of parameters in the VAR, but also to allow a focus in the paper on the analysis of the contemporaneous relationship between population change and economic growth. To this end, the model presented here is based on the one adopted by Bloom, Canning and Malaney (2000) in their multi-national study of the relationship between population growth and economic growth. The following models were estimated in first differences using OLS in the time-series component of the study[4]:

National Level:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta NI_t + \beta_2 \Delta OM_t + \beta_3 \Delta AGE_t + \beta_4 \Delta EDU_t + \beta_5 \Delta I_t + \beta_6 \Delta G_t + \beta_7 \Delta NX_t \qquad (1)$$

State/Territory Level:

$$\begin{aligned}\Delta Y_t &= \alpha_0 + \alpha_1 \Delta NI_t + \alpha_2 \Delta IM_t + \alpha_3 \Delta OM_t + \alpha_4 \Delta NX_t + \alpha_5 \Delta EDU_t + \alpha_6 \Delta I_t \\ &+ \alpha_7 \Delta G_t + \alpha_8 \Delta NX_t\end{aligned} \qquad (2)$$

Following Felmingham and Jackson (2003), causation is assumed to flow from investment, government expenditure, education expenditure and net exports to economic growth. Nevertheless, the current literature suggests the possibility of reverse causality for the demographic variables. Indeed, Bloom, Canning and Malaney (2002, p.260) argue that:

> *"Reverse causality potentially undermines the accuracy of recent estimates of the effects of population change on economic growth, because those estimates presume unidirectional causality".*

Furthermore, reverse causality between economic growth and population growth is, in itself an interesting phenomenon to investigate, over and above the need to investigate it due to possible estimation bias. To this end, instrumental variable estimation is conducted and the

[4] First differences were used as the Phillips-Perron test indicates that differencing the variables renders most of them stationary. An exception, however, is the education variable which is non-stationary in first differences. However, the test statistics are just larger than the ten percent critical value and to maintain consistency of the variables in the model and for ease of interpretation, the education variable in first differences is adopted. The reader should therefore be aware of the possibility of spurious regression for this variable.

Wu-Hausman test statistic for endogeneity constructed. The conclusion generated by the Wu-Hausman test regarding the endogeneity of the population variables can also be used to comment on reverse causality (economic growth influences population growth). There are several variants of the Wu-Hausman test presented in the literature, however the variant presented here is that outlined in Johnston and DiNardo (1997), which involves a comparison of the coefficients and the variance-covariance matrices from the ordinary least squares and the instrumental variables regression to ascertain whether the potentially endogenous variables are, in fact, endogenous. As the Wu-Hausman results rely on the instruments selected, the Sargan validity of instruments test is conducted to determine whether the instruments selected were appropriate[5]. The instruments used are the same at both the state and national level. They are the exogenous variables in the economic growth equations, lagged values of the exogenous variables and lagged and contemporaneous number of women between 15 and 40 (women around childbearing age). The last variable is added to improve the correlation of the instrumental variables with the potentially endogenous variables. Nevertheless, it should be noted that Bloom et al (2002) find that when they model total economic growth over a short time period there is no such reverse causality as defined here and that reverse causality only emerges in a cross-section study when cumulative economic growth over a longer time period (for example, a 15 year period) is studied.

Attention should also be drawn to the fact that higher-order autocorrelation was found in both the national and state level time-series studies. The autocorrelation was corrected by using a Gauss-Newton iterative algorithm, as outlined in Pagan (1974)[6].

Although time-series studies of the individual states do allow for some analysis of the relationship between population and economic growth at the sub-national level, the use of panel data for the states and territories is advantageous as it allows for the modelling of

[5] The Sargan validity of instruments test is explained in Stewart and Gill (1998).
[6] Heteroskedasticity is not generally considered to be a problem when time-series data is employed (Gujarati 1995).

temporal effects without aggregation bias (as would occur at the national level) and provides increased precision over the state time-series regression estimates. Both fixed and random effects estimation of the panel data models are undertaken. Generalized least squares (GLS) is used to estimate the random effects model, which generates a combination of 'within' and 'between' estimates. Mody and Srinivasan (1998) argue that random effects is a more comprehensive estimator than fixed effects. Furthermore, the Hausman test statistic suggests randomness, so only the random effects results are reported in the next section. While space considerations prevent the fixed effects results from being reported, it should be noted that the dummy variables designed to capture the fixed different intercepts between the states and territories are jointly significant, which signals a different economic growth process between regions and thus provides further justification for the regional analysis of the relationship between demographic and economic growth variables. An unbalanced panel has been employed, as the series used for the ACT are not as long as those for other states and territories. When an unbalanced panel is used, there is the possibility of selection bias and a Hausman test needs to be conducted to determine if selection bias is present in the unbalanced panel[7]. The Hausman test statistic for the random effects model is 1.88, which signals that the unbalanced panel does not suffer significantly from selection bias. Thus, so as not to discard potentially useful information, the unbalanced panel is used in estimation. The model estimated is:

