An Empirical Study of Sectoral-Level Capital Investments in New Zealand

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Abstract

[I extend the Glick and Rogoff (1995) aggregate time-series, empirical, intertemporal model of country-investment (and the current account) to a sectoral-level, and estimate it for New Zealand. I fit the model to panel data of eleven industries from 1988-2009. The sectoral-level investment growth is a function of lagged investment level, sector-specific TFP shocks, country-specific TFP shocks, and global TFP shocks. The estimates seem robust to government spending shocks and Terms of Trade shocks.]

JEL CLASSIFICATION [E2, C2, C33]

KEYWORDS [Investments, sectoral-level, TFP shocks, panel data]

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1 Introduction

The consensus is that New Zealand has relatively low levels of capital investment and productivity (measured by GDP per hour worked) because TFP is low (Treasury 2008).[i] TFP accounts for the changes in output not caused by changes in labour and capital inputs. TFP growth represents the effect of technological change, efficiency improvements, and our inability to measure the contribution of all other inputs. This argument is consistent with a number of different growth models.[ii]

Essentially, TFP might be the main explanatory variable for capital investments. Prescott (1997) shows that cross-country differences in savings rates – even after correcting the capital stock data to include intangible capital – explain only very small portions of the income differentials between countries. A model with human capital also fails for similar reasons. TFP is the most important variable that can explain differences in cross-country income differences.

Laabas and Razzak (2011) calibrated an aggregate semi-endogenous growth-accounting model that accounts for the *quality* of human capital. They found that three-quarters of New Zealand's GDP per hour growth rate is attributed to TFP growth (not capital, labour, or human capital). And, TFP explains one-half of the productivity growth in Australia. But, at the firm level, lagged investments seem to explain all the variations of current investments. Eberly *et al.* (2012) provide additional evidence for the Christiano *et al.* (2005) model of investment.

Prescott (1997) emphasises that although the U.S. is the most productive nation in the world, it is not the most productive nation in *all* industries. He shows that sector-level productivity differences are not explained by differences in the stock of capital, human capital, or useable knowledge.

Intertemporal models in this literature are usually simulated because they do not have closed-form solutions. Estimation might shed more light on the responsiveness of the sector-level investment growth to various shocks, which might vary across different industries. We could measure the size of these responses; policy responses may be different for different industries.

This paper attempts to explain the behaviour of sector-level capital investment. I combine three different aspects of the investment literature in one. First, I use an intertemporal model, where investment growth is a function of past investment's level and productivity shocks; second I investigate investments at the sectoral level rather than the aggregate level; and finally I estimate the model rather than simulate it.

To do so, I extend Glick and Rogoff (1995). They follow Sachs (1981), Obstfeld (1986) and Frenkel and Razin (1987) who study the intertemporal effect of government spending and productivity shocks.[iii] Their model, however, is an aggregate empirical model – where the investment-growth rate is a function of the lagged investment level, a country-specific TFP shock, and a global TFP shock. I extend this model to study the sectoral-level investments in New Zealand and introduce a third shock – and sector-specific TFP shock. In this version of the model, Sectoral-level capital investment growth rate depends on lag investment level, Sector-specific TFP shock, country-specific TFP shock, and a global TFP shock. I also control for government spending shocks and Terms of Trade shocks (ToT). The former is assumed to be a pure aggregate demand shock as in Glick and Rogoff (1995) while the latter could be either a demand or a supply shock. I do so because there is some evidence for the effect of ToT shocks on the real economy and optimal resource allocation (e.g., Hunt, 2009, Grimes, 2009). Hunt (2009) uses the IMF macro model. Grimes calibrate a general equilibrium model. Both assume a two sector economy of tradable and non-tradable goods. Cassino (2012) provides evidence that subjectively splitting real GDP into tradable and non-tradable goods might be misleading. For example, some clearly non-tradable goods such as housing have intermediate inputs, which are largely tradables.[iv] My sectoral-level modelling and estimation method is consistent with Cassino (2012).

The results confirm the positive association between the shallowness of capital investments and productivity shocks in New Zealand at the sectoral level. I found that, on average, sector-specific TFP shocks have effects on sectoral-level investments, but the effects have different magnitudes for different industries. On average, country-specific TFP shocks are more important for the sectoral-level investment growth and more statistically significant. Contemporaneous global TFP shocks have no effect on investments at the sectoral level, but there is a very strong lag effect. On average, the response of the sectoral-level investment growth to these shocks is twice as large in magnitudes as to country-specific TFP shocks; it is also five times larger than the response to sectoral-specific TFP shocks. And, lagged investment's effect is very significant and varies across industries. On average, both government spending and ToT shocks have positive effects on the sectoral -level investment growth. However, there is evidence that the latter affects investment growth for some industries with a lag between one and two years.

The paper is organized as follows. Next, we introduce the model. Section 3 includes the description of the data. Section 4 includes the estimation and the analysis of the results. Section 5 concludes and provides a short policy discussion.

2 The Model

2.1 Output Supply

The representative agent supplies labour inelastically so that the production function is given by:

$$Y_t = A_{ct} K_t^{\alpha} \left[1 - \frac{g}{2} \left(\frac{I_t^2}{K_t} \right) \right]. \quad (1)$$

Where Y_t is output, K_t is the stock of capital, the term I_t^2 / K_t captures the adjustment costs in changing capital stock over time, A_{ct} is a country-specific TFP shock, where the subscript c denotes country and t is a time index. The stock of capital evolves according to:

$$K_{t+1} = K_t + I_t . \quad (2)$$ [v]

The representative firm chooses an optimal path for investment I_t to maximize the present discounted value of future profits, which is discounted at the world interest rate.[vi] Glick and Rogoff (1995) use solution technologies found in Abel and Blanachard (1986), Shapiro (1986), and Meese (1980) to solve this optimisation problem. They take linear approximation to the first-order conditions, which gives:

$$Y_t \cong \alpha_1 I_t + \alpha_2 K_t + \alpha_3 A_{ct} . \quad (3)$$ [vii]

The parameters $\alpha_1 < 0$ because of the adjustment costs mentioned earlier, and $\alpha_2 ; \alpha_3 > 0$

And

$$I_t \cong \beta_1 I_{t-1} + \eta \sum_{s=1}^{\infty} \lambda^s \left(E_t A_{c,t+s} - \quad E_{t-1} A_{c,t+s-1} \right). \qquad (4)$$

In the above equation, the coefficients are $0 < \beta_1 < 1, \eta > 0$, and $0 < \lambda < 1$. The expectation operator is E taken at time t. The first term captures the effects of lagged investment and the second term captures the impact of revision in expectations about the future path of productivity.

Let's focus on deriving the investment empirical equation first. Glick and Rogoff (1995) assume that the country-specific *exogenous* TFP shock A_{ct} follows a first-order autoregressive process:

$$A_{ct} = \rho A_{c,t-1} + \varepsilon_t \, . \qquad (5)$$

The autoregressive parameter, $0 < \rho < 1$, but could be extended to a higher-order ARMA process. They assumed that ρ =1 because it is consistent with the unit root's test results, and for convenience too. That says that country-specific TFP shocks are persistent and behave like a random-walk process. Assuming ρ =1 and combining equation (4) and (5) yields:

$$I_t = \beta_1 I_{t-1} + \beta_2 \Delta A_{ct} \, , \qquad (6)$$

where the coefficient β_2 is $\equiv \eta[\lambda/(1-\lambda)] > 0$.

Subtracting I_{t-1} from both sides results in the empirical equation for investment:

$$\Delta I_t = (\beta_1 - 1) I_{t-1} + \beta_2 \Delta A_{ct} \qquad (7)$$

Both equations (6) and (7) are estimable equations. The transformation of (6) to (7) does not affect the errors in (6). Glick and Rogoff (1995) address this issue in details. In any case, the estimation of the equations must undergo a careful testing of the residuals.

