ARTICLES

The long-run effects of monetary policy on output growth

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This article looks at how interest rates and inflation affect growth in the capital stock, labour supply, and technology, the main determinants of long-run economic growth. Many additional factors affect long-run economic growth, but most of these factors lie outside the sphere of monetary policy. Monetary policy therefore has only a limited capacity to contribute to economic growth over the longer term. However, the evidence does indicate that keeping inflation low and stable makes a positive contribution to long-run economic growth, and that this is the most effective contribution that monetary policy can make to the economy's performance over time. This finding supports the monetary policy framework operational in New Zealand, which is focused on keeping inflation between 1 and 3 per cent on average over the medium term.

1 Introduction

As Nobel Laureate Robert Lucas has noted, once you start to think about output growth it is hard to think about anything else.[2] Because of the miracle of compounding, over long periods of time small changes in average growth rates cumulate into large differences in income levels.

New Zealand's growth experience over the last 40 years shows how important small differences in per capita growth rates can be. In 1960, New Zealand's per capita income was about the sixth highest in the world. However, over the next 40 years many other economies grew faster, overtaking New Zealand. As a result, New Zealand is now ranked twentieth in terms of per capita income and has a per capita income level about 60 per cent of the United States'.[3]

Economic growth and development are complicated processes that reflect a myriad of important factors. Conway and Orr (2000) provide a synopsis of the key events that have affected New Zealand's output growth over the past half century, including the economic reforms that took place over the last two decades.

In light of New Zealand's economic experience, a natural question to ask is whether there are policy interventions that can be adopted to improve New Zealand's growth performance. Since the Reserve Bank's primary domain is monetary policy, it is appropriate to critically assess the contribution monetary policy can make to New Zealand's long-run economic growth. To date, the consensus view is that achieving and maintaining price stability, whilst seeking to minimise volatility in other macroeconomic variables, is the most suitable monetary policy objective.

The primary focus of this article is thus on the long-run effects of monetary policy on the real economy. In particular, we wish to assess whether monetary policy can have sustained effects on real per capita income growth. Sustained differences in growth rates will unambiguously lead to substantial differences in income levels. Similarly, if New Zealand's per capita income grows faster than richer foreign countries', then New Zealand's per capita income should converge on that of richer countries.'

Section 2 begins by briefly looking at the traditional drivers of growth in economic theory.[4] The main determinants of growth are the accumulation of capital, growth in labour force participation, and the accumulation of knowledge and technology, though these near-determinants of growth are affected by a host of other factors. Section 3 looks at

1 I would like to thank the following people for helpful comments: Nils Björksten, Iris Claus, Bernard Hodgetts, Chris Hunt, Geof Mortlock, and Grant Spencer.

2 Lucas (1988, p 5).

3 The ranking for 1960 is based on nominal GDP per capita converted into United States dollars at the 1960 exchange rate from OECD (1998). The most recent OECD comparison of per capita GDPs uses 2002 data. The latter comparison uses purchasing power parity exchange rates, which try to account for price differentials between countries.

4 Barro and Sala-i-Martin (1999) and Aghion and Howitt (1999) provide good, albeit technical, discussions of this literature.

how monetary policy affects the economy, with particular emphasis on the key factors identified above. The article then discusses the empirical evidence regarding the drivers of growth, and explores how this empirical literature relates to monetary policy.

2 Growth accounting and growth theories

Measuring economic growth

Growth accounting frameworks have been used since the 1950s to decompose output growth into contributions from:

- growth in labour supply;
- growth in capital; and
- growth in total factor (multifactor) productivity.[5]

Output is typically measured using real gross domestic product (GDP) — ie the dollar value of what the economy produces over a given period, normally a year. Since this article looks at the effect of monetary policy (and other factors) on long-run economic growth, the emphasis is on the trend rate of growth through successive business cycles, rather than cyclical variations in economic growth.

Per capita income increases when output grows faster than the population.[6] Consequently, increases in per capita income are strongly dependent on the evolution of non-labour factors of production, ie, capital and total factor productivity (TFP), and on the contributions that these factors make to output. These contributions depend on the interplay between the factors of production.

The evolution of labour, technology and capital

The growth accounting framework is a useful organising device, but it does not explain how factors of production change over time. Growth theories are more explicit about how and why these factors evolve.

The neoclassical model, developed independently by Solow and Swan, has provided the starting point for analysis of economic growth since the 1950s. In the basic neoclassical model, output is assumed to be a function of capital and labour and technological progress. Markets are assumed to work effectively, so there is no misallocation or under-utilisation of existing resources; resources are always put to their best use. Technological progress and labour supply are both assumed to grow at arbitrary rates.