$$\Delta Y_t = \delta_{0i} + \delta_1 \Delta NI_{it} + \delta_2 \Delta IM_{it} + \delta_3 \Delta OM_{it} + \delta_4 \Delta AGE_{it} + \delta_5 \Delta EDU_{it} + \delta_6 \Delta I_{it} + \delta_7 \Delta G_{it} + \delta_8 \Delta NX_{it} \quad (3)$$

All time-series regressions in this study are performed using Shazam software, while the panel data regression results have been generated using Stata software.

[7] The Hausman test statistic is constructed in the same way as the Hausman test for fixed or random effects. The only difference is that instead of using the estimates of the fixed and random effects coefficient and variance-covariance matrices, the estimates for the balanced and unbalanced panel (both random effects) are used.

3. Results

The results from the estimation of equations (1) and (2) are now discussed in some detail beginning with a national time series analysis of the growth model (1) in which case the population growth is represented by its two components: the natural increase (NI) and overseas migration (OM). The outcomes from the state/territory study (equation 2) are repeated in a separate sub section as are the results from panel data estimation.

3.1. Population Neutralism at an Aggregate National Level

Table 1 provides the results from the estimation of (1) on quarterly data where the national rate of economic growth is the dependent variable.

Table 1 Here

The results shown on Table 1 have been estimated first by OLS and then using Instrumental Variables. The selection of instruments is described in the previous section of the paper and the Sargan test statistic shown on Table 1 suggests that the chosen instruments are appropriate. The Sargan test has a χ^2 score of 0.617 well below the 5 percent critical value suggesting the null hypothesis stating that the selected instruments are appropriate be accepted. The OLS and IV estimates are used to construct the Wu-Hausman test described in the preceding section. The null hypothesis associated with this test recognises all the variables on the right hand side of (1) to be exogenous. The alternative hypothesis requires the natural increase and overseas migration variables to be endogenous. The value of the Wu-Hausman test statistic shown on Table 1 (5.353) is below the 5 percent critical value of the χ^2 distribution, suggesting that the null hypothesis of the exogeneity of the population variables be accepted. The absence of endogneneity in equation (1) of the population variables suggests that there is no apparent reverse causation in this case. The absence of endogeneity also suggests that OLS estimation is reliable subject to the usual caveats, regarding serial correlation for example.

The results shown on Table 1 are OLS estimates adjusted for serial correlation using the Gauss Newton algorithm. The outcomes are quite informative. The national economic growth rate is strongly influenced by private capital expenditure (investment) and total education expenditure at all levels and from both public and private sources. The t-ratios on investment (8.109) and education (2.540) are clearly significant at the 5 percent level. There is also some evidence (significant at the 10 percent level) of positive growth effects flowing from government expenditure and net exports. However, it is not possible to reject the notion of population neutralism for Australia using these time series data. None of the three population variables are significantly different from zero at either the 5 or 10 percent level of significance. In particular, the natural increases of the population (t = 0.812) and overseas migration (t = 0.4211) fall well short of standard significance levels[8]. The demographic variable which comes closest to significance in equation 1 is the ageing of the population, which is significant at the 15 percent level.

3.2. States and Territories: Time Series Analysis

Table 2a and Table 2b contain the results flowing from the estimation of equation (2) where the economic growth rates at the state and territory level are the dependent variables. This regional growth model differs from the national one in relation to the decomposition of the population growth rate. At state/territory level there are three components of the total population growth rate namely, the rate of natural increase (NI), overseas migration (OM) and internal (interregional) migration (IM). The international migration variable is not appropriate at the national level.

[8] When the overall population growth rate replaces NI and OM in equation (1), the same conclusion arises. The population growth rate is not significant.

Tables 2a and 2b Here

The same procedures are applied to each state and territory time series: first equation (2) is estimated by OLS and IV and the Wu-Hausman test for endogeneity is conducted for the population growth related variables. The Sargan test for the appropriateness of the instruments used in IV estimation is also applied. These diagnostic tests are analysed first. For each of the eight states and territories the χ^2 score for the Wu-Hausman test is less than its 5 percent critical value indicating that endogeneity does not apply to the population growth related variables in equation 2. Again, we conclude at state and territory level that there is no evidence of reverse causality between population and economic growth rates. Further, all of the values of the Sargan test fall short of at least the 5 percent critical value, indicating that the instruments selected are appropriate for each state and territory.