2.2 Global TFP shocks

To introduce global productivity shocks to the model, Glick and Rogoff (1995) replaced the production function in equation (1) with this:

$$Y_{ct} = \left(A_{gt} \quad A_{ct}\right) K_t^{\alpha} \left[1 - \frac{z}{2}\left(\frac{I_t^2}{K_t}\right)\right] \qquad (8)$$

That says country c output is determined by its own capital stock, and its own country-specific TFP shock and a global TFP shock with a subscript g .

The empirical equation for investment above is replaced by:

$$\Delta I_t = (\beta_1 - 1) I_{t-1} + \beta_2 \Delta A_{ct} + \beta_3 \Delta A_{gt} \qquad (9)$$

Both TFP shocks follow random walks, $0 < \beta_3 < \beta_2$. The effect depends on the permanency of the shocks. The coefficient β_3 can be greater than β_2 , if global TFP shocks are permanent while the country-specific TFP shocks are sufficiently transient.

2.3 Sectoral-specific TFP shocks

Similarly, we re-derive the model for the sectoral level with sector-specific TFP shocks. Aggregate investment is the sum of the sectoral-level investments.

Equation (1) becomes:

$$Y_{it} = \left(A_{it} \quad A_{ct} \quad A_{gt}\right) K_{it}^{\alpha} \left[1 - \frac{z}{2}\left(\frac{I_{it}^2}{K_{it}}\right)\right] \qquad (10)$$

And equation (2) becomes:

$$K_{i,t+1} = K_{i,t} + I_{i,t} \,. \qquad (11)$$

The subscript i denotes sector. The empirical investment equation would be:

$$\Delta I_{it} = (\beta_1 - 1) I_{i,t-1} + \beta_2 \Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t} + v_i + \varepsilon_{it} \quad (12)$$

The magnitude of the effect of the global TFP shock could be larger than both the country-specific TFP shock and the sector-specific TFP shock if the global TFP shock is permanent and the others are sufficiently transitory.

3 Data

The dependent variable in equation (12) is sectoral-level investment growth rate. Sectoral level investments data are from Statistics New Zealand. I use the real stock of capital by isector (K_{it}). The data used in this exercise are net of depreciation, and exclude land. Log investment (I_{it}) is $\Delta \log K_{it}$, where Δ is the difference operator and log is the natural logarithm $(\ln)$. Sector-specific TFP growth data are from the Statistics New Zealand webpage. They are annual TFP growth rate time series data. The sample sizes vary from one sector to another. There are eleven industries with complete time series data from 1988 to 2009, which I use in this paper: (1) Agriculture, Forestry and Fishing; (2) Mining; (3) Manufacturing; (4) Electricity, Water, and Waste Services; (5) Construction; (6) Wholesale Trade; (7) Retail Trade; (8) Accommodation and Food Services; (9) Transport, Postal, and Warehousing; (10) Information, Media, and Telecom; and (11) Financial & Insurance Services. New Zealand's TFP and the global TFP data are from the Conference Board Database. Figure 1 plots the sectoral-level log capital stocks; figure 2 plots investments and figure 3 plots the sectoral-level TFP growth rates. All the data used in the estimation of equation (12) are I(0).

I examined different measures for New Zealand's country-specific TFP growth shock. I used the Conference Board data; I computed the Solow residuals; and I took the average of the TFP growth over the eleven industries in the sample.[viii] I used the latter because it seems to be a more sensible measure for the purpose of this paper than the other two aggregate measures because the aggregate figures include all the industries in the economy while we are only examining eleven industries. Also, the aggregate figures have more service sectors whose outputs are difficult to measure. Barsky and Sims (2011) study the role of *news* shocks. They find that the surprise movements of the Solow residuals, which are called adjusted TFP series, are largely temporary but the permanent component has a predictable component. Figure 4 plots the three measures.

The global TFP growth shock represents the weighted-average of the shocks of the following countries: Australia, U.S., U.K., Germany, China, Hong Kong, Japan, Malaysia, Singapore, Korea, and India. The countries are chosen because they represent New

Zealand's trading partners. The Conference Board estimates of TFP growth are residuals, which are computed by subtracting the sum of two-period average compensation share weighted input growth rates from the output growth rate. Log differences of level are used for growth rates, and hence TFP growth rates are Tornqvist indices. I tried two different weights: a GDP weighted-average of eleven-country TFP shocks and a trade-weighted average. I also tried to split them into Asian countries with or without Australia, the U.S. alone, and the Euro area. Figure 5 plots the data.

4 Estimation and results

I estimate equation (12) using Least-Squares estimator because lagged investment is a pre-determined variable and the shocks are exogenous. The regression is a sector-fixed-effect panel regression, where T is 1988 to 2009 and N is eleven industries. The way this equation is derived does not involve differencing the fixed effect, and since T is greater than N, the least square estimator is appropriate. N is asymptotically identified as T goes to infinity.[ix] I also estimate White cross-section standard errors and a variance-covariance matrix, and correct for the number of degrees of freedom. Note, however, that there a measurement issue. The capital stock is understated because it does not include *intangibles*,[x] which might introduce a bias and inconsistency into the parameter estimates. This issue is beyond the scope of this paper. The problem cannot be resolved here; not until some new data are made available.[xi]

Table 1 reports the initial results of estimating equation (12). The lagged investment effect is statistically significant. The restriction $\beta_1 - 1$ is estimated, and β_1, which is an estimate of the average across industries is, 0.57. Thus, as shown in equation (6), an increase in lagged investment positively affects current investment's level. This is consistent with the estimates reported in Glick and Rogoff (1995), and with Eberly *et al.* (2012) who provide evidence that the specification of investment adjustment costs proposed by Christiano *et al.* (2005) predicts the presence of a lagged investment effect and that a generalized version of that model is consistent with the behaviour of firm-level data. In Christiano *et al.* (2005), there is a second order adjustment cost assumption that leads to this lagged effect, and also gives rise to the role of expectations in investment decisions. The sector-specific TFP shock has a coefficient of 0.06 and is significant. So – on average – a one percent sector-specific TFP shock raises investments growth by only 0.06 percent. The average effect of the country-specific TFP shock on sectoral-level investments is significant and has a larger effect on the sectoral-level investment growth rate than sector-specific shocks. On average, a 1 percent increase in New Zealand's TFP growth rate increases the sectoral-level investment growth by 0.15 percent. So on average, the industries are more sensitive to country-specific TFP shocks than to their own TFP shocks. And finally, on average, global TFP shocks have no effects on the growth rate of the sectoral-level investments in New Zealand.

In table 2, I re-ran the same regression, but I assumed that the global TFP shock affect sectoral-level investment growth with a lag. The typical interpretation of the lagged global TFP shock is that these shocks have a significant delayed effect. However, the lagged values can also be proxy for expected or anticipated shocks under rational expectations and perfect foresights. In the standard real business cycle model with fully-flexible prices, an increase in the expected future productivity raises the real interest rate, but decreases the current level of investment given a value for the intertemporal elasticity of substitution in consumption. Olivei (1999) shows that under price stickiness, the effect of anticipated productivity increases current investment, and the real interest rate. Positive and significant lagged effects of productivity shocks on investment growth in New Zealand might be consistent with price stickiness. Evens (1992) showed that productivity shocks, which are measured as Solow residuals like our measure, are in fact highly correlated with money, interest rate, and government spending, so these shocks can be anticipated. He found that money, real interest rate and governments pending to Granger-cause productivity shocks measured by the Solow residuals. He also found that ¼ to ½ of the variations in these shocks can be attributable to aggregate demand fluctuations. Our finding seems to be highly consistent with such evidence.