The main element that the neoclassical model describes is the accumulation of capital. The evolution of capital depends on how much people invest, which in turn depends on how much people save.[7] Higher savings necessarily reduce current consumption but, by increasing the capital stock, will lead to an increase in the level of income and may enable greater future consumption. The accumulation of capital thus crucially depends on decisions about consuming now versus consuming later.[8]

The structure of the neoclassical model is such that firms eventually do not wish to acquire any more capital because of diminishing marginal returns — the marginal contribution of a unit of capital declines because there is not enough labour available to complement an additional unit of capital. Eventually, therefore, firms stop accumulating capital and per capita output growth ends up depending solely on the accumulation of technological progress, which grows at some arbitrary, exogenous rate.

The neoclassical growth model provides some important insights, highlighting the role of capital, labour and technology in generating output. However, the model also

5 Total factor productivity (TFP) captures both technical efficiency (doing things well) and allocative efficiency (doing things that are valued). TFP also captures any mismeasurement of capital or labour.

6 Labour productivity (output per worker) and per capita income differ by the extent to which people are not in the workforce and by the number of hours worked.

7 The basic neoclassical model is a closed economy model, and hence ignores the possibility of mobilising savings from other countries.

8 This point is made more transparently in the Ramsey-Cass-Koopmans model than in the Solow-Swan model. See Romer (1996, ch 2).

has a number of deficiencies.[9] One of the most important deficiencies is that technological progress - the key driver of long-run growth in per capita income - is simply a black box. The endogenous growth literature seeks to remedy this deficiency by exploring how technological progress arises. The adjective 'endogenous' is used to indicate that the growth rate of technological progress is determined 'within' endogenous growth models, in contrast to the 'exogenous' rate assumed by the neoclassical model.

The evolution of knowledge and endogenous growth theories

The endogenous growth literature has three broad strands: one strand emphasises research and development (R&D) as a driver of knowledge; a second strand emphasises the role played by human capital; and a third strand, introduced by Schumpeter (1934), highlights 'creative destruction', the way in which new ideas (as embodied in new technologies or business practices, for example) may supplant existing ideas.

Although, on the face of it, the various neoclassical and endogenous theories are quite different, they also share an important commonality. Each strand of the endogenous growth literature is about the incentives to accumulate a factor of production: human capital, knowledge, and new Schumpeterian 'technologies'. Each of these factors can be thought of as additional non-labour factors that can be accumulated to improve per capita income.

To summarise, the neoclassical and endogenous models highlight six determinants of economic growth:

- the rate of capital accumulation;
- the amount of effort devoted to research and development (innovation);
- the rate of human capital accumulation;
- the transmission of knowledge;
- the creative destruction of 'technologies'; and
- the interplay between different factors of production.

The six determinants above can be thought of as the main determinants of growth, but there are also other important factors that affect these determinants. For example, the economics literature identifies political stability, size of government, financial development, macroeconomic instability, microeconomic distortions, corruption, geography, trade barriers, resource allocation, inflation, etc as important contributing factors. Broadly speaking, these additional factors can be thought of as affecting output growth through the six determinants described above.

The primary goal of this article is to explore how monetary policy may affect these six determinants. If monetary policy is to have a durable effect on output growth then it must have an ongoing effect on the growth of factors of production (capital, knowledge, human capital and so on). The monetary transmission mechanisms that are discussed next involve real interest rates and inflation.

3. Monetary policy: real interest rates and inflation

Real interest rates

Traditionally, central banks were assumed to affect the economy by controlling the supply of money.[10] By manipulating the money supply, the central bank was thought to be able to control a nominal interest rate. Today, rather than setting a given quantity of money, many central banks simply set an interest rate directly. In New Zealand, for example, the Reserve Bank sets the Official Cash Rate (OCR) as the mid-point of a corridor of interest rates at which it is prepared to borrow or lend to commercial banks with settlement accounts at the Reserve Bank.[11] The OCR is an overnight interest rate, and serves to anchor the short end

9 Amongst others, the assumption of perfect markets means that there is no unemployment in the model and there is no leisure, so issues regarding labour force participation are entirely ignored. Cohen and Harcourt (2003) discuss the 'Cambridge capital controversy' - a dispute about aggregating capital into a single good. A key issue here is whether it is difficult to scale up technology or to seamlessly substitute between different technologies. 'Half a machine', for example, will often be incapable of producing anything.

10 See the symposium on the monetary transmission mechanism published in the *Journal of Economic Perspectives* (1995).

11 White (2001) provides an in-depth discussion of how monetary authorities control an overnight interest rate.

of the interest rate yield curve. A central policy question is then how this overnight interest rate affects the rest of the economy, and how sustained such effects might be.