The results shown on Tables 2a and 2b are adjusted using the Gauss Newton algorithm. OLS estimates of equation (2) are deemed to be legitimate in the absence of endogeneity. The results are once again informative. The outcomes for the population variables are mixed at state and territory level. The rate of natural increase is significant at the 10 percent level only for Queensland and Tasmania. Overseas migration has no significant impact on growth for any state or territory, while internal migration is significant at the 15 to 20 percent level for NSW, Victoria, WA and Tasmania. The demographic variable which has the greatest impact on economic growth is the ageing variable which is significant (at least at the 10 percent level) and negatively signed for NSW, Queensland, South Australia, while it is significant at the 10 percent level for the Northern Territory. The negative sign of the ageing variable is consistent with an argument suggesting that an ageing population may experience declining productivity. The positive sign of the ageing variable in the equation for Northern Territory growth may reflect the fact that the Northern Territory population is Australia's youngest in a regional context. According to Jackson and Felmingham (2002) the Northern

Territory population is not yet ageing at a significant rate and the proportion aged over 65 may actually be falling slightly. Alternatively, it may be the case that any small increase in Northern Territory ageing is productive and increases Northern Territory growth.

It is patently clear from Table 2 that regional growth rates are driven by government expenditure and private fixed capital expenditure which are highly significant and have a positive impact on regional growth in each state and territory. Net exports are significant (at the 5 or 10 percent level) and negative in their impact on the growth of the larger states, NSW and Victoria.

3.3. State and Territories: Panel Data Analysis

The results to this point are potentially limited by the number of data points contained in each time series: 62 for the states and the Northern Territory and 51 for the ACT. By forming a data panel combining the time series of the eight states and territories, a panel of 485 observations is formed. This panel data study provides an alternative view of aggregate economic growth. The results for the random effects GLS estimation of economic growth equation (3) are recorded on Table 3. The preference for random effects estimation of equation (2) using panel data is explained in Section 2 of this paper and is justified by referring to the Hausman test on Table 3. This has a value of 1.56 which is well below the critical χ^2 score required for the rejection of a null hypothesis that there is randomness present in the panel. It is appropriate in this case to accept the presence of random effects and estimate (3) as a random effects model using GLS.

Table 3 Here

The results from the panel data estimation of equation (3) strengthen the case for the influence of population variables on regional economic growth. Both natural increase and overseas migration apparently help to accelerate the growth rate, both are significant at the 5 percent level and both have positive signs for each state and territory. Although the decision to accept or reject population neutralism is not finalised, it is difficult to accept the hypothesis on the strength of this regional evidence. The age variable does impact in a significant and negative manner on the pace of economic growth, so the arguments advanced in favour of negative effects flowing from the ageing process tend to be supported by the evidence from this study. Internal migration is not particularly significant, a result which may simply reflect the netting out of internal migration effects. Investment, government expenditure and tertiary education expenditure all perform strongly.

4. Interpretations and Conclusions

The objective of this study is to test the hypothesis that population growth rates and ageing have no significant impact on the growth of the Australian economy. This is reflected by others as the "population neutralism" doctrine. To test the proposition two models of economic growth are framed; one for aggregate national data and the other for regional state and territory data. The only differences in the specification of the two models is to be found in the treatment of the decomposed population growth rates: national population growth data was decomposed into two components, namely overseas migration and natural increase while in the regional study population growth has three components, namely overseas migration, natural increase and internal (interstate) migration. Both national and regional studies are based on time series data initially and a panel data set comprised of all the states and territories is also formed.

The national level analysis tends to support the notion of population neutralism as neither overseas migration nor natural increase variables have a significant impact on the Australian national economic growth rate. However, there is some rather inconclusive evidence for a negative effect of population ageing on economic growth. The eight individual time series analyses of regional economic growth reach similar conclusions subject to a few deviations. The natural increase variable does have an impact on Queensland and Tasmania growth, but overseas and internal migration have no effect on regional growth. Population ageing, however, reduces the growth rates of NSW, Queensland and SA.

A different perspective is provided when the data are arranged as a panel. This panel data approach has the advantage of increasing the sample size, so the results from this much larger sample are likely to produce more efficient estimates. Further, the move to panel data has the advantage over the individual regional time series analysis of also preserving the national characteristic of the study. This follows from the composition of the panel which includes all eight Australian states and territories and is in this sense a comprehensive national study.