The time series is short, so one cannot possibly use formal methods to determine the lag structure. Instead, I began with an arbitrary general lag structure of four lags and tested backward using F test. I found the global TFP shock to be only significant at a two-year lag. A one percent positive global TFP shock increases investment growth at the sectoral-level two years later by 0.31 percent. This effect is twice as large as the country-specific contemporaneous shock and at least five times as large as the sector-specific TFP shock. The effect of global TFP shocks on New Zealand indicates that (1) the global TFP shock maybe more permanent than the country-specific TFP shock and the sector-specific shock. The time series are tested for unit root and the hypothesis is rejected in all of them. However, the sector-specific TFP shock time series vary across industries, where the unit root hypothesis is also tested for the panel using commonly used panel unit root tests. The hypothesis of unit root can be rejected. (2) The fact that New Zealand is a small open economy and trades with the rest of the world. I tried a similar estimation methodology with the country-specific TFP shock, but none of the lags were significant. The global TFP shock will be lagged twice in the remaining regressions and the country-specific TFP shock will be contemporaneous.

Then, I re-ran the same regression, but I allowed for lagged investment and for the sector-specific TFP shock to vary across industries. I estimate these two regressions separately to conserve on the degrees-of-freedom.

In table 3, I allowed lagged investments to vary across industries. The sectoral-level TFP effect is 0.08 and the country-specific TFP shock magnitude is 0.22, slightly larger than before. The global TFP shock is 0.27, slightly smaller than before. All these coefficients are statistically significant. Most importantly, lagged investment is significant and varies across industries. It is insignificant in three industries: Manufacturing, Wholesale Trade and Accommodation & Food Services. The coefficients vary significantly. While Agriculture, Forestry and Fishery's has a significant coefficient of 0.90, Transport, Postal, and Warehousing has a significant coefficient of nearly 1, Manufacturing has an insignificant coefficient of 0.18. These results suggest that there is some idiosyncratic persistence at the sectoral level. It remains a puzzle that lagged investment's level does not affect current investment's level in manufacturing.

Table 4 reports the results, where the sector-specific TFP shock is allowed to vary across industries. There are no changes in the average estimates of lagged investment effect, the country-specific TFP shock, and the lagged global TFP shock. The sector-specific TFP shock also varies significantly across industries. The shock is insignificant in six industries, and has a negative effect in the Electricity, Water, and Waste Services and Transport, Postal, and Warehousing Services industries. These two negative signs are inconsistent with theory and may be allowing the parameters to vary with sectors introduced some misspecifications. It is significant in Construction (0.13), Retail Trade (0.37), and Information, Media, and Telecommunications Services. This confirms the average regression, which shows that the sectoral-level investment growth is not highly influenced by sector-specific TFP shocks.

I control the regressions for two shocks: a country-specific government spending shock and a ToT shock. Glick-Rogoff (1995) treat government spending shocks as pure aggregate demand shocks under the assumptions that the utility function is separable in private and public consumptions and that government spending is financed by lump-sum taxes. Government spending shocks, whether country-specific or global, can have effects on investment through the real interest rate. In Barro (1981) who pioneered this literature, permanent government spending shocks do not alter the real interest rate; hence have no effect on real investments. However, there are difficulties in estimating the effects of government shocks on the real economy. The difficulties arise from disentangling many effects operating at the same time when measuring transitory government spending shocks.[xii]

Government spending is defined as total central-government real expenditures less defence spending and interest payments. It does not include real transfer payments to households. I tried this measure with and without government investment. Statistics New Zealand's website reports the data, but they are incomplete time series and are, hence, unusable. Alternatively, I have two sources: one is the Haver Dataset, which has annual time series, and data compiled used in Claus *et al.* (2006) and used in Parkyn and Vehbi (forthcoming).[xiii] These data are based on (SNA) quarterly data. I convert the data to annual.

Measuring government spending shocks is difficult. I tested the data for unit root using a variety of common statistical tests with different specifications and lags. The tests do not reject the unit root hypothesis. This result may be related to the weakness of the tests, but nevertheless the data have a trend. For this reason, I use the cyclical component of the HP filter as a measure of the government spending shock. Glick and Rogoff (1995) used the residuals from an IMA (1) model. The New Zealand data do not seem to fit this model well. Figure 6 plots my three different data for government spending shock.

The results of estimating the model with government spending shocks are reported in table 5. The estimation strategy is to augment the regression in equation (12) with the above measures of the government spending shock, i.e., the HP cyclical component of government spending, using three different data: the Haver dataset, which report an aggregate government spending chain measure; the Claus *et al.* (2006) data excluding government investments, and the Claus *et al.* (2006) data including government investments. If the coefficients were to be found statistically significant, I would fit another regression with the coefficients varying across industries. Unlike Glick and Rogoff (1995), I find some government spending effects, but the level of significance is measurement-dependent. The measure of government spending shock based on the Haver dataset is insignificant, but those based on Claus *et al.* (2006) are. The cyclical component, which excludes government investments, is significant, but only at the 10 percent level. The inclusion of government investments in the measure of government spending increases the responsiveness of sectoral-level investment growth to transitory government spending shocks. The cyclical component of government spending plus government investments using Claus *et al.* (2006) data is statistical significant. On average, a 1 percent increase in government spending (consumption plus investment) increases sectoral-level investment growth rate by 0.18 percent. Most importantly, the rest of our parameter estimates are robust to the inclusion of the government spending shock.

Finally, I control for ToT shocks. One question is whether industries increase their investments in response to ToT shocks. Another question is whether the ToT shock affects tradable-goods sectors differently from non-tradable-goods sectors. The term of trade is the ratio of export to import prices. The data are from the Haver Dataset. They report quarterly data, which I averaged to obtain annual data. The ToT is for merchandise goods only. The ToT long quarterly data from 1957 display a mean-reverting behaviour. The unit root hypothesis is strongly rejected by a number of common statistical tests. However, the shorter annual sample from 1988 to 2009 exhibits trend and the unit root hypothesis cannot be rejected. That said, an ARMA (1,1) fits the data reasonably well with an MA coefficient 0.92 and an AR coefficient 0.37. Given these results, I measure the ToT shock in two different ways: the residuals of an ARMA (1,1) model, and the cyclical component using an HP filter. The two measures are plotted in figure (7). Visually, the two measures look similar. I estimate the investment equation with ToT shocks, using both measures separately. Both measures of the shock turned out to be statistically insignificant. The results are in table 6.

However, the relationship between government spending and ToT shocks on one side, and real investment growth on the other may not be contemporaneous. It depends on expectations. I re-estimate the investment equation with a lagged government spending and ToT shocks. On average, a ToT shock has a significant effect on the sectoral-level investment growth one year later. The rest of the coefficient estimates are unchanged, but the sectoral-level TFP shock is more significant. Given these results, I proceed to allow the government spending and the ToT shocks to vary across industries with different lags. I begin with a general short lag structure of four lags and test backwards using the F test.

The results are reported in tables 7 and 8. I run two separate regressions to conserve on the number of degrees-of-freedom. In table 7, I report the lagged government spending shock effect on the industries. Most sectoral-level investment growth rates respond contemporaneously to a government spending shock, which includes government investments. But the results vary across industries. Agriculture, Forestry and Fishery reacts with a one year lag. And so does the Mining sector. The response of Mining is quite sizable. There is a ¾ of a percent increase in investment growth for a one percent increase in government spending. Manufacturing investment growth is adversely affected two years after an increase in government spending, but the effect is only marginally significant, so manufacturing maybe irresponsive to such aggregate demand shock neither contemporaneously nor at any other lag. Construction and Wholesale Trade are unaffected. Electricity, Water and Waste Services investment growth rate is highly positively affected a year later; the increase in government spending increases investment growth a year later by more than ½ a percent. Construction and Wholesale Trade are unaffected by the shock at any lag. Retail Trade; Accommodation & Food Services; Transport, Postal, and Warehousing; and Information, Media & Telecommunication industries are positively and contemporaneously affected by the shock. The magnitudes of the increases in the growth rate of investments in response to the shock are large, 0.34, 0.68, 0.37 and 0.36 respectively. The rest of the parameter estimates of the model are robust and retain their estimated values.