In setting a nominal interest rate, such as the OCR, the Reserve Bank is merely promising how much cash it will provide tomorrow for a given amount today, but there is no guarantee as to how much that future cash will be worth in terms of real goods and services, since prices may change. If inflation expectations increased in tandem with every increase in the nominal interest rate, then expected real interest rates would remain unchanged. In practice, inflation expectations exhibit stickiness, so changes in nominal rates will usually be accompanied by changes in expected real rates, at least in the short run.[12] In the longer run, inflation expectations adjust and real interest rates return to levels that equilibrate savings and investment plans.

Limits to monetary control

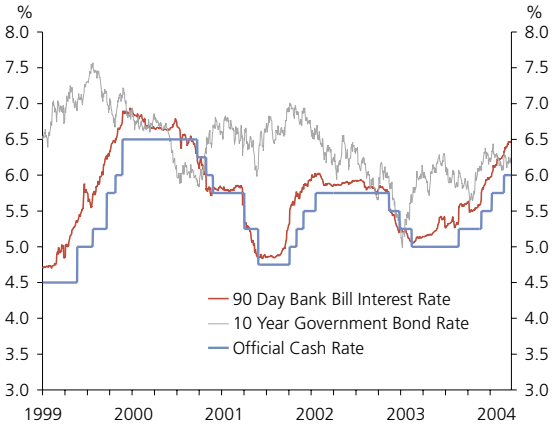
To a large extent, the most important interest rates for investors are the commercial interest rates that prevail over the lifetime of the capital goods the investors are interested in purchasing. If the Reserve Bank can only engineer temporary changes in real interest rates, then one might expect these temporary interest rate changes to have a comparatively muted effect on investment.

Although there is clearly a relationship between the OCR and the 90 day cash rate, the relationship with bond rates, whose maturities may extend out to a decade or more, is more tenuous (see figure 1). These longer term rates are heavily influenced by people's long term inflation expectations, long term exchange rate expectations, and by foreign long term interest rates. The connection with foreign interest rates arises because New Zealand is part of an integrated international financial system. Borrowing overseas and borrowing domestically are substitute sources of finance.

12 It should be noted that price stickiness in levels does not necessarily mean that inflation, the growth rate of the price level, will also be sticky (see Ball, 1994). To cope with this conundrum, Mankiw and Reis (2001) suggest that some people may be slow to incorporate macroeconomic information into their decision-making, creating some stickiness in inflation expectations and hence ensuring that monetary policy can have real effects.

Figure 1

New Zealand interest rates



Source: Reserve Bank of New Zealand

The real interest rate is typically thought to mediate between the world supply of saving and the world demand for funds for investment purposes.

Conventional economic theory suggests that monetary authorities have a limited ability to affect long-term real interests even in closed economies. The vast bulk of financial intermediation is performed by commercial banks and financial markets, and the rates at which these institutions are prepared to borrow and lend will depend on people's preference for saving versus consuming, and perceptions of risk and return regarding investment projects. A central bank cannot permanently dictate what real interest rates investors should be charged or what interest rate should be paid to lenders. Any attempt to do so would result in changes in consumption behaviour or would change savers' propensity to invest in assets denominated in New Zealand dollars. Such behavioural changes would affect the availability of funds for domestic investment, and any reduction in capital accumulation would affect New Zealand's per capita income.

Since New Zealand is an open economy with sizeable capital flows, it is possible for there to be a substantial mismatch between investment in New Zealand and domestic savings — New Zealand investors can make use of foreigners' savings. Thus, there is no longer the neat correspondence between saving (not consuming) and investment that one finds in a closed economy. Since New Zealanders collectively spend more than their income, they are net borrowers from

the international financial system, as represented by current account deficits. The fact that such international lending involves currency risk contributes to the domestic interest rates faced by New Zealand borrowers. If New Zealanders in aggregate saved as much as they wished to invest then this currency premium would not need to be paid.[13]

Real interest rates influence capital accumulation

Since capital accumulation is one of the traditional drivers determining growth, it is not surprising that many authors have investigated how changes in monetary policy affect the accumulation of capital. Firms' desired capital stock depends on expected real interest rates. In baseline models, a reduction in interest rates only has a temporary effect on capital accumulation, until the new desired capital stock has been achieved. However, financial imperfections[14] (which may constrain investors' ability to borrow) and other frictions may delay the adjustment towards the desired capital stock, so capital accumulation might occur for some substantial period of time.[15] Changing the level of interest rates may have a more permanent effect on capital accumulation depending on what happens to other factors of production, such as knowledge. Developments in knowledge, for example, may prevent the onset of diminishing marginal returns to capital.

Real interest rates influence the accumulation of other productive factors

As mentioned in the endogenous growth section, the accumulation of human capital and knowledge, and the development of new technologies, bear a marked similarity to the accumulation of capital. Since the accumulation of these factors will often be financed by borrowing up-front, a reduction in real interest rates should temporarily increase the accumulation of these capital-like factors. Since both knowledge and new technologies are thought to be very durable, an increase in their levels should lead to permanently higher levels of income. However, when interest rates return to higher levels, one would expect the growth rate of these factors to fall back to lower levels.[16]

The exchange rate and the transmission of knowledge

The dissemination of knowledge from the international economy to New Zealand is potentially an important driver of growth; trade and other forms of international engagement are likely to facilitate the dissemination of international knowledge. Since changes in real interest rates may affect the real exchange rate, which in turn affects trade, monetary policy may influence the transmission of international knowledge.