Panel data estimation clearly provides some evidence which suggests that population neutralism should be rejected in the Australian case. The rate of natural increase and overseas migration both stimulate economic growth although internal migration does not appear to influence Australia's economic growth and ageing dampens growth. This result is consistent with arguments suggesting that ageing is associated with decreased economic growth.

In other respects, the standard explanators of growth, namely private fixed capital expenditure, net exports and various measures of the investment in human capital (education) all play their usual role in determining both national and regional growth. In particular, investment and government expenditure are always significant and positive at both the national and regional levels in both the time series and panel data models. Education expenditure contributes significantly to the national growth rate, although this variable is not influential at the state level, an outcome which is partly explained by the narrow focus in the measurement of the variable at the state level. Education expenditure does become important once again in the panel data study.

In summary, we reject population neutralism as an appropriate tenet for the Australian economy. This summary view is based on an Australian perspective, which views the nation as eight regions experiencing different population and growth processes.

Data Sources

State Level:

State Final Demand, Investment, Government Expenditure and Net Exports are sourced from ABS Catalogue Number 5206, Tables 10-18.

The components of state and territory population change are sourced from ABS Catalogue Number 3101 Table 2.

The percentage of the population aged over 65 is sourced from ABS Catalogue Number 3201.0.

The tertiary education expenditure series was provided by the ABS.

National Level:

Real GDP, net exports, investment in physical capital and government expenditure are sourced from ABS 5206.0.

Education expenditure from 1976/77 is drawn from ABS 4230.0 Table 6. The data is sourced from the ABS Year Books over the period 1971/72 to 1975/76.

The percentage of the population over 65 years of age is sourced from ABS Data Cube 3105.0.65.001 Table 19.

The components of population change is sourced from ABS Data Cube 3105.0.65.001, Table 3.

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Table 1: Regression Results of Model I
(Australian Time Series Data)

Model I: $\Delta Y_t = \beta_0 + \beta_1 \Delta NI_t + \beta_2 \Delta OM_t + \beta_3 \Delta AGE_t + \beta_4 \Delta EDU_t + \beta_5 \Delta I_t + \beta_6 \Delta G_t + \beta_7 \Delta NX_t$

Variable	Parameter	Estimate (t-ratio)
Constant	β_0	-332000000 (-0.3948)
NI	β_1	17792 (0.812)
OM	β_2	2276.2 (0.4211)
AGE	β_3	-8017000000 (-1.502)
EDU	β_4	0.120 (2.840)*
I	β_5	1.180 (8.109)*
G	β_6	0.535 (1.779)**
NX	β_7	-275585 (-1.826)*
Diagnostics		
No of Observations		119
R^2		0.5791
Ljung-Box Test (4 lags)		$\chi^2(4) = 0.45$
Wu-Hausman Test		$\chi^2(2) = 5.35$**
Sargan Test		$\chi^2(4) = 0.62$

Note: t-ratios are in the brackets. * and ** represent 5% and 10% significance levels respectively.

Fourth order autocorrelation has been corrected for.

Table 2a: Regression Results of Model II
(Australian States and Territories Time Series Data)

Model II: $\Delta Y_t = \alpha_0 + \alpha_1 \Delta NI_t + \alpha_2 \Delta IM_t + \alpha_3 \Delta OM_t + \alpha_4 \Delta AGE_t + \alpha_5 \Delta EDU_t + \alpha_6 \Delta I_t + \alpha_7 \Delta G_t + \alpha_8 \Delta NX_t$

Variables	Parameter	NSW	VIC	QLD	SA
Constant	α_0	316.83 (5.569)*	113.31 (1.173)	186.74 (3.459)*	97.746 (3.320)*
NI	α_1	0.005 (1.398)	-0.0007 (-0.130)	0.008 (1.876)**	-0.003 (-0.700)
IM	α_2	-0.006 (-1.485)	0.001 (0.695)	0.0001 (0.1255)	0.001 (0.488)
OM	α_3	0.002 (1.593)	0.0006 (1.140)	0.0004 (0.553)	0.002 (1.432)
AGE	α_4	-6834.4 (-6.058)*	-1804.4 (-0.832)	-5689.3 (-4.680)*	-1243.5 (-2.434)*
EDU	α_5	0.795 (0.771)	-0.893 (-0.435)	-0.502 (-0.253)	1.996 (0.830)
I	α_6	1.291 (18.32)*	1.157 (16.600)*	1.109 (18.96)*	1.126 (13.85)*
G	α_7	1.193 (11.30)*	1.170 (13.890)*	1.105 (15.740)*	1.141 (12.44)*
NX	α_8	-0.149 (-2.003)*	-0.116 (-1.817)**	0.024 (0.287)	-0.038 (-0.737)
Diagnostics					
No of Observations		62	62	62	62
R^2		0.985	0.998	0.988	0.974
Ljung-Box Test (4 lags)		$\chi^2(4)$=2.95	$\chi^2(4)$=4.85	$\chi^2(4)$=1.47	$\chi^2(4)$=2.12
Wu-Hausman Test		$\chi^2(3)$=7.37**	$\chi^2(3)$=3.47	$\chi^2(3)$=4.18	$\chi^2(3)$=2.86
Sargan Test		$\chi^2(4)$=5.42	$\chi^2(4)$=6.61	$\chi^2(4)$=2.84	$\chi^2(4)$=9.38**