Table 8 reports the estimated effects of lagged ToT shock on the industries investment growth rates. First, there is a ToT shock positive lagged effect, and more so than the government spending shock. Second, the lag length varies across industries. Third, not all industries respond to ToT shocks. Two of the industries whose investment growth responds to ToT shocks are tradable goods industries (Agriculture, Forestry, and Fisheries and Mining) and three services industries (Electricity, Water, and Waste Services; Transport, Postal, and Warehousing; and Finance and Insurance Services). Fourth, the response is sensitive to how the shock is measured. The HP cyclical component of the ToT shows no association with sectoral-level investment growth, except for Agriculture, Forestry, and Fisheries while the ARIMA (1,1) residuals do.

Investment growth in the mining sector is only contemporaneously affected by ToT shocks, albeit with a very large coefficient. A one percent increase in the ToT increases investment growth by 0.74 percent. Agriculture, Forestry and Fisheries also respond within one year. Agriculture has a coefficient of 0.25. The services industries –such as Electricity, Water, and Waste Services and Transport, Postal, and Warehousing – respond significantly with a two-year lag, and coefficient magnitudes are relatively smaller than the rest. Finance and Insurance Services respond within one year with a very large coefficient of 0.50. For now obvious reasons, Information, Media, and Telecommunication services respond negatively to one-year lag ToT shocks.

5 Conclusions and Policy Issues

I estimated an intertemporal model for sectoral-level investment growth in New Zealand using a panel data of eleven industries over the period 1988 to 2009. The empirical model is an extension of an aggregate time-series, empirical, intertemporal model by Glick and Rogoff (1995). Although the model differs from the real business cycle in some aspects, essentially three random total factor productivity shocks (TFP) drive investment growth at the sectoral level. There are, a sector-specific TFP shock, a country-specific TFP shock, and a global TFP shock. In addition, the level of current investment at the sectoral-level is driven by lagged investment levels. While investment growth responds significantly and contemporaneously to sector-specific and country-specific TFP shocks, it only responds significantly to global TFP shocks with a two-year lag. The response of sectoral-level investment growth to global TFP shocks is twice as large as its response to country-specific TFP shocks, and nearly five times as large as its response to the sector-specific TFP shocks. The lag effect implies that industries anticipate global TFP shocks, hence they react earlier. The responsiveness of sectoral-level investment growth to global TFP shocks rather than domestic TFP shocks (the country-specific TFP shock and the sectoral-specific TFP shock) reflects: (1) global TFP shocks may be more permanent while the sector-specific shocks are transitory. (2) New Zealand is a small open economy.

Government spending shocks, which are treated as a pure aggregate demand shocks, positively affect investment growth at the sectoral-level in New Zealand, but that depends on whether the measure of the shock includes public investments or not. It seems that government investments are important. Also, sectoral-level investment growth seems to react positively to ToT shocks. The reactions vary from one sector to another, and with different lags. While Mining responds contemporaneously and strongly, Agriculture, Forestry, and Fisheries respond with a one-year lag. Also, investment growth in three services industries (Wholesale Trade, Transport, Postal, and Warehousing, and Finance and Insurance Services) respond significantly with a one-year lag. Most importantly, the main estimates of the model are robust to the inclusion of the government spending shock and the ToT shock.

To summarise, the main results of this study are that various random TFP shocks seem to have significant effects on current sectoral-level investment growth. The responsiveness of sectoral-level investments to TFP shocks vary across sectors. And, sectoral-level investment growth seems to increase when the economy as a whole is doing well and more so in anticipation of global TFP shocks. Past investment levels have very strong and relatively varied effects on current investment.

The result that the sectoral-level investment is driven by *random* productivity shocks presents a challenge to policy-making because random productivity shocks are beyond the direct control of policy. Global TFP shocks are strictly exogenous to New Zealand because New Zealand cannot exert any influence on them. Similarly, the model assumes that the country and sectoral TFP shocks to be exogenous too. However, the fact that lagged investment levels are very significant determinants of investment growth gives policy a role. Cross-sectoral variations of the responses of investment growth to various variables also suggest that a one-size-fits-all investment policy is not the right way to go. The government can change policies, e.g., fiscal or labour policies, such that it can influence private investment decisions.

It should not be too contentious to argue that not all investments can lead to economic growth. In endogenous growth models investments in knowledge (e.g., R&D and human capital are inputs into the innovation process that are required to make *new* goods and services) drive productivity growth. Under imperfect competition, there is an increasing-returns-to-scale (externality effect), where doubling of output requires less than a doubling of inputs, which requires a non-diminishing marginal productivity of factor inputs.

That being said, policy may be able to influence labour and capital productivity, and hence increase productive investments. Simply put, the less input used to produce more output the higher TFP is. The government can either directly invest in private businesses or implement policies that influence the incentives of private businesses (either via price or regulatory mechanisms) to invest. There are arguments for and against direct government investments in private economic activities. However, investment is a process shrouded with uncertainty. That is evident in the large fluctuations of the data. There are risks involved, and some are hard to measure. The main concern is that in case the public investment fails to deliver output growth, taxpayer's money would be wasted. Alternatively, it will be argued that policy should provide incentives for the private enterprise to invest in productive capital such as R&D and human capital, training and up-skilling etc. because people respond to incentives.

Here is another example to the same effect. There is more creditable evidence, however, that the tax rate is an important explanatory variable of the supply of labour (hours worked). Labour productivity is pro-cyclical. During booms, firms hire more workers and productivity increases. Workers make decisions about consumption and leisure and on consumption and savings. The tax rate is the *intratemporal* factor that affects the supply of labour. It distorts the relative prices of consumption and leisure at a point in time. If people expect future taxes on income to increase, they will choose to consume less relative to their incomes, and work more (see Nickell (2003), Prescott (2004), and Shimer (2009)). The government has a variety of tax policies, which could influence the firm's decision to invest in productive capital, which affects growth and productivity directly.

Table 1 (Equation 12)

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1) I_{i,t-1} + \beta_2 \Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t} + v_i + \varepsilon_{it}$$

Coefficient	Estimate	P-value
β_1	0.57	0.0000
β_2	0.06	0.0646
β_3	0.15	0.0310
β_4	-0.10	0.6228
Weighted R^2	0.26	
DW	2.05	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock.

The regressions include sector-fixed-effect.

The standard errors are White-cross section corrected.

Sample is 1988 to 2009, and N=11 industries.

Table 2 (Equation 12 with lagged global TFP shocks)

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1) I_{i,t-1} + \beta_2 \Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + v_i + \varepsilon_{it}$$

Coefficient	Estimate	P-value
β_1	0.59	0.0000
β_2	0.07	0.0447
β_3	0.16	0.0236
β_4	0.31	0.0000
Weighted R^2	0.29	
DW	2.05	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock.

The regressions include sector-fixed-effect.

The standard errors are White-cross section corrected.

Sample is 1988 to 2009, and N=11 industries.

Table 3 (Equation 12 with lagged investment vary across industries)

$\Delta I_{it} = \beta_0 + (\beta_{1i} - 1) I_{i,t-1} + \beta_2 \Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + v_i + \varepsilon_{it}$

Coefficient	Estimate	P-value
β_2	0.08	0.0170
β_3	0.22	0.0000
β_4	0.27	0.0012
$\beta_{1,i}$ (lagged investments)		
1. Agriculture, forestry, fishing	0.90	0.0000
2. Mining	0.66	0.0000
3. Manufacturing	0.18	0.2433
4. Electricity, Water and Waste Services	0.73	0.0014
5. Constructions	0.54	0.0007
6. Wholesale Trade	0.12	0.3864
7. Retail Trade	0.47	0.0042
8. Accommodation & Food Services	0.28	0.3340
9. Transport, Postal & Warehousing	0.99	0.0000
10. Information Media & Telecom	0.41	0.0443
11. Financial & Insurance Services	0.62	0.0625
Weighted R^2	0.40	
DW	2.05	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock. The regressions include sector-fixed-effect. The standard errors are White-cross section corrected. Sample is 1988 to 2009, and N=11 industries. The coefficient β_1 affects the level positively as shown in equation $I_t = \beta_1 I_{t-1} + \beta_2 \Delta A_{ct}$.