There are two caveats to this line of reasoning. First, the empirical importance of openness is subject to some dispute; see for example Rodrik et al. (2002). Second, other factors also affect the real exchange rate (commodity prices, people's risk assessments of NZ dollar assets, etc), and many of these factors are not shaped by monetary policy. Transitory disturbances to real interest rates explain only some of the variation in the level of the exchange rate. The effect of exchange rate volatility will be taken up at the end of section 3.

Long-run money growth drives trend inflation

If the supply of money increases in excess of people's desire to hold money, then people will spend the money to hold other goods instead. If the increase in demand for goods is large relative to firms' capacity to supply goods and services, then firms will be encouraged to increase their prices, resulting in inflation. In the long run, the trend growth rate of money is thought to be the principal driver of inflation. Because of this correspondence between money growth

13 The risks associated with a variable exchange rate can be 'sold' to a third party, but that party will usually charge a price to accept the risk, ultimately increasing the cost of borrowing.

14 See Claus and Smith (1999) for a discussion of the credit channel, which details some of these issues.

15 These other frictions include 'time-to-build' constraints: capital must be manufactured, which precludes instantaneous adjustment of the capital stock.

16 The new growth rate could potentially be higher if the new technological advances make a material contribution to the process of innovation.

and inflation, inflation is sometimes used as a direct proxy for the performance of monetary policy.

Inflation can reduce money balances, increasing capital accumulation

Higher inflation drives up nominal interest rates and causes people to economise on their holdings of money since money earns no direct return. (Money in this context means cheque account balances and currency, rather than savings deposits which earn interest.) Even if nominal interest rates increase one-for-one with inflation, so that real interest rates are unchanged, higher inflation may still affect the desired level of capital and other factors of production.

Money is one type of asset that people have in their asset portfolios. Other assets include property, savings deposits, shares, cars, and direct ownership of physical capital associated with businesses. Since higher inflation reduces the purchasing power of a given stock of money, higher inflation rates reduce the incentive to hold money. If people still wish to save the same amount, but do not wish to save by holding money (due to higher inflation), then they are likely to increase their holdings of other assets, such as capital. Thus, higher inflation may cause people to accumulate more capital in their savings portfolios, a so-called Tobin effect.[17]

However, since assets such as physical capital have higher returns than money, money is a comparatively small component of aggregate wealth. Consequently, the Tobin effect is likely to have a fairly small effect on capital accumulation. This conclusion is consistent with simulation results from theoretical models.[18]

Inflation can reduce money balances, reducing capital accumulation

One of the primary functions of money is to facilitate transactions. In some models, money (like capital and labour) is an additional factor that facilitates production.[19] By making it easier to purchase the nuts and bolts of business, money facilitates production. Money thus complements capital in production, and hence higher money balances increase the level of capital desired by firms.[20] Conversely, higher inflation reduces the incentive to hold real money balances and thus reduces the desired level of capital. This negative inflation effect is in sharp contrast to the Tobin effect.[21] Perhaps more compellingly, Feldstein (1997) argues that inflation can have a marked effect on capital accumulation because of the way in which inflation interacts with the tax system. His results indicate that keeping inflation at very low rates is highly desirable.

Higher inflation can reduce labour participation

Higher inflation only affects transactions mediated through markets, such as the consumption of goods and services. Since leisure in its basic form does not involve the use of money, higher inflation does not affect the cost of leisure. Consequently, higher inflation makes consumption more expensive relative to leisure, encouraging people to take more leisure. But in taking more leisure people inherently work less, thus reducing their labour force participation. The decline in labour force participation can be even more pronounced when inflation interacts with the tax system — for example higher incomes may bump people into higher income tax brackets, further reducing the incentive to work.[22]

Although changes in labour supply are likely to lead to changes in the level of income, they obviously cannot account for ongoing changes in the growth rate of income, since there are natural limits on how much (or how little) people can work. Similarly, many of the inflation effects on the capital stock relate to the level of capital stock that will ultimately be acquired by firms in the economy, rather than the growth rate. In the long run diminishing returns may mean that there are limits placed on the accumulation

17 Tobin (1965).
18 Walsh (1998, pp 75-80) discusses such simulations.
19 See Orphanides and Solow (1990) for a technical discussion of many of these models.
20 For a technical discussion, see Levhari and Patinkin (1968).
21 See Ho (1996) for an endogenous growth model with a Tobin effect.
22 See for example Gomme (1993). The welfare costs of lower work are partially offset because working less means that leisure increases which also contributes to welfare.

of capital (though 'long' may be quite some time). However, since new capital acquisitions may embody new technologies, the impact of diminishing returns from capital may be rather muted, since the new technologies may be improved substitutes for labour.