Note: t-ratios are in the brackets. * and ** represent 5% and 10% significance levels respectively.

Third order autocorrelation has been corrected for in all of the regressions in this table.

Table 2b: Regression Results of Model II
(Australian States and Territories Time Series Data)

Model II: $\Delta Y_t = \alpha_0 + \alpha_1 \Delta NI_t + \alpha_2 \Delta IM_t + \alpha_3 \Delta OM_t + \alpha_4 \Delta AGE_t + \alpha_5 \Delta EDU_t + \alpha_6 \Delta I_t + \alpha_7 \Delta G_t + \alpha_8 \Delta NX_t$

Variables	Parameter	WA	TAS	NT	ACT
Constant	α_0	65.986 (2.830)*	16.386 (2.765)*	2.007 (0.5057)	7.128 (0.554)
NI	α_1	0.00351 (0.964)	-0.007 (-1.695)**	0.0007 (0.140)	0.0007 (0.155)
IM	α_2	-0.004 (-1.452)	0.002 (1.335)	-0.0003 (-0.307)	-0.0006 (-1.050)
OM	α_3	-0.0001 (-0.278)	0.001 (0.3197)	-0.003 (-1.176)	0.0002 (0.376)
AGE	α_4	-693.41 (-1.163)	-15.059 (-0.152)	139.82 (1.891)**	167.27 (0.783)
EDU	α_5	-0.950 (-0.662)	-0.352 (-0.330)	-0.039 (-0.028)	-0.077 (-0.0591)
I	α_6	1.098 (28.05)*	1.182 (21.28)*	1.046 (43.70)*	0.990 (11.13)*
G	α_7	1.252 (10.86)*	1.305 (12.39)*	1.127 (14.46)*	1.016 (26.72)*
NX	α_8	0.017 (0.456)	-0.037 (-0.630)	0.006 (0.595)	0.394 (1.470)
Diagnostics					
No of Observations		62	62	62	51
R^2		0.990	0.969	0.993	0.993
Ljung-Box Test (4 lags)		$\chi^2(4)$=2.53	$\chi^2(4)$=1.13	$\chi^2(4)$=0.89	$\chi^2(4)$=0.85
Wu-Hausman Test		$\chi^2(3)$=1.78	$\chi^2(3)$=0.75	$\chi^2(3)$=3.41	$\chi^2(3)$=3.43
Sargan Test		$\chi^2(4)$=6.80	$\chi^2(4)$=3.41	$\chi^2(4)$=9.27**	$\chi^2(4)$=4.53

Note: t-ratios are in the brackets. * and ** represent 5% and 10% significance levels respectively.

Third order autocorrelation has been corrected for in all of the regressions in this table.

Table 3: Regression Results of Model III
(Australian States and Territories Panel Data)

Model III: $\Delta Y_t = \delta_{0i} + \delta_1 \Delta NI_{it} + \delta_2 \Delta IM_{it} + \delta_3 \Delta OM_{it} + \delta_4 \Delta AGE_{it} + \delta_5 \Delta EDU_{it} + \delta_6 \Delta I_{it} + \delta_7 \Delta G_{it} + \delta_8 \Delta NX_{it}$

Variable	Parameter	Estimate (t-ratio)
Constant	δ_0	48.93 (4.86)*
NI	δ_1	0.011 (7.53)*
IM	δ_2	0.001 (1.30)
OM	δ_3	0.005 (3.78)*
AGE	δ_4	-991.79 (-4.75)*
EDU	δ_5	1.132 (2.15)*
I	δ_6	1.152 (43.31)*
G	δ_7	1.302 (25.73)*
NX	δ_8	-0.209 (-7.55)*
Diagnostics		
No of Observations		485
(Adj) R^2		0.929
Hausman Test		$\chi^2(8) = 1.56$

Note: t-ratios are in the brackets. * and ** represent 5% and 10% significance levels respectively.

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