Table 4 ***(Equation 12 with sector-specific TFP shocks vary across industries)***

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1) I_{i,t-1} + \beta_{2,i} \Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + v_i + \varepsilon_{it}$$

Coefficient	Estimate	P-value
β_1	0.56	0.0000
β_3	0.13	0.1134
β_4	0.32	0.0000
β_{2i} (Sectoral-level TFP)		
1. Agriculture, forestry, fishing	0.05	0.5932
2. Mining	0.09	0.4309
3. Manufacturing	0.11	0.2693
4. Electricity, Water and Waste Services	-0.11	0.0563
5. Constructions	0.13	0.0008
6. Wholesale Trade	0.16	0.1386
7. Retail Trade	0.37	0.0012
8. Accommodation & Food Services	-0.00	0.9972
9. Transport, Postal & Warehousing	-0.09	0.0285
10. Information Media & Telecom	0.50	0.0673
11. Financial & Insurance Services	-0.44	0.3182
Weighted R^2	0.35	
DW	2.15	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock. The regressions include sector-fixed-effect. The standard errors are White-cross section corrected. Sample is 1988 to 2009, and N=11 industries.

Table 5 (Equation 12 with a transitory government spending shock)

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1)I_{i,t-1} + \beta_{2,}\Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + \beta_5 G_{c,t} + v_i + \varepsilon_{it}$$

Coefficient	Estimate	P-value	Estimate	P-value	Estimate	P-value
β_1	0.57	0.0000	0.57	0.0000	0.53	0.0000
β_2	0.08	0.0280	0.08	0.0433	0.08	0.0248
β_3	0.13	0.0380	0.18	0.0088	0.10	0.1382
β_4	0.35	0.0000	0.33	0.0000	0.18	0.0193
β_5 (i)	-0.04	0.1579	-	-	-	-
β_5 (ii)	-	-	0.15	0.1043	-	-
β_5 (iii)	-	-	-	-	0.18	0.0075
Weighted R^2	0.31		0.29		0.31	
DW	2.06		2.05		2.06	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock. The regressions include sector-fixed-effect. The standard errors are White-cross section corrected. Sample is 1988 to 2009, and N=11 industries.

i The coefficient corresponds to the measure of government spending shock G, which is based on Haver Dataset.

ii The coefficient corresponds to the measure of government spending shock G, which includes government purchases only. Source: Claus *et al.* (2006).

iii The coefficient corresponds to the measure of government spending shock G, which includes government purchases plus government investments. Source: Claus *et al.* (2006).

Table 6 (Equation 12 with a Terms of Trade Shock)

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1)I_{i,t-1} + \beta_{2,}\Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + \beta_5 ToT_{c,t} + v_i + \varepsilon_{it}$$

Coefficient	Estimate	P-value	Estimate	P-value
β_1	0.58	0.0000	0.60	0.0000
β_2	0.07	0.0487	0.07	0.0432
β_3	0.21	0.0172	0.17	0.0272
β_4	0.38	0.0000	0.29	0.0000
β_5 (i)	-0.08	0.1371	-	-
β_5 (ii)	-	-	-0.009	0.7264
Weighted R^2	0.30		0.29	
DW	2.05		2.05	

$I_{i,t}$ is sectoral-level investment; Δ is the difference operator; $A_{i,t}$ is a sector-specific TFP shock; $A_{c,t}$ is a country-specific TFP shock; and $A_{g,t}$ is a global TFP shock. The regressions include sector-fixed-effect. The standard errors are White-cross section corrected. Sample is 1988 to 2009, and N=11 industries.

i The shock is measured by the cyclical component of the HP filter.

ii The shock is measured by the residuals of an ARIMA(1,1).

Table 7 ***(Equation 12 with a transitory government spending shock which varies across industries)***

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1)I_{i,t-1} + \beta_{2,i}\Delta A_{i,t} + \beta_3\Delta A_{c,t} + \beta_4\Delta A_{g,t-2} + \beta_{5i,}G_{c,t-j} + v_i + \varepsilon_{it}$$

Coefficient		Estimate	P-value
β_1		0.44	0.0000
β_2		0.07	0.1158
β_3		0.13	0.0369
β_4		0.17	0.0022
β_5	j Lag (Year)		
1. Agriculture, forestry, fishing	1	0.18	0.0435
2. Mining	1	0.74	0.0589
3. Manufacturing	2	-0.11	0.0989
4. Electricity, Water and Waste Services	1	0.56	0.0000
5. Constructions	-	-	-
6. Wholesale Trade	-	-	-
7. Retail Trade	0	0.34	0.0419
8. Accommodation & Food Services	0	0.68	0.0166
9. Transport, Postal & Warehousing	0	0.37	0.0238
10. Information Media & Telecom	0	0.36	0.0644
11. Financial & Insurance Services	-	-	-
Weighted R^2		0.40	
DW		2.10	

Government spending includes government investments. -, denotes insignificant therefore not reported.

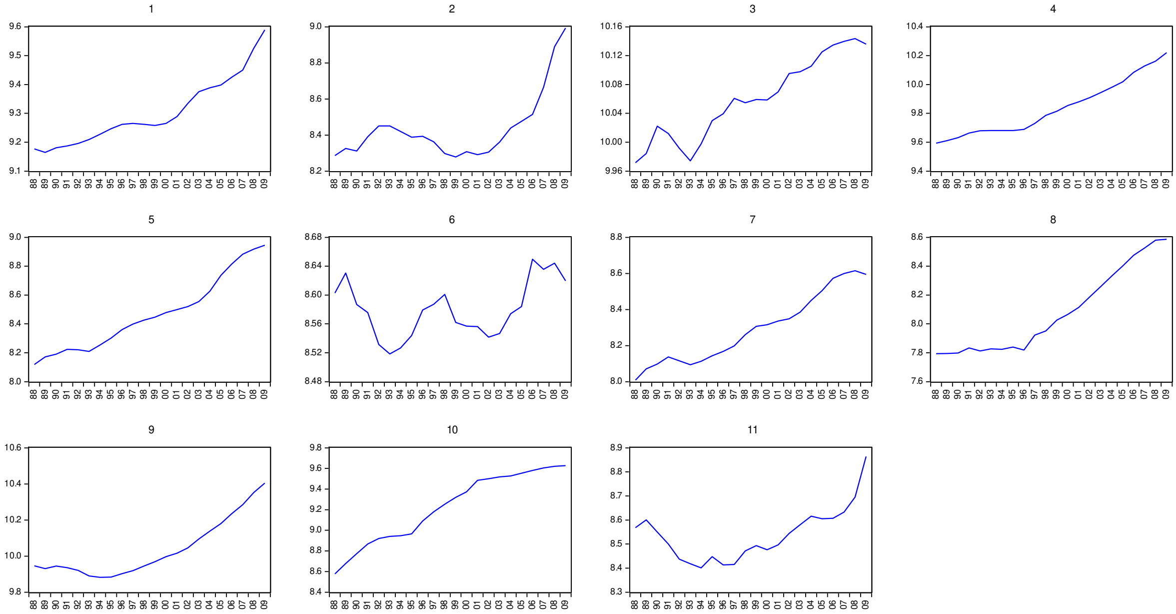
Table 8 (Equation 12 with a ToT shock which varies across industries)

$$\Delta I_{it} = \beta_0 + (\beta_1 - 1)I_{i,t-1} + \beta_{2,i}\Delta A_{i,t} + \beta_3 \Delta A_{c,t} + \beta_4 \Delta A_{g,t-2} + \beta_{5i,}ToT_{c,t-j} + v_i + \varepsilon_{it}$$

Coefficient		Estimate	P-value
β_1		0.55	0.0000
β_2		0.07	0.0585
β_3		0.16	0.0044
β_4		0.22	0.0011
β_5	j Lag (Year)		
1. Agriculture, forestry, fishing	1	0.24	0.0823
2. Mining	0	0.74	0.0143
3. Manufacturing	-	-	-
4. Electricity, Water and Waste Services	2	0.15	0.0889
5. Constructions	-	-	-
6. Wholesale Trade	-	-	-
7. Retail Trade	-	-	-
8. Accommodation & Food Services	-	-	-
9. Transport, Postal & Warehousing	2	0.14	0.0248
10. Information Media & Telecom	1	-0.28	0.0336
11. Financial & Insurance Services	1	0.49	0.0740
Weighted R^2		0.36	
DW		2.22	