Inflation can divert effort away from factor accumulation

Haslag (1997) argues that higher inflation degrades welfare, irrespective of what it does to real variables such as output. One explanation for this decline in welfare is that inflation diverts effort to activities that would not otherwise be undertaken, such as transaction services and management to mitigate the effects of higher inflation.[23] Inflation may also distort portfolio allocations towards assets that are good hedges against inflation (say, land and houses for example) but that are not necessarily very productive.

The diversion effect of inflation affects capital accumulation, and is also likely to draw resources away from research and development and the acquisition of human capital, potentially reducing technological progress or total factor productivity. Efforts to innovate are likely to be one of the most durable sources of ongoing growth, and inflation may be particularly harmful if it reduces such effort. The endogenous growth literature emphasises that knowledge accumulation may not be susceptible to diminishing returns in the same way that physical capital is.

To sum up, a permanent increase in the growth rate of money (an increase in inflation) may affect desired capital stocks and labour participation. Inflation may also divert effort away from research and development and human capital accumulation, thus adversely affecting economic growth. Although some models suggest that inflation may have a positive effect on the desired level of capital, on balance the negative effects of higher inflation are probably more pronounced, hindering long-run economic growth.

23 See Bonato (1998) for a discussion of the costs of inflation in New Zealand.

Can transitory changes in policy have permanent effects?

The preceding subsections argued that a monetary authority could only have a transitory effect on real interest rates, and that a permanent change in inflation was most likely to have negative effects for output growth. This still leaves the possibility that a transitory change in real interest rates might have permanent effects on output or output growth.

The conventional view is that transitory changes to policy will have transitory effects on real output. Typically, expectations and prices are thought to adjust to new circumstances, and people will change their behaviour, causing the economy as a whole to return to its original state of balance. For example, a temporary monetary policy action might prompt greater investment in capital. If, however, this additional capital was less profitable than originally expected, then investors would either sell the capital or let it depreciate out of existence. Either way, the private sector's subsequent actions would unwind initial decisions, so that the initial monetary policy stimulus only had a temporary effect on output.

The endogenous growth literature opens up new possibilities. Transitory changes in policy might affect the accumulation of knowledge or 'technological progress'. Since knowledge and technological progress are thought to be highly durable, transitory policy disturbances might have near-permanent effects on the level of output.

How does such a possibility affect the implementation of monetary policy? William McChesney Martin, former chairman of the Federal Reserve Board in the United States, once noted that monetary policy is about 'taking the punch bowl away just as the party gets going'. The perspective provided by the endogenous growth literature does not really change this punch bowl problem. The positive effects of higher money growth or lower interest rates have to be weighed against the possibility that unacceptably high inflation outcomes might arise.

Experience from a number of countries demonstrates that high inflation occurs when excessively large volumes of cash are pushed into an economy. For example, following World War I Germany experienced a period of hyper-inflation — inflation rates of over 50 per cent per month — because the

government simply printed huge volumes of notes to meet its financial obligations.

Although hyper-inflation is an extreme example, the basic problem is just the same at lower rates of inflation: how much monetary stimulus is enough for the economy to work effectively, without drowning the economy in inflation? Taking the punch bowl away sufficiently early may be very important. If inflation gets unacceptably high, there may be substantial costs associated with returning to lower inflation levels, depending on people's expectations of this disinflation process, ie, the credibility of any announced policy change.

The impact of volatility on long-run economic growth

Long-run analyses of economic growth have typically assumed that the trend in output can be separated from the cycle around that trend. An alternative view is that the trend and cycle are intimately connected. If macroeconomic volatility is harmful to trend growth, and monetary policy can help to mitigate volatility, then there is yet another mechanism by which monetary policy will affect trend growth.

Theory provides competing mechanisms by which volatility may affect the trend. The Schumpeterian view suggests that the acquisition of human capital, or the reorganisation of business routines, will increase when output is low. For example, firms typically try to cut costs when times are bad by reorganising their activities. However, if learning is a by-product of doing then learning is likely to be procyclical: 'doing more' means learning more. Similarly, Fatás (2002) suggests that R&D is procyclical — firms invest more in R&D when the aggregate economy is growing strongly. If the effects of the upside and downside are asymmetrical, then having greater volatility may adversely affect the trend.

The effect of uncertainty on capital accumulation is theoretically ambiguous, since it depends on the properties of capital goods and on the costs of adjusting capital stocks. Increased uncertainty about returns means that delaying investment can be desirable (to avoid getting stuck with a capital stock that is too big), whereas other kinds of uncertainty can actually increase investment.[24] The empirical evidence regarding volatility also tends to be mixed — different data sets and techniques yield differing conclusions as to the relationship between output volatility and output growth.