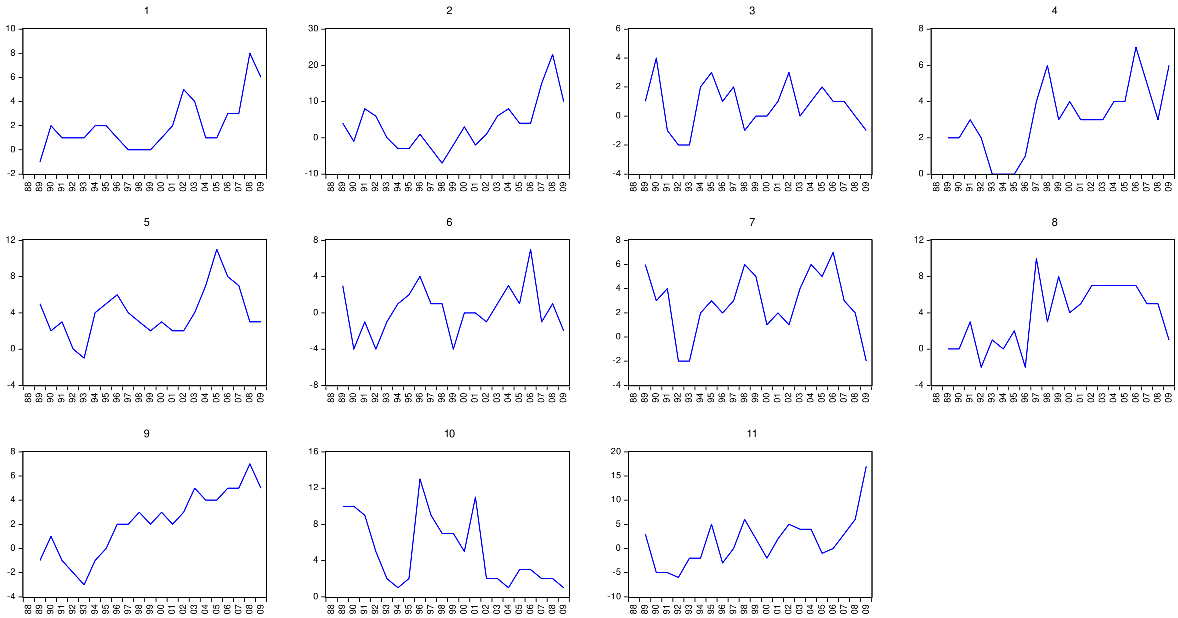
- Denotes insignificant therefore not reported.

Figure 1: Sectoral-Level Log Capital Stock



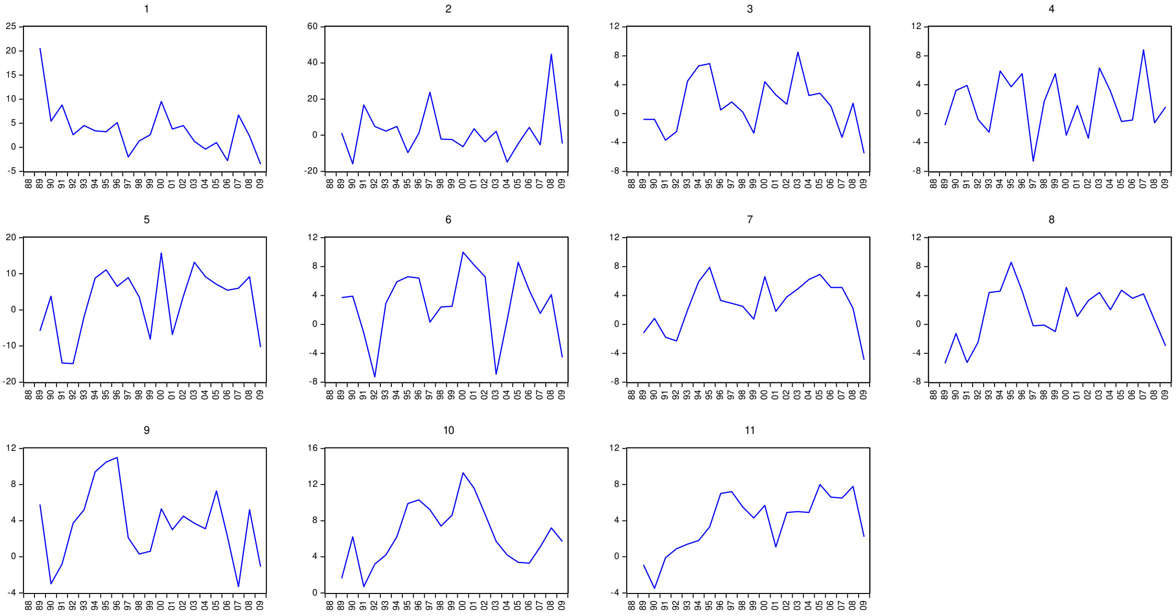
1) Agriculture, Forestry and Fishing; 2) Mining; 3) Manufacturing; 4) Electricity, Water and Waste Services; 5) Construction; 6) Wholesale Trade; 7) Retail Trade; 8) Accommodations and Food Services; 9) Transport, Postal, and Warehousing; 10) Information, Media and Telecommunications; and 11) Financial and Insurance Services. Source: Statistics New Zealand.

Figure 2: Sectoral-Level Log Investments



1) Agriculture, Forestry and Fishing; 2) Mining; 3) Manufacturing; 4) Electricity, Water and Waste Services; 5) Construction; 6) Wholesale Trade; 7) Retail Trade; 8) Accommodations and Food Services; 9) Transport, Postal, and Warehousing; 10) Information, Media and Telecommunications; and 11) Financial and Insurance Services. Source: Statistics New Zealand.

Figure 3: Sectoral-Level TFP Growth Shocks



1) Agriculture, Forestry and Fishing; 2) Mining; 3) Manufacturing; 4) Electricity, Water and Waste Services; 5) Construction; 6) Wholesale Trade; 7) Retail Trade; 8) Accommodations and Food Services; 9) Transport, Postal, and Warehousing; 10) Information, Media and Telecommunications; and 11) Financial and Insurance Services. Source: Statistics New Zealand.

Figure 4: New Zealand Average TFP Growth Shock

Figure 5: Global Average TFP Growth Shock

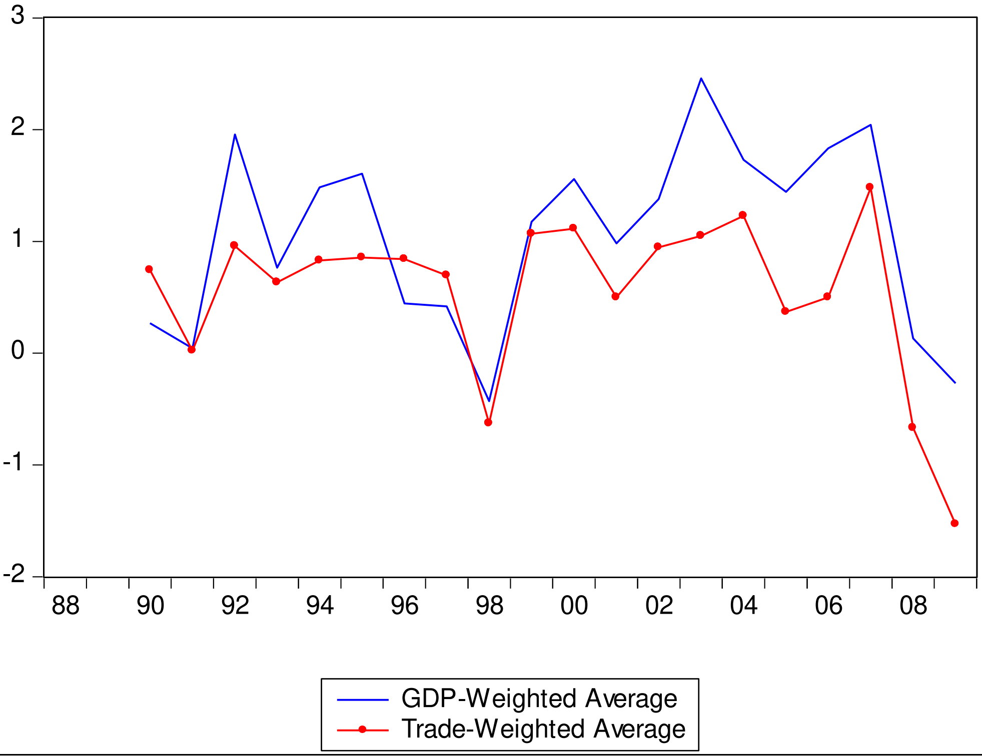


Figure 6: Government Spending Shocks

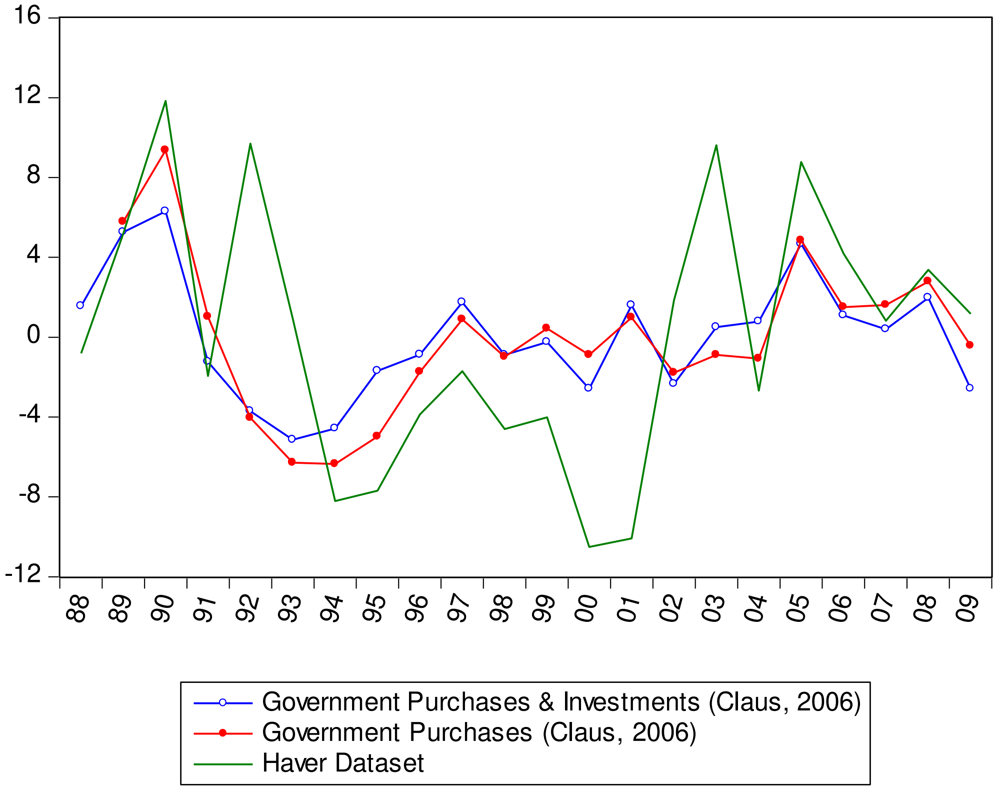
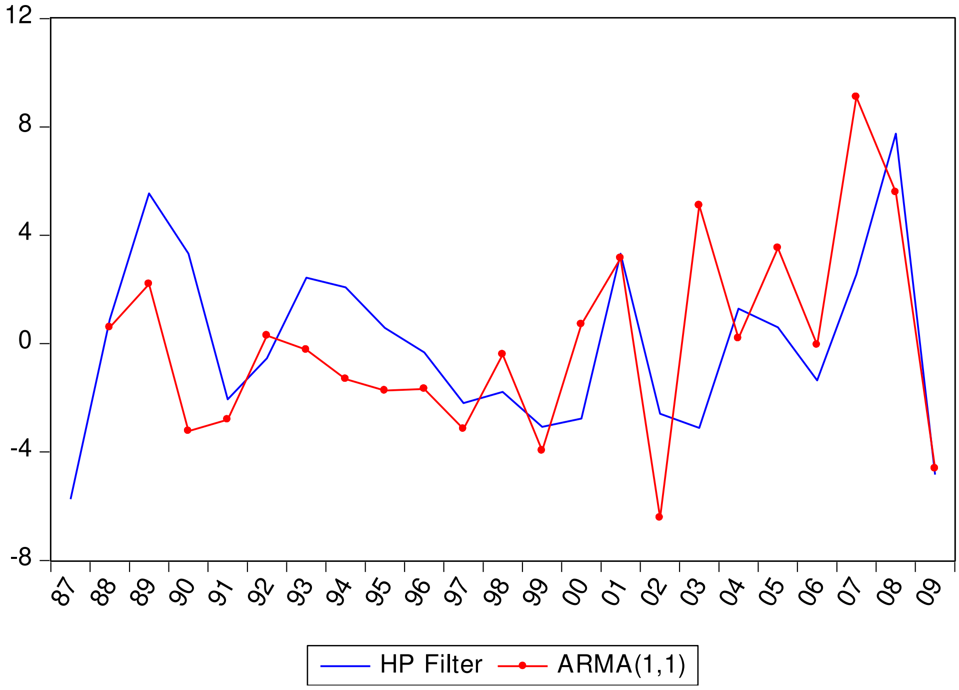


Figure 7: Terms of Trade Shocks



References

Abel, A. And O. Blanchard, 1986, The Present Value of Profits and Cyclical Movements in Investment, Econometric 54 (March), 244-73.

Acemoglu, D. And J-S Pischke, 1999, Minimum Wages and on-the-Job Training, NBER Working Paper No. 7184.

Arato, H., and K. Yamada, 2012, Japan's Intangible Capital and Valuation of Corporations in Neoclassical Framework, Review of Economic Dynamics 15, 459-478.

Barro, Robert J., 1981, Output Effects of Government Purchases, Journal of Political Economy 89, 1086-1121.

Baxter, M. And M. Crucini, 1992, Business Cycle and the Asset Structure of Foreign Trade, Federal Reserve bank of Minneapolis- Institute for Empirical Macroeconomics Discussion Paper No. 59.

Barsky R. and Eric R. Sims, 2009, News Shocks," NBER Working Papers 15312, National Bureau of Economic Research, Inc.

Cassino, E., 2012, Is Tradable GDP a Useful Indicator? Memo, New Zealand Treasury, Wellington.

Christiano, L., M. Eichenbaum, and C. Evans, 2005, Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy, Journal of Political Economy 113, 1-45.

Claus, I., Aaron Gill, Boram Lee and Nathan McLellan, 2006, An Empirical Investigation of Fiscal Policy in New Zealand, New Zealand Treasury Working Paper 06/08.

Eberly, J., S. Robelo, and N. Vincent, 2012, What Explains the Lagged-Investment Effect? Journal of Monetary Economics 59, 370-380.

Evens, C., 1992, Productivity Shocks and Real Business Cycles, Journal of Monetary Economics, Vol. 29, issue 2, 191-208.

Frankel, J. And A. Razin, 1987, Fiscal Policies and the World Economy, Cambridge, MA: MIT Press.

Glick, R. and K. Rogoff, 1995, Global versus Country-Specific Productivity Shocks and the Current Account, Journal of Monetary Economics 35 (February), 159-92.

Grimes, A., 2009, Capital intensity and welfare: traded and non-trade sector determinants, New Zealand Economic Papers, vol. 43(1), 21-39.