As mentioned in the discussion of the monetary transmission mechanism, decisions about domestic interest rates can affect the exchange rate. Volatility in monetary policy may also have important effects on exchange rate volatility, and recent work suggests that exchange rate volatility may have non-trivial effects on welfare.[25] Consequently, reducing monetary policy volatility may benefit welfare by helping to reduce exchange rate volatility.[26]

Reductions in inflation volatility should also make it easier to make good decisions about investment, savings, and consumption. Empirically, inflation is also found to be more volatile at higher levels, so aiming for lower levels of inflation is likely to reduce inflation volatility.

Erratic and unpredictable interest rate movements may also make it difficult for individuals to assess relative price movements, which in turn may affect their willingness to invest in capital goods (since money is typically borrowed to purchase capital). Typically these effects are thought to be short-lived, but if there are connections between volatility and trend growth, then the effects may be more substantial.

The general policy sentiment is that the costs of macroeconomic volatility are likely to outweigh any benefits. Consequently, clause 4b of the Policy Targets Agreement, signed by the Governor of the Reserve Bank and the Minister of Finance, states that in implementing monetary policy the Reserve Bank should seek to avoid unnecessary volatility in output, interest rates, and the exchange rate. Hunt (2004) discusses the Reserve Bank's interpretation of clause 4b in more detail. As a whole, the inflation-targeting framework

24 See Romer (1996, ch. 8) for a discussion of some of these issues.

25 Obstfeld and Rogoff (2001).

26 Bachetta and van Wincoop (2000) argue that different exchange rate regimes may be optimal from a welfare perspective depending on people's preferences and the choice of monetary rule. Thus, bad outcomes from exchange rate volatility need not imply that a fixed exchange rate regime is optimal.

adopted by the Reserve Bank of New Zealand is intended to be both transparent and credible, to avoid erratic monetary policy behaviour that would exacerbate other, unavoidable economic uncertainties.

Section 3 began by discussing the effects of monetary policy on interest rates. It was argued that the Reserve Bank has a limited ability to affect long term real interest rates. Since changes in interest rates should affect the level of the desired capital stock, rather than the long-run growth rate, these temporary changes in interest rates may only have temporary effects on capital accumulation. Money models show that an increase in the inflation rate may have permanent effects on the level of output, though different models suggest that the real effects may be positive or negative. On the whole, the costs of higher inflation are thought to outweigh the benefits. Macroeconomic volatility may yield an additional channel by which monetary policy affects trend growth.

Since different theories provide competing and sometimes contradictory conclusions as to the outcomes of monetary policy, it seems appropriate to visit the data, to see what the real world has to say about the relationships between monetary policy and long-run output growth.

4 The empirical literature — cross-sectional evidence

The empirical growth literature has tried to identify variables that explain why there have been such large variations in different countries' growth outcomes. Different studies have investigated political factors, historical factors (such as colonial history), financial development, macroeconomic stability, culture, foreign aid, and so on. In response to this outpouring of research, a number of economists have become concerned about the robustness of the relationships that are 'found' in the data.

So what relationships appear robust in growth regressions? The short answer is 'it depends'. Different authors identify different variables as being robust determinants of growth.[27] Equipment investment and schooling are fairly common robust determinants, as are predominant religious affiliations and geographical locations. Monetary and financial variables often do not make the cut in robustness comparisons, though some authors have argued that adequately specified regressions require the standard deviation of inflation and the standard deviation of domestic credit as explanatory variables.

In the long run, inflation is typically understood to be a monetary phenomenon, and so inflation can be thought of as a proxy for the performance of monetary policy. Brook et al. (2002) provide a summary of the evidence from cross-country studies regarding the consequences of inflation for growth. Although not significant in all regressions, high rates of inflation generally appear to be harmful to growth and, at least for developed countries, the detrimental effects appear to occur at quite low rates of inflation (say 3 per cent).[28] The cross-country studies also generally imply that higher inflation volatility is harmful to growth. Since inflation volatility is positively correlated with the level of inflation, maintaining low and stable inflation appears to be an appropriate policy goal, supportive of long-run growth. The OECD (2003) suggests that lower inflation volatility primarily affects per capita output through allocative efficiency (allocating resources to their best use), whilst lower inflation rates foster capital accumulation.

5 What do New Zealand data say about monetary policy's effect on output?

One of the key difficulties associated with cross-country data is that individual countries are very unlike their peers in many different dimensions. An alternative approach to cross-country regressions is to consider how a single country responds to innovations in monetary policy variables, such as money or interest rates.

27 See Levine and Renelt (1992), Sala-i-Martin (1997), Ley and Steel (1999), Hoover and Perez (2004), and Kalaitzidakis et al. (2002) among others.

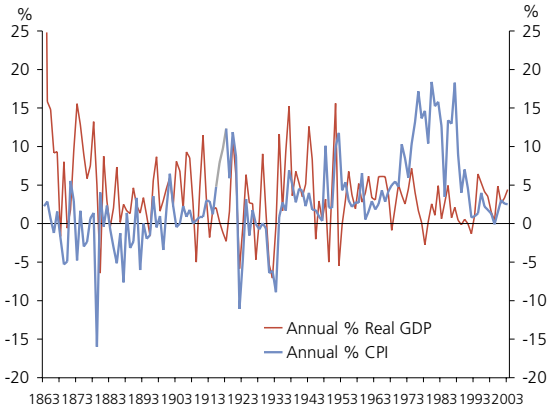
28 Somewhat higher inflation might be warranted for less developed countries (LDCs) since seigniorage — government income obtained from printing money — is an important source of revenue for LDCs with ineffective taxation systems.

To understand the long-run effects of monetary policy one needs to be able to trace out the effects over a long period of time — multiple decades, rather than simply one or two. Annual prices and real gross domestic product data are available for New Zealand going back to 1863. Figure 2 illustrates the annual growth rate of output and annual inflation.

There are four things that are notable from this figure. First, both GDP growth and inflation are volatile. Second, there are short periods where inflation and output move together, in the late 1920s and early 1930s for example. Third, although the volatility of output growth has changed in the last 40 years or so, relative to the pre-World War II experience, it is not obvious that the average growth rate has changed. Fourth, the 1970s and 1980s are notable for much higher rates of inflation.

If higher inflation was intrinsically beneficial, then one would expect output growth over the 1970s and 1980s to be higher on average. However, growth actually appears to be lower during this high inflation period.[29] Statistical tests indicate that the average GDP growth rate has remained constant over the entire period in figure 2, indicating that no change in monetary policy has permanently increased — or decreased — the average growth rate of output. Interestingly, the data in figure 2 also span a number of different monetary policy regimes, including both floating and fixed exchange rates, and yet the average level of real output growth appears stable. The stability in average growth rates suggests that changes in monetary policy regimes are not the most important drivers of output growth.

Figure 2
Annual real GDP and CPI growth rates



Source: Reserve Bank of New Zealand

In a study of 14 countries, Rapach (2003) suggests that a permanent increase in inflation would permanently increase the level of output (the level of output, not the growth rate). Rapach's results hinge crucially on whether inflation has permanently changed in these countries, a claim which is controversial. New Zealand's inflation rate does not appear to have experienced any permanent changes, so it is not possible to assess the impact such permanent changes would have.[30] From this perspective, the run up in inflation during the 1970s and 1980s was actually a temporary, though lengthy, phenomenon and New Zealand has now returned to the generally low inflation environment that prevailed through to the 1960s.

Rapach's analysis uses three variables (output, interest rates and prices), compared with the more usual approach that simply focuses on money and output. A general problem with these small systems of variables is that all of the developments in the economy are being attributed to just two or three variables. For example, in a two variable model of money and output, a non-monetary shock might be responsible for both a permanent effect on output and a permanent effect on money, but could be misidentified as a permanent shock to the money supply. One way around this problem is to generalise the model, to incorporate more variables into the analysis.

In a forthcoming Reserve Bank of New Zealand discussion paper Cîtu (2004) develops a small model with output, prices, interest rates, and the exchange rate as constituent variables. He estimates the model parameters using data from the late 1980s to 2002. Theoretically, one can use this model to assess how permanent changes in interest rates affect the other variables in the model. In practice, statistical tests suggest that there are no permanent shocks to interest rates,

29 There is an obvious caveat to this observation about the inflation-growth relationship: as we saw in the cross-sectional literature, the relationship between inflation and growth may be distorted by simultaneous developments in other variables.

30 Speculating what would happen when policy is changed may be problematic if one does not take into account how private sector expectations evolve: the 'Lucas critique'.

so it is not possible to assess how such permanent changes would affect output. As a whole, Cîtu's model suggests the parameters cannot be estimated precisely enough to provide a clear statement about whether monetary policy – in the form of inflation or interest rates – has permanent effects on real output. To make statements about the long run requires a long span of data.