Hall, R., 1978, Stochastic Implications of Life-Cycle Permanent Income Hypothesis: Theory and Evidence, Journal of Political Economy 86 (October), 971-87.

Hunt, B., 2009, The Declining Importance of Tradable Goods Manufacturing in Australia and New Zealand: How Much Can Growth Theory Explain? IMF Working Paper No. 16.

Laabas, B. and W. A. Razzak, 2011, Economic Growth and the Quality of Human Capital, MPRA Working Paper, Munich.

Lopez, R. A., 2005, "Trade and Growth: Reconciling the Macroeconomic and Microeconomic Evidence," Journal of Economic Surveys, Vol. 19 No.4, 623-648.

McGrattan, E. R. And E. C. Prescott, 2000, Is the Stock Market Overvalued? Quarterly Review of Federal Reserve Bank of Minneapolis, 20-40.

McGrattan, E. R., and E. C. Prescott, 2004, The 1929 Stock Market: Irving Fisher Was Right, International Economic Review 45, 991-1009.

McGrattan, E. R., and E. C. Prescott, 2005, Taxes, Regulations, and the Value of U.S. and U.K. Corporations, Review of Economic Studies, 72, 767-796.

McGrattan, E.R. and E. C. Prescott, 2010, Technology Capital and the U.S. Current Account, American Economic Review 100, 1493-1522.

McGrattan, E.R., and E. C. Prescott, 2011, Unmeasured Investment and the Puzzling Boom in the 1990ss, American Economic Journal: Macroeconomics 2, 88-123.

Meese, R., 1980, Dynamic Factor Demand Schedules for Labor and Capital under Rational Expectations, Journal of Econometrics 14 (September), 141-158.

Nickell, S., 2003, Employment and Taxes, CESIFO Working Paper No.1109, (December).

Obstfeld, M., 1986, Capital Mobility and the World Economy: Theory and Measurement, Carnegie-Rochester Conference on Public Policy 24, 55-104.

Olivei, G., 1999, Productivity Shocks, Investments, and the Real Interest Rate, Federal Reserve Bank of Boston, Working Paper No. 99-2.

Parkyn, O. and T. Vehbi, 2013, The Effects of Fiscal Policy in New Zealand: Evidence from a VAR Model with Debt Constraint, New Zealand Treasury Working Paper (forthcoming).

Prescott, E. C., 1997, Needed: A Theory of Total Factor Productivity, Federal Reserve Bank of Minneapolis Staff Report No. 242.

Prescott, E. C., 2004, Why Do Americans Work So Much More Than Europeans? Federal Reserve Bank of Minneapolis Quarterly Review, Vol. 28, No.1, 2-3.

Razzak, W., 2007, "Explaining the Gaps in Labour Productivity in Some Developed Countries: New Zealand, Australia, The United States and Canada, 1988-2004," Applied Econometrics and International Development, Vol. 7-2, 196-232.

Sachs, J., 1981, The Current Account and Macroeconomic Adjustment in the 1970s, Brookings Papers on Economic Activity 12, 201-268.

Shapiro, M., 1986, Investment, Output and the Cost of Capital, Brookings Papers on Economic Activity 1, 111-152.

Shimer, R., 2009, Convergence in Macroeconomics: The Labor Wedge, American Economic Journal Macroeconomics, Vol. 1 No. 1 (January), 280-297.

i Investment, Productivity and the Cost of Capital: Understanding New Zealand's Capital Shallowness. Treasury Paper 08/3.

ii The argument is consistent, for example, with the endogenous growth AK model, which assumes that output is given by the following simple production function: $Y = B[K^{\alpha}(TL)^{1-\alpha}]$, where Y is output, K is the stock of capital, and TL is labour-augmented technical progress, such as human capital. It is assumed that workers follow a process of learning-by-doing *a la* Arrow thus: $T = \gamma K$, Which says T is proportional to K , and γ is a constant term. In the Arrow model, workers also learn by working with the firms' capital and from knowledge spillover from other firms. Substituting for T in the production function and solve, we arrive at: $Y = B(\gamma L^{1-\alpha})K = AK$, hence the AK model, where $B(\gamma L^{1-\alpha}) = A$. The marginal product of capital is $\partial Y / \partial K = A > 0$. Thus, growth is perpetual since the MPK is positive.

iii Glick and Rogoff (1995) argue that a country-specific productivity shock can alter consumption rather than the complete markets open-economy real business cycle model. Baxter and Crucini (1992) show that the two approaches yield similar results for cross-country correlations unless the degree of persistence of the productivity shock is very high.

iv Cassino (2012) is an internal New Zealand Treasury research memo, which illustrates that dividing GDP into tradable and non-tradable sectors lacks empirical evidence. Indeed, take housing for example. It is typically assumed to be a non-tradable goods sector even though most, if not all, intermediate inputs into housing are tradable goods.

v Glick and Rogoff (1995) do not have depreciation in the capital stock equation. They say it slightly complicates the empirical specification but does not appear to affect the results.

vi The assumption is that the marginal utility of consumption and investment is time-invariant because country-specific TFP shocks cannot be diversified.

vii It is assumed that productivity shocks are homosecedastic and that the variance terms that would appear in the second-order approximation are constants.

viii The Solow residuals are computed as follows: $Y_t / K_t^{0.4}.H_t^{0.6}$,where K_t is the aggregate stock of capital, which I approximated using the Perpetual Inventory Method. I assumed that initial stock of capital K_0 is three times real GDP, depreciation rate is 8 percent annually, and I used Gross Capital formation plus the change in inventory as a proxy for investments. The share of capital 0.40 is approximately equal to the average ratio of gross operating surplus / GDP ratio over the period 1988-2011.

ix It could be argued that certain investments affect productivity as in endogenous growth models, hence linear least squares estimates are biased and inconsistent. An IV estimator must be used if the argument is correct. I do not have adequate instruments to use for such regression. The lags are short too.

x There is a small but growing literature on this issue. Countries are becoming interested in measuring intangible capital. See Arato and Yamada (2012) for Japan, a number of papers by McGrattan and Prescott (2000, 2004, 2005, 2010, and 2011) for the U.S. for example.

xi It would possible to estimate a GMM regression if sectoral-level instruments are available, but they are not. One potential instrument might be the growth rate of human capital at the sectoral-level.

xii According to the theory, permanent and transitory transfers do not affect anything, except the distribution of government spending. Permanent and transitory purchases, on the other hand, have real but different effects. Permanent purchases work though the wealth effect, where higher purchases reduce private wealth because they absorb income and make it unavailable to households. They have no interest rate effects, but they increase output by increasing hours-worked. People work more to compensate for the decline of wealth. Transitory purchases don't change wealth because they don't alter the present value of taxes (more accurately, of resource absorption by the government), but they do have intertemporal substitution effects for two reasons. First, they directly increase interest rates. Second, they change the timing of tax distortion. A temporary increase in government purchases, unmatched by a future temporary increase, has both a permanent component and a transitory component, so it has a mixture of the two kinds of effects. Both permanent and transitory changes in transfers have real effects if they involve marginal distortions. If the transfers are purely lump sum, they will not have any direct distorting effects, but they will have indirect effects if they cause changes in distorting taxes that are used to finance them. If the transfers are income-related, then they are themselves a kind of distorting (negative) tax and so will have real effects.

xiii This is the description of the Claus et al. (2006) data. "Quarterly aggregate data are collated for all variables from June 1982. All fiscal series cover central government with the exception of government investment, which also includes local government, because a central government investment series is unavailable. The purchase of frigates in 1997 and 1999 are removed from both the purchases of government goods and services and the goods and services tax (GST) series. Quarterly fiscal data were constructed using two data sources: Statistics New Zealand National Accounts Data and the New Zealand Crown Accounts (and their supporting financial data). Data on government purchases of goods and services (both current and capital) were drawn from the National Account (1993) expenditure GDP series for the period June 1987 to date, and were backdated to June 1982 using the National Accounts (1968) expenditure GDP series."