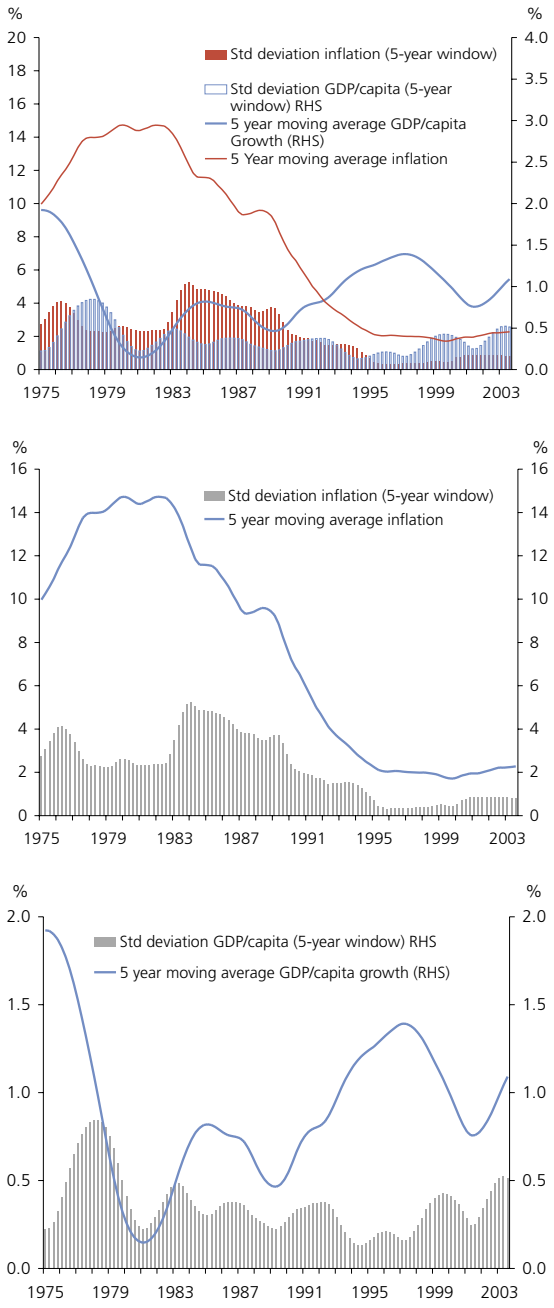
Figure 3 provides a more recent snapshot of New Zealand data, illustrating five-year moving averages of year-on-year inflation and growth in GDP per capita. The standard deviations are for year-on-year growth rates of output per capita and inflation, but are also calculated for five - year samples. Again, the usual caveats apply regarding the importance of additional factors that have not been depicted.

The bars in the chart represent volatility in inflation and output. Inflation volatility has dropped markedly since the 1980s, and has stabilised at low levels. Output volatility, with the exception of the very beginning of the sample, has remained fairly constant. Still, there is no obvious relationship between output volatility and the trend in per capita output growth.

In general, the macroeconomic out-turns over the last decade or so appear to be reasonably promising in comparison to all but the early 1970s. Nevertheless, if New Zealand's per capita income growth averages 2.5 per cent per year, it will still take 20 years to reach the per capita income levels of the United States, even if the United States stands still.

Figure 3

Per capita growth and inflation — levels and variability



Source: Reserve Bank of New Zealand

6 Conclusion

This *Bulletin* article began by outlining the causes of growth and theories of how those causes evolve. Section 3 described how monetary policy affects the real economy through real interest rates and inflation. Macroeconomic volatility, and policy efforts to stabilise volatility, may also have implications for growth.

The theoretical literature discussed in section 3 noted that monetary policy is constrained in its ability to institute permanent changes in real interest rates, particularly in the context of globally integrated financial markets. Transitory changes in interest rates are generally thought to have a transitory impact on factor accumulation (eg, capital investment), and hence should not permanently affect the growth rate of output. Although monetary policy only has a transitory effect on real interest rates, it can determine the average rate of inflation. Section 3 illustrated that permanent changes in inflation rates may have mixed effects on capital accumulation, at least theoretically, though on balance

higher inflation rates are thought to be negative for output growth.

The empirical cross-country literature looks at how growth outcomes are related to different determinants. Although there are questions about robustness, empirical cross-country analyses suggest that lower inflation variability and lower inflation levels enhance growth.

On the basis of the cross-country literature, the maintenance of price stability appears to be the main contribution that monetary policy can make to growth. This view is embodied in the Reserve Bank of New Zealand Act (1989), and in the Policy Targets Agreement signed by the Minister of Finance and the Governor of the Reserve Bank. As a subsidiary objective, the Reserve Bank also seeks to minimise volatility, though the exact connections to trend growth or welfare have not been demonstrated unequivocally.

Ultimately, though, the accumulation of capital and knowledge, alongside mechanisms that relocate resources to their best use, are likely to be the most important drivers of per capita income growth. Microeconomic policies that affect research and development, the acquisition of human capital, the transmission of information, and the incentive to participate in the labour force are likely to have more substantive effects on growth than monetary policy. The New Zealand Treasury, the Ministry of Economic Development and other branches of government have active research programmes that seek to analyse how such interventions might be made.[31]

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31 See http://www.treasury.govt.nz/release/economicgrowth/ for example.

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